Design Expo

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HYPER-S

Real Parkour

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Team Members

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Problem Statement

Nowadays, people are trapped in their smart phones, sliding their fingers all the time and forgetting to do physical exercises. For the sake of people's health, our team figures out a way to let ordinary people exercise while entertaining. Our equipment is more focused than the present products in market, and its low cost would allow ordinary people to afford having fun in such a healthy way.

Concept Generation

Infrared (IR) light sensors gives an effective and good performance in detecting the movement of people's feet. Flat motor coils are used to improve playing experience.

Design Description

The design is a stage. Player can stand on it and make movements to control the parkour game on the computer terminal (Fig.1).

Fig. 1 Prototype

Four Infrared (IR) light sensors and four flat motor coils are allocated at specified positions (Fig.2). When the player/exerciser stand on the stage, the light sensors can detect their position and send signal to the computer control terminal to control the parkour game. Meanwhile, once the light sensor detect the foot on it successfully, the flat motor coil will shake to show let the player know.

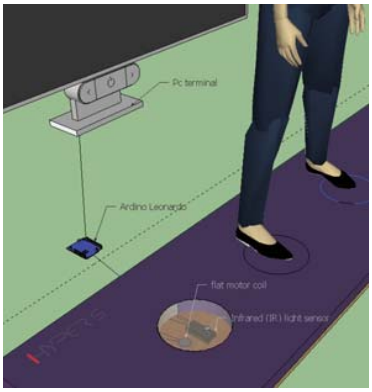

Fig. 2 Principle of prototype

Modeling and Analysis

For the basic structure, we find a wooden board for the stage and put a blanket on the board for better appearance and comfort. We dig four holes both on the board and blanket for the placement of sensors and motors.

Detecting the movement of players and sending corresponding signals to the computer are significant in this project.

We place four light sensors in the stage to detect movements of the player. We collect the figures measured by light sensors both when players stand above the sensor and when there is no block above the sensor. Based on the collected data, we program the Arduino Leonardo board to make it work as the keyboard of the computer and link it to the light sensors.

To give players a better experience of playing the game, we place motors beside light sensors and let them vibrate as long as certain movements are detected.

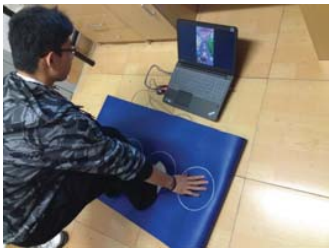

Fig. 3 Tester playing prototype

Validation

We conduct several experiments to test the functionality of the prototype. First, we test the sensitivity of sensors. We link the sensors to the Leonardo board and connect the board to the computer. Then we place the sensors into the wooden board and test how well the sensors can detect the movements of players.

Second, we test the vibration of motors. We connect the motors to the motor driving board and use Leonardo to control the driving board and let the motor vibrate. Then we test the intensity of vibration.

Finally, we test the fluency of the game. We assemble all the components and operate the game to test the fluency of the game.

Conclusion

Eventually, our prototype operates successfully. Our project is able to help people exercise physically more and provide an affordable, brand new Parkour experience for a wide range of Parkour lovers.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

3D Tetris in lightcube

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

MIRACLE

Team Members

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Problem Statement

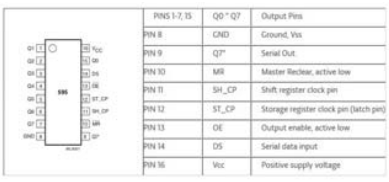
From the day the games based on electricity appeared, the form of the game has always stayed in the 2D stage. Although some games are quite interesting, the prim 2D form cannot give gamers a brand new experience. In order to break the limits of the games of 2D form and give all game lovers a more exciting experience, we decided to design a 3D game based on CUBE8.

Concept Generation

CUBE8, which is controlled by the Arduino board and has many LEDs, is equal to the pixel in the electrical screen so that we could use LEDs to illustrate the animation.

Design Description

There are many ways to control the LEDs to achieve the effect we want. After some investigations and considerations about the technique and the knowledge we have now, We finally decided to use the Arduino board to control our product since all of us have been familiar with it. We also use 8 HC595 chips to control the light emission of the LEDs. Each chip has 8 ports, and each port is able to output 1 signal at one time. And by using HC595 we could adjust the electric potential so that we could control so many LEDs at one time. By this way, we could say the Arduino is the brain of the project and the HC595 chips are the interlinkage between the controller and the effectors.



PINS 1-7, 15	Q0 ~ Q7	Output Pins
PIN 8	GND	Ground, Vss
PIN 9	Q7'	Serial Out
PIN 10	MR	Master Reclear, active low
PIN 11	SH_CP	Shift register clock pin
PIN 12	ST_CP	Storage register clock pin (latch pin)
PIN 13	OE	Output enable, active low
PIN 14	DS	Serial data input
PIN 16	Vcc	Positive supply voltage

Fig. 1 The schematic diagram for Hc595 chips

Since the LED has unilateral conductivity, we just need to switch the electric potential to switch the light emission. Because of the persistence of the vision, we can see the CUBE8 shine at the same time although the 8 layers are not flashing at the same time. Since we expect the light intensity to be the same among layers, the period for each layer to flash should be adjusted to an appropriate value.

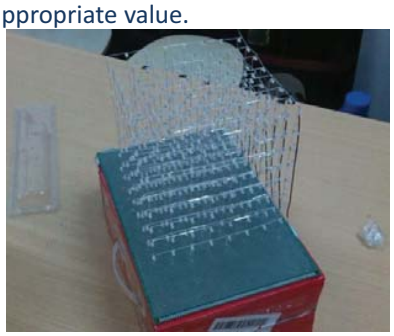


Fig. 2 The whole structure of the CUBE8

Modeling and Analysis

The largest goal we want to attain is the visual effect and the happiness to control the game. So if we desire to be able to make it into a game, we should use a tool serving as the input. And finally we decided to use the rocker module since it is pretty easy to perform in our project and at the same time it makes the product more like a game. We also consider what game we want to design. After a brainstorm among the members in our group, we ultimately decided to make a game based on the classical game “Tetris”. And it also serves as an expansion from the classical 2D game to a 3D one.

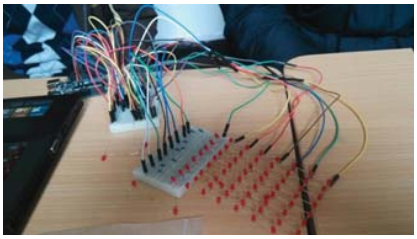


Fig.3 The prototype for testing the program

Validation

In order to find whether each LED is intact after the process of welding, we use multimeter to test the luminance of each LED. The luminance of each LED indicates the perfect condition of the elements. We also made a prototype before the final product was made to test the validation of the program. Also it was not easy to test the program, the final result showed the program perfectly fits in.

Conclusion

After some works to debug the program, the CUBE8 can finally illustrate the animation we previously set. It can also start a game controlled by a rocker module as desired. Besides the product we designed and manufactured, the process to work together not only gave a rise to the friendship among the members of our group, but we learned how to work together efficiently and how to get information and knowledge outside the class. The project 2 is definitely a valuable experience in our life.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Super Target

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Muxin Liang, Yufan Sun, Zhibo Cai, Jiexin Chen,Xingjian Liu

Problem Statement

In boxing training, people cannot measure the quality of their performance. Moreover, training is little fun. So in this project, a super target is constructed to help carry out boxing training in a more interesting and scientific way.

Concept Generation

When fist comes, laser sensors can detect it and control the motor, then the sandbag will move to escape from the hit. Accelerometer will measure the power of hit.

Design Description

The design can be divided into two parts, the target moving part and the power measuring part. In the first part, seven laser sensors are installed on the top of the frame. When a hit comes, the sensors will detect it, and then the Arduino controls the motors to rotate. The motor is connected to a designated sandbag by a leather belt thus it enable the sandbag to move along the sliding track. Then the target can move to escape from user's hit. In the second part, an accelerometer is installed behind the target. When the sandbag is hit, the accelerometer will measure the power and present it on an LCD screen.

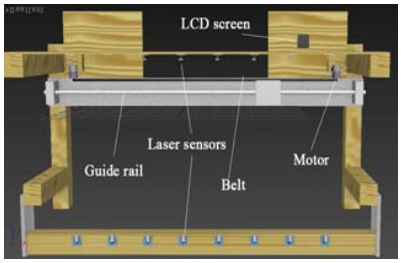


Fig.1 Our design in 3Dsmax(front)

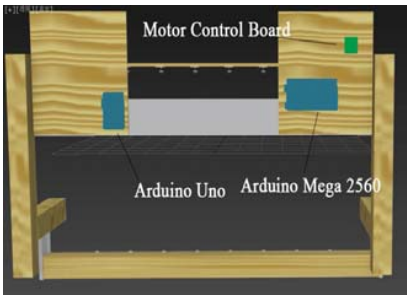


Fig.2 Our design in 3Dsmax(back**)**

Modeling and Analysis

The function of avoiding hits requires our target have a satisfying speed. Hence, we use two motors to drive the sliding block. We also extend the laser sensors to detect the fists, allowing the whole system to respond. Because our target will measure hitting power at the same time, the stability of the system is important. Hence, we reinforce the connection between parts and add weight to the target---sandbag to minimize impacts of the hits.

Our target also requires an attractive appearance. Hence, we paint on the structure to make the whole system look smart.

Taking the cost into account, we choose wood as our material instead of metal, we also choose small LCD screen to reduce the cost.

Validation

Our tests and improvements on the project are the following:

(1) We test the accelerometer and the LCD screen to guarantee the target can measure the hitting power.

(2)We test and adjust the laser-sensors to make the target move well on the guide rail.

(3)We test and improve the physical structure to make the system more stable.

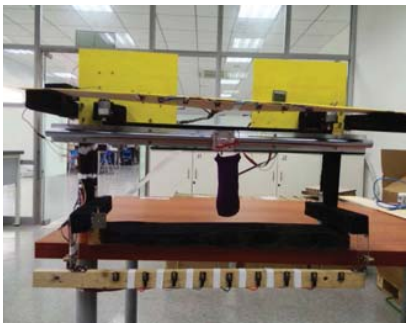


Fig.3 The final prototype

Conclusion

Eventually, our Super Target can move along the guide rail well, and it can also move when the laser sensors emit a signal. The accelerometer works well,too. It manage to measure the hitting power; and the LCD screen manages to show the power. Therefore, our project can be counted as successful.

However,the target's capacity of elude the hitting is not good enough because of the limited speed of the motors and the delay in the sensors. If more advanced equipment introduced, the project will perform better.

Acknowledgement

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Dr. Pamela Mansutti, Instructor of Technical Communication.

Unidrum

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

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Problem Statement

Nowadays, an increasing number of people are interested in playing the drum. However, a real set of drums may be too heavy to carry. In this project, students are required to design a special instrument serving as a portable drum. It enables people to practice the drum wherever they are.

Concept Generation

Piezoelectric sensors are used to receive signals, and the arduino board and MP3 module control the release of the music.

Design Description

The basic idea of our design is to develop a portable drum. It is also a new instrument for people to enjoy and create music.

We use acrylic board to be the drum head. Four sensors are placed under the drum head to test the location of the hit. There are four cushions under the sensors to protect the sensors. They can also enlarge the effect of the force on the drum. Finally, we settle a base board at the bottom to fix the drum.

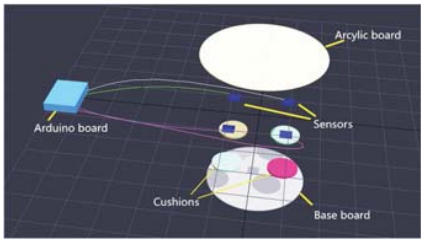

Fig. 1 3D plot of Unidrum

The drum head is divided into eight parts. Each part corresponds to a specific kind of timbre. Every time people hit the drum head, those four sensors will receive four different signals. By analyzing the transformation rate of signals and the difference between them, the arduino board can recongnize which part people hit.Then, the mp3 module will receive the order from the arduino board and play the relevant audio files. At the same time, the LED RGB matrix will display the corresponding pictures to give feedback to players.

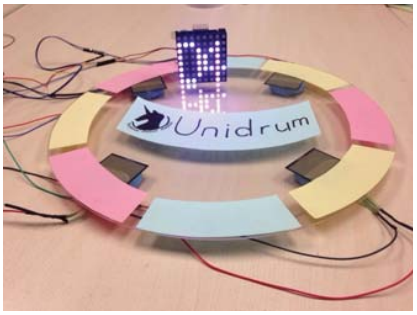

Fig. 2 The prototype of unidrum

Modeling and Analysis

To make our drum work more efficiently, we focus on the analysis of several parts.

Firstly, we tested many materials to find the best one to be the drum head. Among them, we chose the acrylic board. The acrylic board has the feature of lightness, hardness and flexibility. It enables the drum head to have less effect on the judgement of the sensors.

Secondly, we tested numerous kinds of sensors to find the most suitable one for our project. We examined the sensitivity and the range of the force that the sensor can receive. We finally decided to use the piezoelectric sensors.

Thirdly, we tested the scope of the eight parts. According to our experiment, the edge of the drum head performs best. So we decided to limit the hit area to the edge of the acrylic board.

Validation

After finishing our prototype, we did different tests to make sure that it can work well. We tested the accuracy and the possibility of the drum.

We analyzed the result and made a chart. From the chart below, we can see that the drum performs well in most cases. However, some parts like part four may have some mistakes when operating.

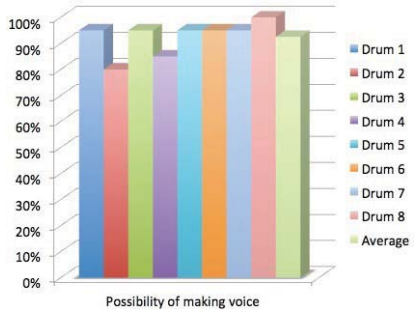

Fig. 3 Column chart of the possibility test

Conclusion

Our team completed the project successfully. By hitting the drum head, we can easily gain the experience of playing the drum. Moreover, by changing the audio files in arduino board, we can have different sounds of different instruments. In other words, the unidrum can serve as a new instrument. The most remarkable advantage of the drum is its protability. Besides, the prototype would be more attractive if the mp3 module performs better.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

A display of IoT with Bluetooth and window

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

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Problem Statement

Have you ever been in a situation where you went out for shopping while accidently leaving the windows opens. Half way through your trip, you realized that it is starting to rain very heavily and when you rush back to close the window, you found out that it is too late already and everything is soaked. Or have you been in a scenario where you slept soundly, and suddenly heard some noise as if the thief was trying to break in from the window, which made you feel very scared. Not being able to remotely control your equipment at home, or not having furniture that are intelligent enough to assist it's owner is really a big problem in the 21st century where everything is moving in such a fast pace.

Concept Generation

For the budget limit, the design of this project is simply based on analyzing of the data obtained from numerous sensors and executing relative actions of the functions of the window and also the action of the other appliances via Bluetooth, which is like a simplified IoT.

Design Description

A high torque Servo with a slide way is connected to the frame and a slide bar is connected to the window

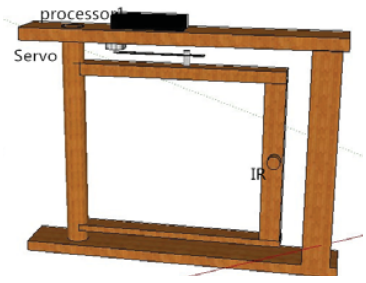

Fig.1 Structure of Smart Window

so that the window can rotate corresponding to servo when the controller of the smart window sends opening or closing sign to the servo. It happens the sensors are being triggered by variables such as temperature, humidity, or whether it is raining or not.

When the sensors get certain data, they can lead the controller to send various kinds of information to the central controller through the Bluetooth module and the central controller will open, close or modify the status of the other electrical appliances. We have included a small fan (representing the air conditioner), a humidifier, a night-light and buzzer (representing the alarm) in the prototype.

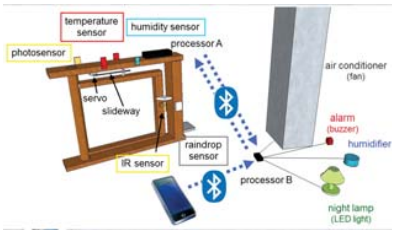

Fig.2 Concept Diagram

Modeling and Analysis

Deciding and building the structure of the window was quite difficult. We decided to choose a rotating window because it symbolizes the most basic furniture we have at home. We came up with many ideas in how to rotate the window, but most of these plans involve the problem of building the gear track, which is hard to tackle. So we settled on the sliding structure.

We would like to establish an IoT model with window. However, due to the complexity and the lack of expenditure, we decided to build a smart window.

The control of other electrical appliances by the central controller is established by altering output voltage We use motor driving board to control the voltage.

After the main program for window controller and central controller are finished, we may test if both the programs are valid by reading or writing data that processed by the controllers through computer.

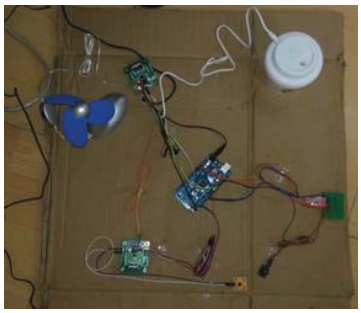

Fig.3 A bird-view of the slave board and appliances

Validation

To ensure that the window and other electrical equipment work normally, we must do experiments on different window forcing structures.

We will also do researches on the light, raindrops, humidity, temperature sensors respectively.

Conclusion

Our Smart Window can open when it is rain or when it is dark outside. It can also turn on the night light when it becomes dark. we can control the system with our smart phones through Bluetooth as well. This project is just a brief demonstration of the concept of IoT. It will apply more appliances and sensors when be used in daily life.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Glove Keyboard

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Xi Chen, Yu Feng, Tianmu Lan, Dazhi Wang, Ruchen Zhen

Problem Statement

Nowadays, the size and the weight of the laptops always depend on the keyboard, which usually makes contribution to the inconvenience of carrying the laptops. And it is difficult for us to type on the keyboard and to use mouse when we lie on the bed, sit on the ground or sit in bumpy cars.

Concept Generation

By transforming the bending of fingers into resistance change, we can distinguish the key which user is pressing, which enables the glove we made to replace the traditional keyboard.

Design Description

After analyzing and discussing, we decided to use strings, rotary rheostats, buttons, Arduino board，infrared sensors, photosensor and related subassembly to achieve our goal.

First, we sewed the strings on each finger tip of the glove and linked each string to the corresponding rotary rheostats and we also linked a elastic string to each rotary rheostat. This part can transform the bending of the finger into resistance change to distinguish the row which user is typing. And the elastic string will make the rotary rheostat get back to initial status after the finger of the user get back to nature position.

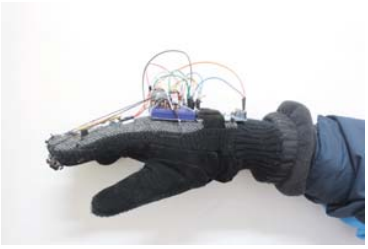

Fig.1 The side view of glove keyboard

After that, we sewed the buttons on each finger tips. Because when we typing, each finger except the index finger can just correspond to one column, we just need to know which finger is applying force and we can know which column the user is typing. Since we tend to use index finger control two columns in our daily typing, we used the infrared sensors to distinguish which column the user is typing.(Fig.2)

Moreover, we also placed a photosensor in the palm, which can give the signal to the Arduino board about which direction the hand is moving.

The final step is linking the buttons, IR sensor, photosensor and the rheostats to the Arduino board, which is placed on the back of each hand. Then, by linking it to the computer, we can type anything we like now and we can also use the glove as a mouse.

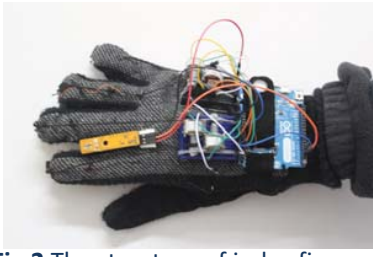

Fig.2 The structure of index finger

Modeling and Analysis

We took accuracy as our most critical principle. In other words, we must ensure the key which user is typing will not be mistakenly recognized to be another one. So, we typed each key in progress to make sure that each key can be distinguished.

Besides, we typed a short essay without backspace to ensure that the parameters we set before accord with the typing habit of the user. We also asked ten classmates to have a try. After each try, we would ask his or her feeling, which can help us adjust the places of components.

Validation

Because of the size of the glove, our prototype has strict restriction on the size of user's hands. Expect for this drawback, the glove keyboard worked quite well. After we adjusting the factors few times, the average accuracy of glove keyboard is over 80% now, and it could be improved in the future. (Fig.3)

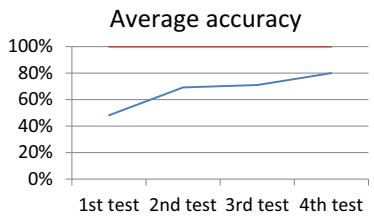

Fig.3 Average accuracy

Conclusion

Our design successfully achieves the goal we set before. It can type out whatever we want in some uneven places. It also has reliable accuracy , which means it can be used as a tool instead of a toy.

In addition to that, we also gain a lot of knowledge, corporation experience and happiness. This is the priceless treasure we got in this project.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Laser Marker

THE FUTURE GADGET LABORATORY

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

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Problem Statement

DIYers, people who love to make creative designs themselves, may find it difficult to draw the pictures they want on an item with hard surface, like mobile phone sets and wooden bookmarks. A picture drawn by hand may not last long, especially on slippery surface. Also, the accuracy of the hand-drawing is poor, making the picture far from satisfactory.

To solve this problem, our team designed a laser marker to mark pictures with accuracy on hard or slippery surfaces.

Concept Generation

Two stepper motors control the motions of the laser emitter in order to mark the picture we desire on the material.

When applying the scanning function, an IR sensor sends the signal of pictures to controlling board, and the controlling board controls the on and off of the laser emitter to print the picture scanned.

Design Description

Two stepper motors are served as X-axis and Y-axis to control the position of the laser emitter, and they are fixed on a shelf vertically.

1. Direct printing function

Using the extension of Inkscape to transform a vectorgraph (bitmap can be transformed into vectorgraph by Inkscape) into g-code which the stepper motor controlling board can run according to. Then the Arduino board receives the g-codes sent by the computer and control the motions of the two stepper motors. The laser emitter is always on during the carving process, which will not affect the outcome.

2. Copying function

The laser emitter moves in a determined track and the on and off of the laser emitter is controlled by the IR sensor attached on the laser emitter. When the IR sensor detects black color, the laser emitter will be turned on so that we will get a picture which is similar to the picture we scans.

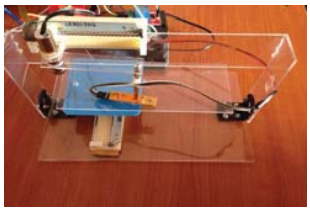


Fig.1 Prototype

Modeling and Analysis

We mainly analyzed the three aspects of our prototype.

1. Stability

We design three tests for the direct printing function, one for printing a circle, one for printing a pentagram, one for printing a complicated picture. Each test has been performed twice. Also, we designed two tests for the scanning and printing function, one for controlling the laser, the other for printing a logo. These tests are performed to measure the stability of the prototype

2. Accuracy

The marked picture should has good accuracy. The error marking range is acceptable within 0.5 millimeter. Accuracy is directly linked to the visual effect of the marked picture.

3. Speed

Higher speed guarantees better user satisfaction. We expected the speed of working to be 1mm/s.

Validation

The system works with great stability especially when the picture is not complicated. Only the test of printing a complicated picture (a face of Yao Min) fails once.

In accuracy test, the direct printing function has the error range within 0.1mm, while the copying part has error within 1mm. The former part shows great accuracy, but the latter part is not enough in this part. The overall visual effect of the work are fine.

Fig.2 Accuracy test result

Marking speed is a little bit slow. Direct printing circles and pentagrams takes about 4 minutes. The speed is about 0.4mm/s, which is lower than the expected value.

Conclusion

Our design can accomplish the task to mark the picture we want on the material we want successfully. The whole system works with good stability and accuracy is fine. The unsatisfactory part is the working speed. Now we can design pictures on certain material without the trouble of making poor hand drawing and exhausting revising.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Army Chess Judge

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Yuxuan Guo, Xinyi Wu, Hongxi Zhang, Zhengyu Shi, Hanyang Liu

Problem Statement

Traditionally, players of Army Chess have to find a judge for them due to the rule that players can not see each other's chess. The judge needs to find out whose chess is superior than the other. While sometimes it is difficult to find a judge. And for those beginners, it is hard to figure out the order of the chess. Furthermore, the judge can not enjoy the game but just doing the boring work.

Therefore, our group decide to make the Auto-judging Army Chess Box. This product is an equipment used to judge the order of the chess. Moreover, it can guarantee the chess will not be seen by the other player. In this way, players do not need to find a judge; what they only need is this special box that can solve all the problems and everyone can enjoy the game.

Concept Generation

RFID(Radio Frequency Identification) readers can control servos based on the information stored in the passive tags.

Design Description

After several meetings and consulting TA, we decided to use RFID technology in our project. Every chess contains a RFID passive tag inside it. When two chess meet together, the players put the chess on the RFID reader. The reader reads the tag and sends the information to the Arduino board. Then, the Arduino board judges which chess survives. Next, the Arduino board sends an instruction to the servo on the losing side. The servo sweeps the losing chess to a container.

Fig. 1: Electronic part

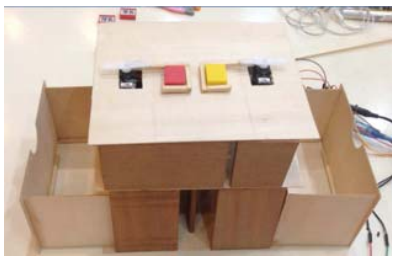


Fig 2: Structure of prototype

Modeling and Analysis

It is important for us to judge the type of the chess and the order of it, and we need to control the angle and the time to operate the servo precisely.

At first, we program the Arduino and connect the RFID readers to it, and this forms a testing prototype. We put different types of chess with tags on the RFID reader to imitate the working conditions. After that, we attach the servo to the Arduino, and then try different length of brush to find out the best one.

To make a both strong and light box, we test several materials and finally choose wood. The structure of the box also be tested many times until it is strong enough to hold all the equipment inside it.

Validation

We have done several tests to guarantee the prototype can work successfully. First of all, we make sure that every chess can be read easily. Next, we test whether the comparison of the chess can be worked out and if the servo turns to a certain angle then sweeps the losing chess into the drawer.

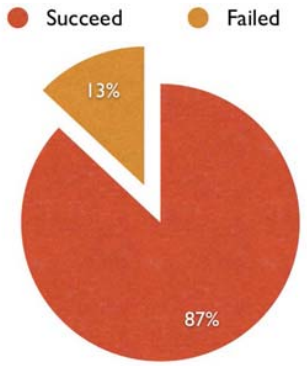


Fig. 3: Servo sweeps chess away

Conclusion

Finally, our product is qualified to be a judge of Army Chess and automatically take away the losing chess. Furthermore, we all gain a lot from the project. We apply the knowledge and skills learned from the lecture, and try to work professionally.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Cake Allocator

Instructors: Prof. Peisen Huang, Prof. Pamela Mansutti

Team Members

Shengjie Pan, Meng Qu, Yipeng Mou, Yue Wang, Zhihong Luo

Problem Statement

Our team is going to build a cake allocator—a cake cutting machine--to automatically divide a cake into equal, neat slices. The allocator can free users from cutting cakes with a knife and provide them with more time to enjoy the cake.

Concept Generation

A servo, a step motor, and a Bluetooth board are three main components to carry out the functions.

Design Description

We decided to use a servo to rotate a cake plate and a step motor to move the cutter on the slip way. Within a polar coordinate, any point on the cake can be reached by combining the linear and circular motion.

Moreover, we achieved the remote control by using a Bluetooth board and programming on the Android system. Then, users can simply input commands on the smart phone. The signals will be transferred to the machine via Bluetooth connection.

There are three functions of our project. The first is to cut the cake into equal pieces. The number of slices are limited between 2 and 15.

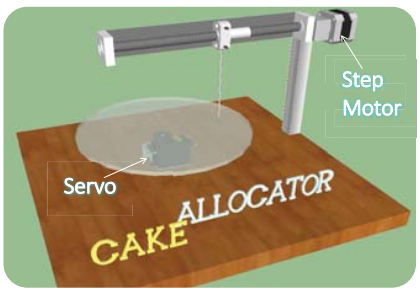


Fig. 1 3D model of the cake allocator

The second is to cut out special shapes, such as a heart. The last one is to manually control the machine by using the gravity sensors in the smart phone, so the size of each slice can be decided by users.

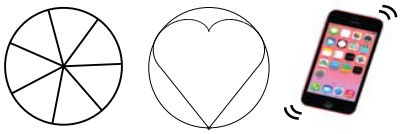


Fig. 2 Three functions

Modeling and Analysis

To cut the cake into same slices, we have to let servo turn a certain degree every time. However, the servo can only be controlled to turn at a certain speed, so we did come tests to calculate the speed of the servo and let it turn for a certain period of time. Then the step motor drives the cutter to move between the edge and centre of the cake plate.

As for the special shapes, we drawn some graphs and fit relative functions. Then we use these functions to control the speed of the servo and the step motor. To realize the gravity control, we programmed on the Android system, read the value of gravity sensors in the smart phone, and sent the results into the cake allocator.

Validation

After the construction and programming of our first prototype, we did several tests to evaluate the overall appearance of the cake allocator. First, we tested if the slices are in the same size. We measured the central angle of the slices and compared it with the desirable angle. We repeated the test to two different situations. According to the measurement, we found that our project was accurate and precise. Another test measured the time consumed in the cutting process. And the result turned out that we should improve the speed of cutting.

No. of slices	Desire (degree)	Measurement (degree)			
4	90	88	88	87	89

Tab. 1 Test of even distribution

No. of slices	3	4	5	6	8
Total time(s)	58	61	80	83	108

Tab. 2 Test of time consumption

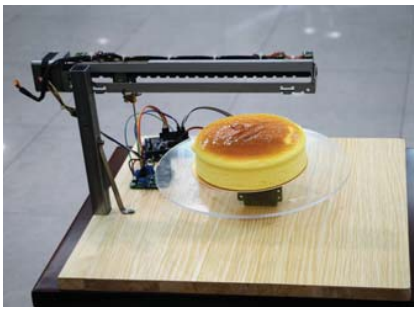


Fig. 3 Prototype of the cake allocator

Conclusion

Eventually, we accomplished our task to construct a household cake allocator, which can automatically divide the cake into equal pieces. The advantage of our cake allocator is that it is time-saving and user-friendly. What's more, it attains a smaller size and a lower cost than the product in the market.

Acknowledgement

Dr. Peisen Huang, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Smart Carrier

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Wenxiao Jiang, Jiangrui Liang, Yuxin Liu, Tianxing Ma, Jiawei Zhang

Problem Statement

Situation A: It is a mess to carry several suitcases yourself at the airport or railway station.
Situation B: A golfer may not be able to afford a caddie or a caddie may just violate one's private space.
Situation C: A librarian may find it a mess to do arranging job with a heavy handcart.
If there exists a carrier that can follow the user automatically, it will help a lot. Our group is motivated to design such a smart carrier.
We find a paper "Electronic Luggage Follower" online, which is wrote by Cesar Nunez, Alberto Garcia and et al. In the paper, they propses a method to follow the user. We develop it and make the function of following more perfect. But we do not have a bumping-avoid function because of the lack of fund and time.

Concept Generation

Three ultrasonic sensors and two Xbees are used to locate the position of the user and control the servo and the motors.

Design Description

Two ultrasonic sensors and a Xbee is installed on the carrier, one ultrasonic sensor and another Xbee is installed on a terminal on the user's body. The layout scheme is showed in Figure 1.

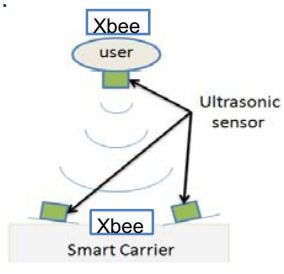


Fig. 1 Layout scheme

If we just let the two ultrasonic sensors on the carrier work, we can get three distance values d1, d2, and d3, then we can evaluate the distance value s between the user and the carrier by using Heron's formula, as it shows in Figure 2.

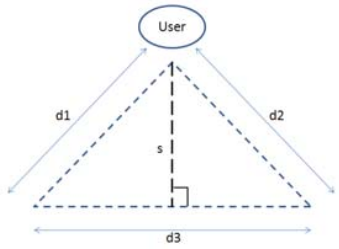


Fig. 2 Triangle sketch

The motor's rotation speed is decided by the value of s, the turning angle of the carrier is decided by the difference between d1 and d2. So that the carrier can follow the user automatically.
By using Xbees, we are able to transmit statistics between the Arduino board on the carrier and the board in the terminal on the user's body. So that we can always find the real user who sends the true source of ultrasonic waves, and thus we can avoid following a stranger passed by across the carrier and the user.

Modeling and Analysis

A. Since the smart carrier is designed to follow the user automatically, security factor should be tested. We set several grades of rotation speed of motors to control the distance between the user and the carrier. We set a minimum dangerous distance and the carrier will be forced to stop if the distance between carrier and the user is less than that value. We should check whether the carrier can follow the user when he speeds up or slows down.

B. Since the smart carrier may be used in golf court, its ability of climbing hills and the stability should be tested. We put the carrier on different slope and put the terminal in horizontal way. Then we test whether the carrier can follow the user in such situations and find out the maximum slope on which it can work properly.

Validation

Slope (degree)	5	10	15
Normal	yes	yes	no

Fig. 3 Slope Test

Velocity (m/s)	0.3	0.5	1.0
Normal	yes	yes	no

Fig. 4 Velocity Test

From Figure.3 we know that our carrier can well follow the user if the slope degree is less then 15. From Figure.4 we know that our carrier can only follow the low speed user.

Conclusion

The smart carrier is built up finally. It can follow the user with a stable speed of 0.3m/s. It fails to follow the user if he speeds up to more than 1m/s in a sudden. It can follow the user when the slope angle of the hill is less than 15° , but it fails in situations with bigger angles. It will not be misdirected by strangers passed by, but it sometimes fails to continue following the user when straners pass. In conclusion, the smart carrier is a success, we make some developments on old system made by Cesar Nunez and et al.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

The EyeGuard System

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Ardo Williams Hintoso, Chenyan Chi, Rui Chen, Guoyi Lou, Xiaodong Yu, Weiyu Zhu

Problem Statement

The population of people wearing spectacles has been growing rapidly. This could be accounted into bad working conditions such as reading too closely, reading in a really dark environment, which are often ignored. While the omnipresent phenomenon might seem trivial, eyesight problems actually affect people for the rest of their lives.

Concept Generation

Two distance sensors and a light intensity sensor are used to judge whether the working situations are appropriate. Two tiny flashlights, a vibrating motor are used to remind the user of the wrong working conditions.

Design Description

Our solution is simple: a revolutionary spectacle that can give users prompts when conditions are inappropriate for working.

First, we add two distance sensors on the frame; they can measure the distance from other objects or merely between the two sensors. If they are too close to the desk or each other, a vibrator fixed on the glass will vibrate to remind the user to adjust his or her working posture.

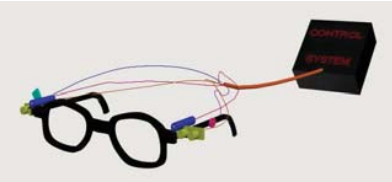


Fig. 1 3Ds Max plot of the EyeGuard spectacles

Furthermore, we have a light sensor to output figures of illumination intensity. It will be behind one distance sensor, also on the frame. If the surrounding is too dark, two small bulbs installed behind the distance sensors will shine to improve the illumination condition as well as warn the wearer of it.

All the components above will be controlled by a relay and electricity required comes from a couple of small batteries.

Fig. 2 Finished Prototype

Modeling and Analysis

Four main criteria are set for our project.

Comfort: It has to be comfortable to a certain extent because it is a wearable technology. As long as it doesn't cause pain, it will do the job.

Weight: The spectacles shouldn't be too heavy because after long period of working, it may cause discomfort to the users.

Stable: The system should work perfectly even it has been used for a long period of time. Moreover, the electronic structure should be as simple as possible to decrease malfunction as well as to increase stability.

Safe: The electrical parts should have no contact with the users so as no possible injuries happen.

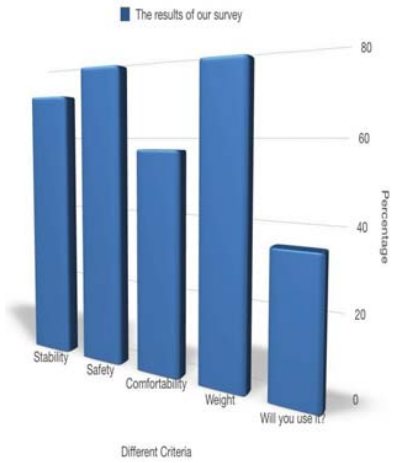


Fig. 3 Bar Chart of the survey result

Validation

We've conducted a survey to see if th e prototype meets our expectations. I n this survey, 27 students who live in X33 F1 & F2 give their opinions on if o ur prototype is safe, comfortable, ligh t, works stable.

Conclusion

By combining mechatronic systems with behavioral psychology practices such as negative reinforcement, the EyeGuard spectacles does tackle the problem and targets a need. Our design sufficiently satisfies the criteria we set, but it does have room for improvement; we plan to add additional functions in the near future.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Automatic tennis ball collector

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Xiang Li, Xuyang Tao, Yukai Lin, Hongzhao Liu, Wenyang Zhu

Problem Statement

It is quite annoying to pick up all the balls in a tennis court after a really tiring match.Therefore, we are going to design such a mechtronic system that can pick up all the tennis balls automatically according to their positions after the game.

This mechtronic system is able to detect the position of the tennis ball accurately, and by using the mechanical arm, it can pick up the ball tightly and put it into its basket effectively.

Concept Generation

The photo sensors can detect the position of the tennis ball. By giving signals to the Arduino, it can drive the mechanical arm to catch the tennis ball, and it will put the ball into the basket on the second layer. Then the robotic car will turn around the court and keep searching for the remaining balls until it picks up all the tennis balls.

Design Description

There are two layers of our prototype.

On the lower layer, there are Arduino Uno, a driver board, the battery box, and the mechanical arm (Fig.1) which are connected by two servos. In the front of the prototype, we settle the infrared sensors (Fig.2) which are the advices for detecting the position of the ball. When the sensors detect the ball, it will transit signals to the Arduino, and Arduino will control the mechanical arm to pick up the ball.

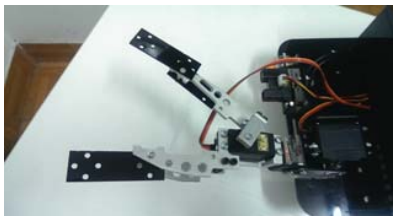


Fig.1 Mechanical Arm

Fig.2 Infrared Sensor

On the upper layer, the main body is a basket which is used to load the tennis balls.

Modeling and Analysis

Defining the positions of the balls and getting the balls into the container of the robot are the key processes in this project. Thus, we mainly focused on the following two aspects in our tests on our prototype:

a) Accuracy: We require high accuracy in defining the positions of the balls, so we need to observe the angle and distance the car should turn and move according to the feedback of the infrared sensor. Thus, we have done several tests on the accuracy and improve our original Arduino program.

b) Stability: We require high stability of the mechanical hand. Accordingly, we’ ve done some tests on the mechanical hand and decided the best position it should be at to catch the ball and the best height it should be at to release the ball.

In this way, we greatly improved the chance of getting the ball into the container successfully. Fig.3 shows the process of using the mechanical hand to catch the ball up.

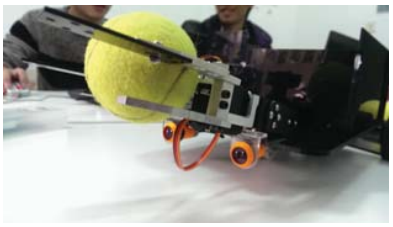


Fig.3 Use the mechanical hand to catch the ball

Validation

At last, we did 20 experiments on accuracy and 16 experiments on stability. We improved the two properties greatly, making sure the robot can find out the positions of all the balls on the court and the mechanical hand can catch up the balls successfully. In a word, we greatly improve the properties of both the accuracy and the stability.

Conclusion

Finally, our robot can efficiently collect all the balls in a defined region practically without mistakes. Through the process, we learned the importance of perseverance and thinking critically about a design. Thus, we believe this design will be very useful to help people have more fun in a tennis ball match if put into use one day in the future.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Automatically Elastic Clothes Collector

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Jiahao Gong, Shuoren Fu, Tian Zhou, Jiaqi Huang, Shijia Yang

Problem Statement

Everyone who hangs clothes out always faces the problem that their clothes cannot be drawn back in time and get wet because of the sudden rain.

In this project, students are required to design and construct an automatically elastic clothes collector to collect clothes automatically in rainy days to prevent them from being soaked when people are not able to collect the clothes in time.

Concept Generation

The main components of the automatically elastic clothes collector include two linear actuators which can stretch out and draw back, two power units, one transverse bar, two light sensors, one rain-drop sensor, one timer, one awning and some fixing devices.

Design Description

A light sensor and a rain drop sensor are set on the top of the automatically stretch clothes collector(Fig.1).

When it starts to rain, the rain drop sensor is triggered and sends a signal to the arduino board then the DC motor begins to work to rotate the powerful strings twined on it(Fig.1). Then the stick is drawn back so that the clothes on it will not get wet.

When it stops raining and there is enough sunshine to dry the rain-drop sensor, then the two sensors work together to send the signal which makes the motor pull the stick outward again so that the clothes can get the sunshine again.

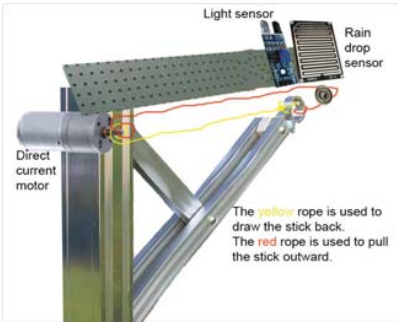


Fig. 1 Concept diagram

Modeling and Analysis

After analysis, we find that four aspects of our prototype need to be tested. The stability of the stand and the intensity of the strings should be assured because the breakdown of a simple component can also make the whole system not able to use. The strings we use are knitted tightly by three stripes of fishing lines, and our stand is made of alloy(Fig.2).

The purpose of designing this product is to stop the clothes that hung outside from being soaked, so our linear actuators must operate quickly to shorten the time during which the clothes are exposed to water.
Thus ,we make the DC motor rotate in high speed so that the stick can be drawn back in time.

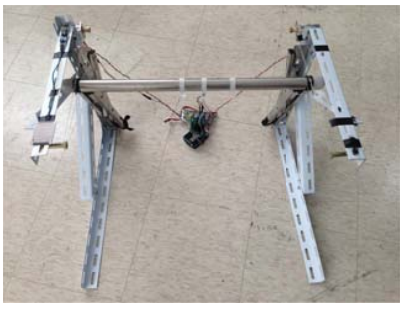


Fig. 2 The prototype

Also, the sensitivity of all the sensors must be high so that they can trigger the actuator within a short time. Thus we test all sensors' response time that we write the proper program to make full use of these sensors and make it response in time.

Validation

Firstly, we tested about the elasticity of our automatically elastic clothes collector. We must make sure that the linear actuators can react immediately when the humidity sensor detect that it is raining. We have recorded the time of the whole process.

Secondly, we tested about the sensitivity of the sensors, we used a pressure spray bottle and took down the reaction time of the collector when we press different times.

Conclusion

Finally, we completed our automatically elastic clothes collector after the hard-working of our five group members. It is able to take charge of the clothes on it automatically when people are not at home. Thus, it is a useful machine which can make our daily life better.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Electronic Blackboard Cleaner and Writer

MAX WELL

Instructors: Prof. Peisen Huang, Prof. Pamela Mansutti

Team Members

Yizhou Wei, Weitao Sun, Yun Peng, Xiao'er Hu, Qing Liu

Problem Statement

A: Elementary school students are always short, so it is hard for them to reach the top of the blackboard with traditional erasers.
B: Cleaning the blackboard stops teachers' teaching process, making the class discontinuous.
C: Some vague pictures sketched on the blackboard may confuse students.

Therefore, in this project, we are motivated to design an electronic cleaner & writer that can both erase the blackboard automatically and sketch basic graphs. Our group aim at simplifying the blackboard cleaning process to save time and strength, and making sketching more convenient and accurate.

Concept Generation

High torque motors, liner sliders and ultrasonic ranging sensor are chosen to solve the problem.

Design Description

After discussions, we decided to use the high torque motor to pull the vertical liner slider to run on the horizontal linear slider. (Fig. 1) There is another motor that enables the eraser and chalks to move freely on the vertical liner slider. The ultrasonic ranging sensor is used to prevent the eraser from hitting the edge of the blackboard. The machine can clean the blackboard both automatically (using buttons) or Semi-automatically (using handle) (Fig. 2).

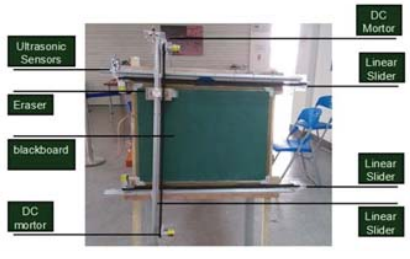


Fig. 1 The completed prototype

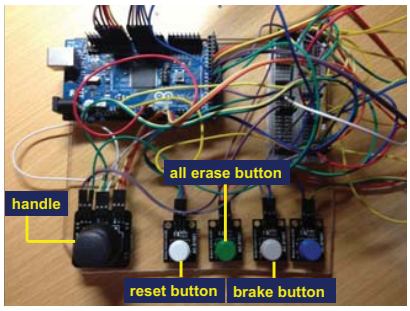


Fig. 2 Controlling board

Modeling and Analysis

In order to complete our prototype, we had several tests.

A: Sliding orbital testing: The material of sliding orbital is a factor affecting the performance of the device in aspects of speed and accuracy. we tried kinds of materials and finally used linear slider because it is smooth and easy to control.

B: Pressure testing: The pressure between blackboard and eraser needs to be tested because too large pressure may cause sliding failure and too small one may cause cleaning failure. To solve this problem, we first tried spring but it would make the eraser shake left and right. Then we applied copper supports, but it still didn't work well because it was either too tight or too loose. After adding nuts, the device behaves as well as expected.

C: Sensor testing: The sensor's performance decides the accuracy of the positioning of the slider. We ran several tests to see the efficiency of the ultrasonic ranging sensor and found the accuracy of our sensor is ±2 cm.

Validation

After we formed the prototype, we did several tests to evaluate our finished product. We compared the testing results with the standard we set before.
The results are listed in Fig. 3

Item		Standard	Result
Speed	whole	30-80s	60-64s
	one position	5s	0-5s
Accuracy		±5cm	±2cm
Cleanliness		no clear ash can be seen	little ash can be seen
Battery life		≥150 times	about 100--120 times

Fig. 3 Comparison to standard
As can be indicated from Fig. 3,our prototype behaves as well as we expected in general.

Conclusion

After efforts, we finish our project successfully. The electronic blackboard cleaner & writer can wipe the blackboard automatically and efficiently. However, it can not draw geometric figures accurately because the chalk can not be installed stably. Apart from that, the biggest gain we get is that all of us know how to be a great engineer. We have teamwork successfully, we can solve problems quickly, we know the ethics and sprits that an engineer must have, and we really enjoy the working process.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Intelligent Water Level Controller

Wings of Silver

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Dawei Wan, Hanxiang Li, Zhihao Yuan, Yisong Shen, Yongyin Zhang

Problem Statement

Have you met the situation that when you go to the public bathroom, the water on the floor is so deep that covers your ankle? The situation happens quite often in the public bathroom beside the first restaurant and is really annoying. Traditionally, people use floor drain to let water flow out. However, this solving plan is not so efficient and the manager of the public bathroom can't know what happens inside unless they get in and see the room condition by his own eyes.

Therefore, we manage to make a system which can control the water level automatically and intelligently. It should be able to warn the manager when the water level is too high and could not be lower, a situation happens usually owes to the drain stuck.

Concept Generation

IR sensors detecting water level can control the warning system and the water pump based on water level (Fig.1).

Fig. 1 The Detector and the Pump

Design Description

A pole partly painted black is fixed on a buoy to reflect the water level. Two IR sensors will be fixed on the wall to detect the water level (Fig. 2).

When the lower IR sensor detects black, the pump will start working, and when the higher one detects black, it means that something worth attention happens and the warning light will be turned on to ask the manager to get inside the room and have a look.

Fig. 2 Detection System

The water pump will be placed in the floor and will try its best to pump water out. Also, the warning board will be placed in the manager's office. The lights will tell the manager where need his special attention (Fig. 3).

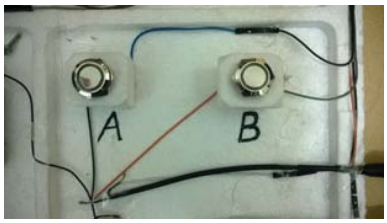


Fig. 3 Warning Board

Modeling and Analysis

Firstly, it's important to detect the water level accurately and response this piece of information to our system and react correctly. We link the sensors, pumps and lights to the Arduino to build a prototype. We program the Arduino and use electrical relay to control the pumps and lights. We find it's essential to make sure that the detector can show the water level accurately and sensitively. We made several designs of detectors and experiment them. We are curious about the following properties: the lowest water level that it can detect and the reliability of the detector. We also made tests to make sure that the pump is able to control the water level when the input current is huge.

Finally, we want to make sure that multiple equipments can be settle in different parts of the room because we find that the water levels in different parts of the bathroom are different. We link another set of the system to the Arduino and tested them together.

Validation

We do several tests to make sure our prototype is able to work. First, we test whether the pump can react at the right time. Then we test whether the light will be turned on when the higher sensor detects black. We also recorded the time our system need to bring the water level back to normal.

Then we operate two sets of the system and operate together. The program shows the ability to handle them separately and accurately.

Conclusion

Finally, our Intelligent water level controller can pump water automatically when there is too much water and can warn managers when some accidents happen. Thus it can help managers to supervise the public bathroom easily and will make the bathroom convenient for the users and bring them better washing experience.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Chestnut Shell Cutting Machine

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Yi Jia, Yutian Wang, Leyi Yin, Weilun Peng, Chengpei Xi

Problem Statement

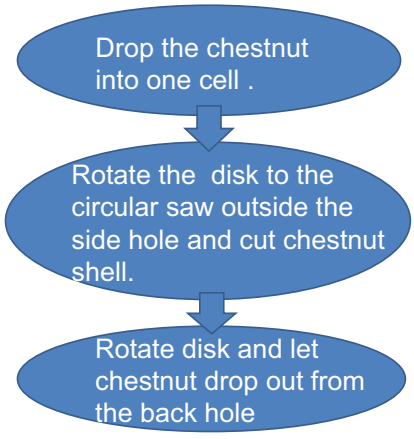
Chestnut is a popular snack in China. The most common kind of chestnuts people purchase has a cutting on the shell so that consumers can peel it into 2 parts with ease. Since the shell of chestnut is really hard, workers have to spend a lot of time cutting it, and may even hurt their fingers. Hence, we decide to design a machine that can cut the shell of chestnut automatically in our project.

Concept Generation

One circular saw, one rotating disk, one stepping motor and position sensors are mainly needed to complete our plan.

Design Description

We refer to the idea of the "Intelligent Medicine System" to construct our rotating disk. There are 6 cells on the rotating disk to house 6 chestnuts. Two shells are placed up and down the disk with one hole to drop in the chestnuts and one hole to drop out them. There are 3 steps to complete the cutting process.



There are also a funnel and a tunnel to help put in the chestnuts more user-friendly.

We use the laser cutting machine to cut Acrylic boards and assemble the parts to realize the disk designed. The design is shown in figure1.

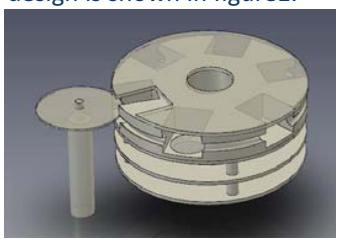


Fig.1 Disk structure

Modeling and Analysis

Identifying the proper rotation speed of the rotating disk is important in order to successfully cut the chestnuts. We need to find the critical values of the motor's angular speed so that both the chestnut's and the grinding wheel's needs can be fitted.

The structure of the rotating disk is the most important part of our chestnut cutting machine. We use AutoCAD to design the rotating disk and the shells. We change the size of the holes on the disk for several times to make the structure more suitable for chestnuts to drop in. The final graph of our AutoCAD design is shown in figure2.

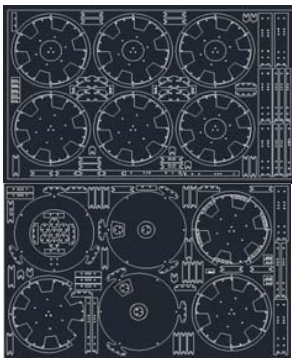


Fig.2 CAD design

This disk fits the shapes and sizes of chestnuts and fit the grinding wheel. The final prototype is shown in the picture below(Fig.3).

Fig.3 Final prototype

Validation

We do several tests to make sure our prototype is able to work. We test the motor's speed and torque to ensure that it could make the chestnut shells ideally cut.

Conclusion

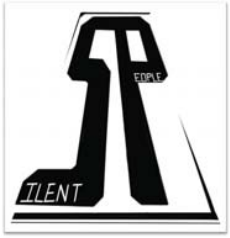
Our final design can successfully cut the shell of chestnut automatically. Additionally, with the help of the position sensor, the machine can give people an alarm when the chestnuts get stuck or are used up.

Furthermore, because of the rotating disk, chestnut can be cut one after another, which highly improves the efficiency of the machine. With all these functions, the chestnut cutting machine can spare people from boring and hard cutting tasks.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.



Real KOF

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Yizhou Wang, Zhiyuan He, Bohuan Yang, Zhenren Lu, Wei Jian

Problem Statement

The human-computer interaction is not perfect. Many body languages of human still cannot be recognized by computer. Our project is to improve human-computer interaction. Our idea is to use sensors to capture actions and translate them into machine language. So we design a device to create a new way for people to play “King of Fighter”.

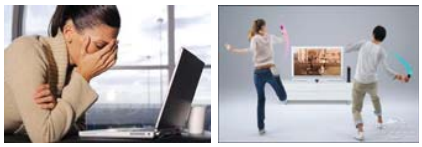


Fig. 1 Human-computer interaction

Concept Generation

Sensors are used to measure the player’s punch, kick and movement. All the information collected by sensors will be processed, and then the processed information are transmitted to the computer to operating the game smoothly.

Design Description

After analyzing and discussing the problem, we decided to use four acceleration sensors, a blanket with special circuit and an Arduino Mega board as the final method for the design.

Two acceleration sensors are placed inside a pair of boxing gloves, the acceleration sensors will respond when the player punch. Other two acceleration sensors are attached to the player’s legs, they will react when the player start to kick. There are four keys on the blanket with circuit, each one is connected to one direction just like the dancing blanket.

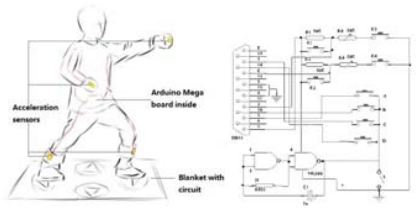


Fig. 2 Concept design and the circuit

The Arduino Mega board will collect and process all the information from these sensors and transfer the processed information to computer, to run the game smoothly.

Fig. 3 Overview of the prototype

Modeling and Analysis

We have searched for numerous ways to make it portable and easy operated.

A: Portable: we required the portability of our device, so we need to reduce wires and the size of devices. Thus, we choose Arduino Mega board to collect all the information, and make the blanket and the Arduino Mega board connected to the computer separately.

B: Easy operated: the device we made is designed for students and white-collar workers. It should be easy operated. We increase the sensitivity of acceleration sensors, so when the player is a beautiful lady. Our acceleration sensors still can recognize the punch and the kick. Eventually we use four acceleration sensors which are much more sensitive.

Validation

Before the final exhibition, we have run several tests to make sure our prototype reliable.

Firstly, we test the blanket with circuit to see whether the player can manipulate it precisely.

Then, we put on the special gloves and tie the sensors to legs. We punch and kick continuously to see if the character controlled can punch or kick smoothly and accurately as we do.

Conclusion

Finally, our project successfully translated the human body language into machine language. The effect of our “Real KOF ” is quite amazing, which can amuse the audience. We learned to find what people need in life and how to meet their needs. In addition. it is wonderful to work as a team to face success and failure together, which is not only a valuable experience, but of great help to our future.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

https://pbs.twimg.com/profile_images/1799738572/Cobra_Logo_whiteSpace.gif

Cockroach Terminator

Instructors: Prof. Peisen Huang, Prof. Pamela Mansutti

Team Members

Chaofeng Wu, Pengwei Ni, Xinyue Ou, Yiwen Zhou, Yuanxin Qian

Problem Statement

Cockroaches are harmful and disgusting. They are difficult to be found and tracked. In this project, we are motivated to design a useful and entertaining tracking system that can find the position of a cockroach and track it.

Concept Generation

A camera, a laser pointer, three servos to rotate the laser pointer and a compute to be the controller.

Design Description

Our device is composed of a detecting camera, a controller computer and a tracking system.

We use programs on the controller computer to process the pictures we get from the detecting camera and sending signals to the tracking system. The tracking system is made up of two different-sized boxes and a laser pointer. The two boxes rotate around different axes so that the laser pointer placed on the smaller box can monitor the whole workspace. Once the location is confirmed, the laser will be locked on the cockroach and tracks its path.

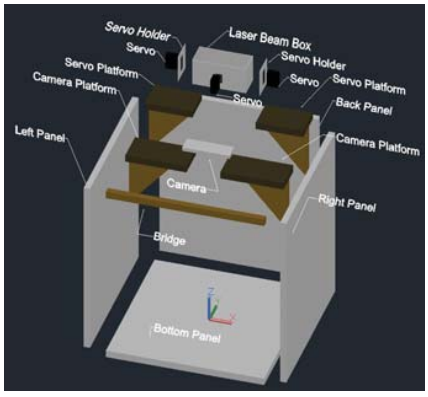


Fig 1. 3D model of the prototype

The whole process of locating the cockroach when it barges in the workspace is shown as follows.

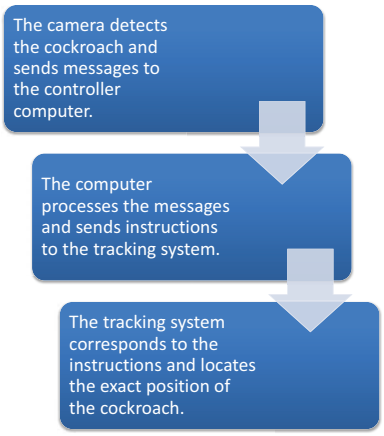


Fig. 2 Process of locating the cockroach

Modeling and Analysis

Our Project is required to find and locate the cockroach accurately, quickly and repeatedly. We mainly analyze three aspects of our prototype.

a) Accuracy and preciseness

Our prototype requires high accuracy and preciseness of the laser beam. Therefore, we contract the workspace to guarantee more preciseness. Also, we set our program to a high division value. To test the prototype's accuracy and preciseness, we put a black ball on the different positions of the base board and repeat the experiment on each position more than 10 times.

b) Speed

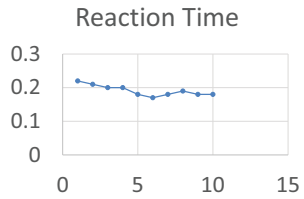
Our prototype requires fast movement of the laser beam. The laser beam should be able to aim at the target in less than 1 second. We count the time servos spend to point the laser beam at the target. At the same time we improve the program so that the time of the whole process is limited within 0.5s.

c) Stability

As the target may barge in the workspace repeatedly, our prototype requires to be work many times without mistake. We test every step individually and fix the mistakes. The whole process is required to perform without mistakes for more than 10 times

Validation

We did 50 tests to test our prototype. We have collected and analyzed the data from the tests. The reaction time has been limited to within 0.2s. The individual pixel is as small as 0.4 mm^2 The data showed that our prototype satisfied the criteria quite well.



Conclusion

Eventually, after the cooperation and hard work of our teammates, our Cockroach Terminator can successfully automatically find the position of a cockroach and track its path as it moves. Thus, it is able to help us find the cockroach or other unexpected aliens. In all, all five of us have learned a lot about engineering and improved our skills through the project.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

Magic Pianist

Instructors: Prof. Huang Peisen, Dr. Pamela Mansutti

Team Members

Yao Ji, Jieming Song, Jingyuan Wang, Hanling Yang, Kaici Zhu

Problem Statement

Nowadays, piano is popular among people of all ages. However, self-learners and parents of a young kid may find it difficult to send in a responsible, patient and well-qualified teacher that can teach at any time they want because of the lack of piano teachers.

Thus, they need the equipment that can provide them with a more convenient way to learn how to play the piano. In order to solve the problem, our team is going to devise a pair of five-finger mechanic hands, which can play rhythm like the hands of a pianist. Self-learners and young kids can learn how to play the piano easily by watching what the magic pianist does.

Concept Generation

Sensors and Arduino can control the mechanic hands which are made up of servos, setlines and drawtubes, and carried by a robotic car.

Design Description

The magic pianist is made up of the carrier and the finger part. For the carrier part, the sensors detect the encoder and are linked to the Arduino board. The signals are sent to the motor driving board and determine the movement of the carrier. (Fig.1).

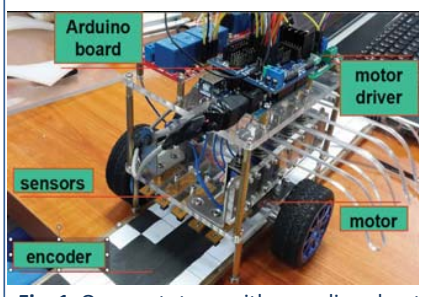


Fig. 1 One prototype with encoding sheet

The finger part consists of the Arduino board, which connects to the five relays. Each relay controls the current in the electromagnet. The electromagnets move together and apart which enable the artificial fingers to mimic the up and down of the human ones. (Fig.2)

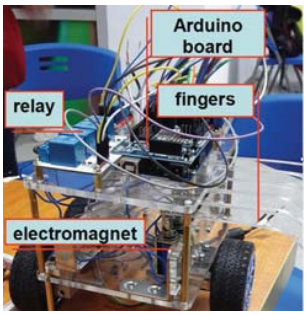


Fig. 2 How finger works

Modeling and Analysis

It is important for us to identify the working situation of the magic pianist so that we can make proper revisions. We need to determine the accuracy, speed of movement and the synchronous rate of the two hands. Testing codes were written to evaluate the working situation of the prototype. (Fig. 3).

For the accuracy, we need to ensure that the rhythm played by the hands should be identical to the rhythm on the music score. However, after testing over twenty times, we found that the hands always make errors after some time. Since this is a prototype, we have to set up a time limit within which the hands do not make any mistake. According to the feelings of most audience, we set 20 seconds as the criteria.

For the speed of movement, we need to make sure the music played is neither too slow nor too quick. We expect the hands to play 80 notes per minute which will be fit for the user.

Since the two hands play different parts in the project, we need to control the synchronous rate of them. No more than 8 times of out-sync per minute is the criteria.

Fig.3 The magic pianist is playing the piano

Validation

We have carried the main two tests 20 times to find out whether the prototype satisfies the criteria we previously set. Due to the limitation of time, the test for the synchronous rate is yet to be done.

For the accuracy, the average error time is after 30 seconds when the carrier runs beyond the target key. For the speed of movement, the hands play averagely 75 notes per minute. The intervals exist because it takes time for the carrier to move the hands to the target key. For the synchronous rate, the result is expected to reach the criteria, i.e., no more than 8 times of out-sync per minute.

Conclusion

Finally, our magic pianist can move automatically to play recognizable rhythm without any mistake within 30 seconds. However, we need to improve its speed of movement to satisfy the user and our criteria.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.
Dr. Pamela Mansutti, Instructor of Technical Communication.

Real-time Carer for the Elders

Instructors: Prof. Huang Peisen, Prof. Pamela Mansutti

Team Members

Xuefeng Hu , Xiaoshu Liu, Qihan Sun, Jihong Wang, Sihan Wang

Problem Statement

Nowadays, we are now gradually stepping into an aging society, but most of the family members cannot have enough time to take care of the old. When heart attack comes to them or they accidentally fell over, it is difficult for them to make a phone call for help, and that leads to a higher risk of the olds' death alone at home. Expecting to solve this problem, our team will design a real-time carer system for the old.

Concept Generation

A heart rate sensor, a gyro sensor, two Bluetooth module, LEDs, and a Android smart phone that form a sensor-actuator system(Fig.1).

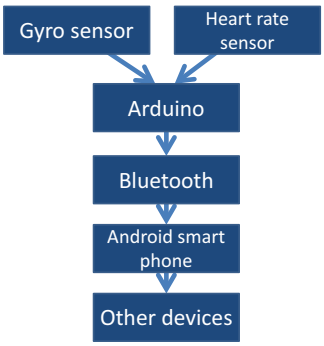


Fig. 1 Flow Chart

Design Description

The gyro sensor is used to judge if the old falls down by measuring whether the acceleration of the device is much larger than usual. At the same time, a heart rate sensor monitors the real-time pulse of the old. If the old falls down or his pulse changes suddenly, the Bluetooth module will send a message to the phone, which has installed a nice program(Fig.2). When the phone gets message from the Arduino, it will send a pre-edited message to a particular phone which may be a family member of the old; he can also send the message manually just by pressing "HELP!" if he feels sick but the device fails to discover that. If the old is just fine after delivery, he can press "I'm OK" to send another message to show his safety. Besides that, you can also set up the time that the old should take medicine, it will remind the old by the alarm clock or the LEDs.

Fig. 2 Program Index & Settings

Modeling and Analysis

Indentifying the situation about whether the old falls down or not, and whether he has the regular pulse, we need to find the values of the acceleration and his heart rate. Then we need to make the connection between sensors and phone.

We program the Arduino and connect it to the sensors to build a prototype. We get the data directly from the heart rate sensor and the gyro sensor, then we analyze and calculate it into the values we need. Then we put them on one of our team members to simulate the situations the device will meet in real life(Fig.3).

After successfully operate the sensors, we connect the Arduino board to the Android phone with Bluetooth, and test the delivery and the receiver of the messages. At last, we check every function in the Android program, especially the settings part.

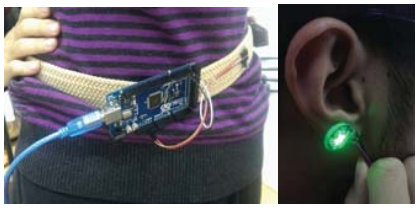


Fig.3 Sensor Test

Validation

We have several tests to ensure that our prototype works probably. First, we test the sensitivity of the gyro sensor and pulse sensor to guarantee the device does not make any error.

Secondly, we install all parts together on a fellow, and let him fall down for several times. The result is within expectation, and another phone receives the HELP! Message from the old.

After all examines, the device works well and it's really stable and reliable for an old who lives alone.

Conclusion

Finally, our real-time old carer, both hardware and software, can perform well. Further more, we finish the project with a controllable cost, and it's really user-friendly and very easy to use.

Acknowledgement

Dr. Huang Peisen, Instructor of Intro to Engineering.

Dr. Pamela Mansutti, Instructor of Technical Communication.

3D Reconstruction and Display of Artificial Tissues Using Real-Time Ultrasound Images

Sponsor: Shawn Ma, ***Covidien***
Mentor: Wei Tan, ***Covidien***
Team Members: Hao Li, Sihan Xiao, Tianyuan Zhao, Jiaying Xu, Yufan Huang
Faculty Advisor: Prof. Kai Xu & Prof. Vincent Chang

Problem Statement

A 3D reconstruction modeling system using real-time ultrasound imaging can be used to help doctors have effective visual experience of heart disease diagnosis. The project goal is accomplished by designing a mechanical arm for data collection, 2D image processing using matlab, synchronization of position data and image data for 3D point cloud and finally 3D reconstruction.

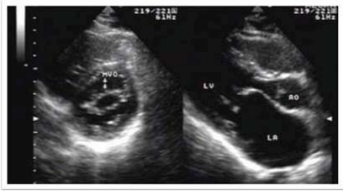


Fig 1. Ultrasound image for heart tissue[1]

Concept Generation

There are 5 main sub-functions in our project: scanning system, calibration, 2D image processing, synchronization and 3D reconstruction. For each sub-function, a proper solution according to the specifications are selected.

Specification	Parameter
Mechanical size (mm^3)	500*500*500
Weight (kg)	10
Position accuracy (mm)	±1
Stability	Able to hold the position without external force
2D Image Resolution (pixels)	720*540
Detection volume (mm^3)	200*200*100
Min object dimension (mm^3)	5*5*5
Max penetration depth (mm)	80
2D Image processing time (ms)	<500
Data points	10000
Sample rate (kHz)	1
Updating rating (Hz)	30
3D reconstruction time(s)	60

Design Description

Scanning system: A mechanical arm is designed for this system. The material is acrylic board. It has 6 DOF and can detect the heart from different angles.

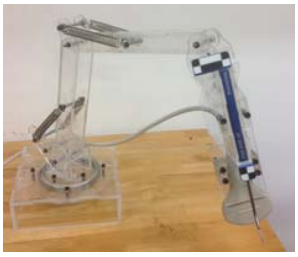


Fig 2 Mechainical arm

Since the ultrasound machine cannot record the spatial position information, a special structure is designed at the end of the arm to hold the ultrasound probe and the marker. So position data and image data can both be collected.

Synchronization: For each ultrasound image, there is a corresponding position data. So these two information need to be combined together to form a data packet for the later usage.

Calibration: The ultrasound image is a 2D data. For the 3D reconstruction, these 2D data points need to be transferred to 3D points. This requires us to design a calibration experiment to accomplish this task and find out the transformation matrix.

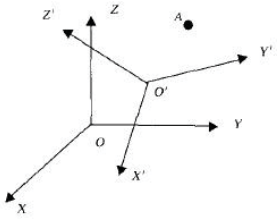


Fig 3. 3D datum transformation [2]

2D image processing: When the original 2D image is gotten, only the sharp feature of the image need to be left. Noise reduction and edge detection are applied to the image to get the sharp feature of the image.

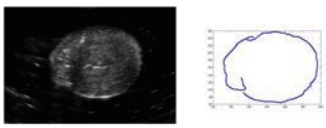


Fig. 4 2D image processing

3D reconstruction: After 2D image processing, calibration and synchronization, the 3D absolute space coordinates of all points needed of the 2D images are calculated. These points form the 3D point cloud and the 3D model is constructed based on the 3D point cloud.

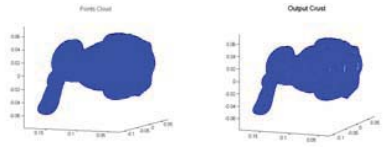


Fig 5. 3D point cloud & 3D model

Validation

Validation Process:

The requirement of size, weight and self-balance function can be directly confirmed. An object of required volume will be placed in front of the mechanical arm. Then we will move our mechanical arm along the outer surface of this object to test whether the set detection volume can be met. Some of the specifications are pre-determined by the facilities we used in our project. As for the speed of image processing, we can start our processing while recoding the time it use. Thus we can confirm the time requirement for each process.

Conclusion

The design of our project meets all the engineer specifications. The 3D model is complete and closed. The surface features of the original object are kept and can be used for further analysis.

Acknowledgement

Sponsor: Shawn MA and Wei TAN from Covidien.
Prof. Kai XU from UM-SJTU Joint Institute
Huan LIU, Jiangran ZHAO, Mingxiao Fu and Guoqing LIU from UM-SJTU Joint Institute

Reference

[1]http://www.xjcsk.com.cn/cgzs/show.asp?id=64
[2]http://baike.baidu.com/picview/1309806/1309806/0/9304c8883c4355daa5c27268.html#albumindex=0&picindex=0

Magnetically Anchored Stereo Vision Unit for SILS(Phase I)

Sponsor: Shawn Ma, ***Covidien***
Mentor: Jindi Zhang, ***Covidien***
Team Members: Xiaodi Ding, Yuezhou Chen, Hanwen Zhang, Hencheng Zhou, Tongquan Ding
Faculty Instructor & Advisor : Prof. Kai Xu

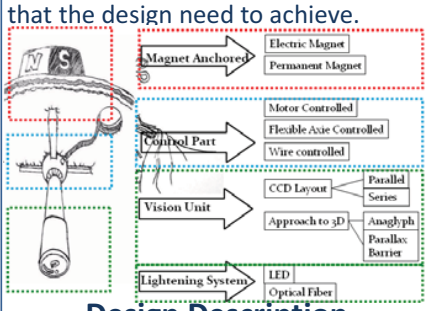
Problem Statement

Single Incision Laparoscopic surgery (SILS) is applied to treat abdominal disease with smaller incision. The project goal is to improve SILS by: 1. Designing and Manufactureing a vision unit, which can be magnetically anchored on the inner side of the abdominal wall and provide steady 3D image. 2. Ensuring the vision unit could have two active DoFs for pan and tilt motion.

Fig. 1 schematic diagram of SILS

Concept Generation

Four sub-system concepts are generated according to the function that the design need to achieve.



Design Description

The design mainly consists of two parts, the main body which is inserted into the abdomen and the toolbox controlled by surgeon.
The main body is shown in Figure 1. When main body is inserted into the abdomen, we release the wire. The four magnet stand will freely expand and anchor on the abdomen. Two camera(Misumi MO-B3506-3) and six LEDs(Philips Luxeon C) are placed on the top groove for stereo vision. One FPC board is placed at the bottom of groove for space saving.

Fig. 2 Prototype of our design

wire-control is used to adjust the position of desired view field. It would help the doctor get a more clear vision inside of patient's body. As shown in FIgure3, four holes on the left is connected to four directions on the main body. The other hole is for side bar. When the surgeon is intended to change angle, he just need to put bar one hole and rotate, the wire in other three hole will rotate freely.

Fig. 3 ProE sketch of tool box

Modeling and Analysis

A COMSOL 4.3a model is built to simulate the magnetic flux inside the tissue in the surgery. The force calculation module ensures that the magnetic force can stably anchor the vision unit.

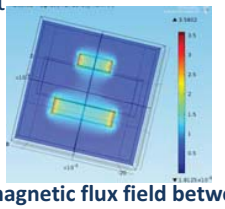


Fig. 3 magnetic flux field between the EPM and IPM

Validation

We construct a simulation model of abdomen(45*25*18 cm^3) to valid the results. Material plexiglass was chosen. A black fabric cloth covers the simulation model. One person operated the toolbox and another person used protractor to test tilt angle and pan angle. At the 18mm (deepest) from the camera, we put an object to simulate the organ. The third person observed the feedback signal on the computer to ensure the image is clear during the process. Light intensity meter was used to evaluate the illumination.

Fig. 4 Experiment setup

Expected Validation Results:

✓ Tilt angle range -50—50 degrees
• Viewing distance: 100-150 mm
• Field of view: 50 degree in both direction
• Illumination >=330lm
•Precision of toolbox: 1 rev/5 degree

Note: √ means specification approved and · means validation is on the way since DR 3.

Conclusion

Our design can fulfill the two main purposes of our project and all benchmarks. It uses permanent magnet to stably anchored the vision unit on the abdominal wall. Also, tilt motion can be controlled by toolbox. In addition, we use Open CV in Matlab to realize real time anaglyph 3D imaging.

Acknowledgement

Sponsor: Shawn MA from Covidien.
Mentor: Jindi ZHANG from Covidien.
Kai XU from UM-SJTU Joint Insitiute
Zhengcheng DAI and Guoqing LIU from UM-SJTU Joint Institute

Reference

[1]http://www.misumi.com.tw/iframe/35063.html

Improving Design Workflow, BOM Management and Drawing Standards for PDM Implementation

佳通轮胎 Giti **Sponsor:** Wu Zhicheng, ***Giti Group/Seyen Machinery*** 上海精元机械有限公司 SHANGHAI SEYEN MACHINERY CO.,LTD
Team Members: Jiang Xinzhuo, Christoph Meysel, Su Nannan, Wang Mengqi, Tang Tang
Instructor: Prof. Xu Kai

Problem Statement

Product Data Management (PDM) is a software used to share, change and manage information and Data of a certain product on it's way through the supply chain. By implementing this software Seyen Machinery aims at significally improving their current manufacturing situation. Before PDM implementation, modifications and optimizations of the current product data and structure have to be undertaken.

Fig. 1 The supply Chain and PDM [1]

Concept Generation

After weighing an iterative Need-Solution process against our sponsor's requirements, a task-workflow was created at which's end stands the creation of a SQL-Database.

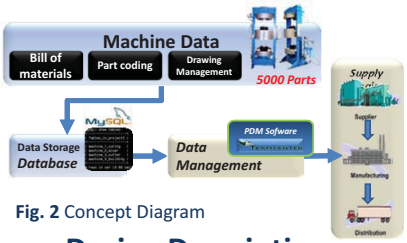


Fig. 2 Concept Diagram

Design Description

A. Bill of Materials (BOM) structure

BOM is a list of the raw materials, sub-components and parts needed to manufacture an end product.

Fig. 3 Indented BOM

Different departments use BOM for different purposes. Our design is an indented Bill which satisfies most needs. It clearly shows the machine's structure as well as suppliers' and finance related information, etc.

B. Part Coding Standard

The coding standard corresponds to the three different parts in a machine – manufactured parts, standard parts and purchased parts. These are distinguished by the first bit of the code represented by letters J, B or W. All coding contains material classification and serial number parts. The last bit in a code shows specific information of each part.

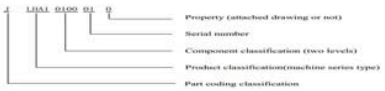


Fig. 4 Manufactured Part Code

C. Drawing Management

The main issue to be solved is the process of sharing and changing different designs and their drawings. We created a new process and a checklist. Additionally, information on a drawing's locations will be stored in the database and an engineering change numbering system adopted.

D. My-SQL Database

To combine all the abovementioned designs in a single delivery, our team decided to provide our sponsor with a database that would hold all their current product's data in the new and enhanced format.

Fig. 4 Command line client

Thus, feeding the new PDM Software with data is significantly easier and much more efficient.

Modeling and Analysis

Our designs are modeled and analyzed separately, according to our sponsor's needs. While the BOM and Part coding tasks have been modeled using standard office tools, the Drawing Management process is modeled using MS Visio and has a print-out hardcopy Checklist for employees. The Database uses My-SQL programming commands and will be implemented into a computer network at Seyen Machinery.

Validation

For every of our 4 tasks, an own validation plan has been worked out. The BOM, Part Coding and Drawing Management tasks have been tailored to the needs of our sponsor Seyen. Meeting their requirements was first priority. The new developments will be checked against the existing ones and if necessary modifications will be done. The SQL-Database structure is kept flexible which means it can be adapted to different circumstances.

Conclusion

This optimization project aims at improving a company's manufacturing situation. While quantitative numbers will only be available after our sponsor implemented PDM, we can already say that from all the improvement and optimization work, our sponsor greatly benefited by increasing the efficiency of several of their key manufacturing processes.

Acknowledgement

Sponsor: Mr. Wu Zhicheng from Giti/Seyen
Prof. Xu Kai from UM-SJTU Joint Institute
Prof. Vincent CHANG and Prof. Shane Johnson from UM-SJTU Joint Institute

Gas Turbine Guide Vanes Angle Detection & Control Method

Sponsor: Ow Lau, ***Siemens*** SIEMENS
Team Members: Kai Huang, Zhaowei Shi, Can Wu, Zheyuan Xu, Qianrong Zhu
Instructor: Prof. Kai Xu

Problem Statement

The angular position of the compressor inlet guide vanes are controlled by an actuator. However, the ring may experience the eccentricity under the action of the driving force(Fig. 1). Therefore, each vane has different angle, and this situation lead to the deviation of the average result got from the angular sensors [1].

The main objective of the project is to derive a mathematical model to predict the vane angles and using sensors to get the parameter that are needed in the model.

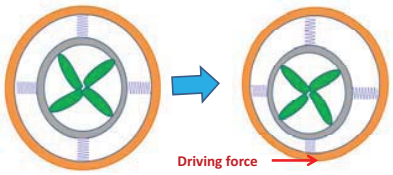


Fig. 1 Eccentricity of the ring under the action of the driving force

Concept Generation

Concepts are generated according to the relationship between the position of the ring and vane angles. In order to get each vane angle accurately, a function should be derived ($\alpha = f(x_1, x_2, x_3, x_4)$). The general concept is showed in the flow chart (Fig. 2).

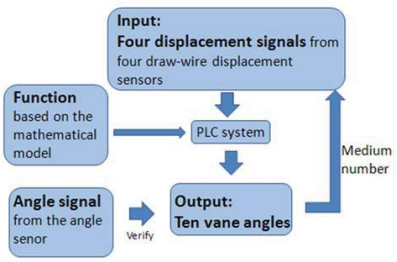


Fig. 2 Flow chart of the project

Design Description

In total, five sensors are installed. Four draw-wire displacement sensors are used to detect displacement signals (system input) while an angle sensor is used to detect the angle signal (results verification) (Fig. 3).

The PLC (programmable logic controller) is used to process the signals and accomplish the PID control. The program is also designed to calculate all the angles for display. It outputs an analog signal for the frequency converter to adjust the rotation of the motor.

According to Siemens' need, we design HMI (Human-Machine Interface) as the input of our system. Our customer can input target vane angle through a touch screen. Then the touch screen will display all detected vane angles to the customer. HMI help customer to detect & control vane angles directly and easily.

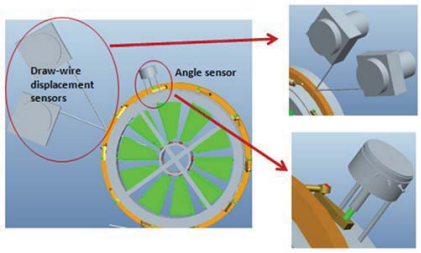


Fig. 3 Sensors installation of the project

Mathematical Model

The mathematical model is used to work out ten target vane angles with our selected inputs.

Mathematical model mainly involves space geometry. The accuracy of the output is the most essential index. In order to improve the accuracy, we take enough detail to restore the prototype as meticulous as possible. In addition, ten functions are independently expressed and variables are independently measured to reduce the error caused by the craft.

The procedure can be divided into two parts. The first step works out the linkage positions on the ring with our inputs. The second step works out the target functions for ten vane angles with the result from first step.

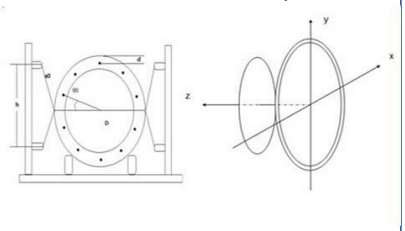


Fig. 4 Coordinate system for two steps

Conclusion

This project aims to predict derivation of angles and try to control it. The main task is to design a whole proposal with system of measurement and PLC control. We choose the displacement sensors as input to calculate different angles. We also use PID program to accomplish the goal to control our revised prototype. Under the instruction of Prof. Kai Xu, we are able to complete our previous goal and meet the engineering specifications.

Acknowledgement

Ow Lau, system engineer from Siemens
Prof. Kai Xu from UM-SJTU Joint Institute

Reference

[1]http://202.120.46.147/access/content/attachment/23cd822b467aa2c72041/Vm450_Ve450_Project%20List%20_%20Description_2013F_V2.pdf

UG PLM Application Study in Actuation Ring of Gas Turbine

Sponsor: Yucheng Tang ***Siemens***
Mentor: Chao Ren ***Siemens***
Team Members: Jing Wan, Wang Xiang, Tingben Xiao, Hui Shen
Faculty Advisor & Instructor: Prof. Kai Xu

Problem Statement

In order to promote the efficiency of mass production in industry, it is very crucial to build a CAPP(Computer Aided Process Planning)[1]system, which is applied by UG NX in this project. UG NX is a powerful software contained functions from CAD to CAM, which is used to generating CNC code. An example is applied of the actuation ring. The project is started from the CAD model building of the ring, and ended in the ring manufacturing by CNC automatically.

Fig 1. UG NX, CNC machine are crucial in manufacturing

Concept Generation

The first part is the CAD part. The 3-D model generated by CAD can be used to do the CAM simulations. The second part is CAM simulation. By simulation, the detail of the whole processing plan can be got and shown. For both two parts, some main conditions should be considered. Finally, The CAPP system is used to determine the parameters of the working process. For the three parts, some main conditions should be considered.

Concept	Main conditions
CAD drawing	compatibility, convenience, cost, calculation rate and operability
CAM simulation	accuracy, fitting different pattern, convenience, updatable and cost.
CAPP system	steps and characters definition, process card generation and parameter calculation by database

Table 1. Concept generation

Design Description

There's not an existed program can achieve our objective, so it is crucial to make several programs to make the CAD model to the CNC code.

The first part of our project is about reading the CAD model. The CAD is saved as a *.stp file. In this file, it includes every point and vector information. And from the point and vector, the feature details are calculated. And the feature details can be used to decide the process steps and get the parameters of each feature, such as position and size.

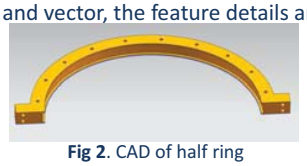


Fig 2. CAD of half ring

The second part is to decide the processing type, cutting path and the cutter. The feature's type decides the processing type and the cutting path, and the size decides the cutter.

The third part is inputting the processing steps and processing information back to the UGNX and simulating the machining process. And after the simulation, the CNC code can be output, and the code can used on a real CNC machine to built the part we decided.

The first and second parts are called as CAPP, and the third part is called as CAM. We make this system to do this by computer because it can lower the manual cost, and it can help to decrease the designing time.

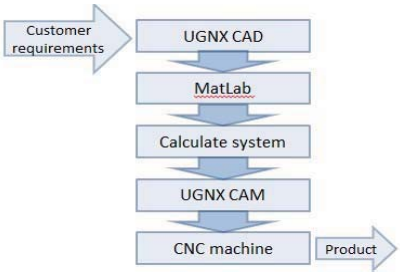


Fig 3. the working flow of the project

Validation

Validation Process:

The model was simplified to the most simple one, with only two characteristics, a ring and some threaded holes on it. Then this model was processed by our design systems to get the processing flow of it. If the processing flow is feasible and the time spent on getting the flow is short, then our system works well.

The data of the model was changed several times, because the processing flow should make some change in response to the change of the model automatically. What is more, the prototype of the model was made by the processing flow we designed, so that whether the processing flow is feasible was got.

Validation Results:

The processing flow was got by our system. The consuming time from initial modeling to final getting G-code is less than one hour, and the time spent on the computer calculation is less than 15 minutes.

When the data of the model was changed, our system found the different and the data in the processing flow was changed in response. When the data was changed very by a wide margin, the processing flow made some substantial change. When the height of the ring is much larger than the diameter of it, the two end plane should be machined firstly, while when the diameter is much larger than the height, during the first processing step, the inside cylindrical surface is needed to be machined.

At the same time, the prototype of the ring was processed by our designed processing flow successfully, showing that our processing flow is feasible.

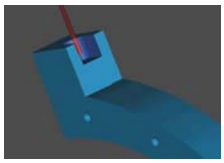


Fig 4. CAM of ring from UG

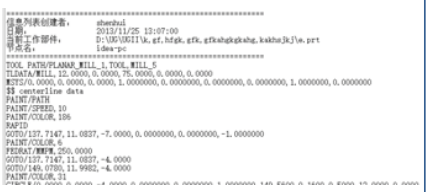


Fig 5. CNC code generated from CAM

Conclusion

The PLM technology would saves a lot of time and money. For the model sizes contained in database, the CAPP system would help to run UG from CAM to CNC code. In the future, the technology should be enriched the database.

Acknowledgement

Sponsor: Yucheng Yang and Chao Ren from Siemens
Prof. Kai Xu from UM-SJTU Joint Institute
Jiangran Zhao from UM-SJTU Joint Institute

Reference

[1]http://en.wikipedia.org/wiki/Computer-aided_process_planning

Lubrication and Sealing System for High Speed TRB Pair on Gearbox

Sponsor: Shijiang Liu, ***GE Power & Water***
Team Members: Jumin Liang, Jingyuan Peng, Yazhe Hu, Qifan Qiu, Hongye Sun
Instructor & Advisor: Prof. Kai Xu

Problem Statement

GE Company chose taper roller bearing(TRB) pairs to use on high speed shaft in the gearbox of the offshore wind turbines. It is known that taper roller bearings have pumping effect on lubricant oil when rotating. Pumping effect is caused by the pressure difference between the two sides of the tapered roller.
The project goal is to quantify the pumping effect by measuring pressure distribution along the axial direction and use software simulation to predict the performance of the real model.

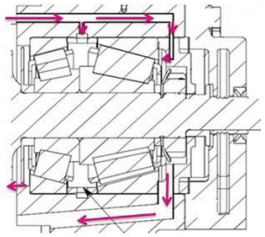


Fig. 1 Structure of the gearbox [1]

Fig. 2 Taper roller bearing (TRB) [2]

Design Description

This design has several parts: A 32234 tapered roller bearing, two bearing supporters to undertake the weight of the bearing, a shaft actuated by an electric motor to rotate the bearing, a base board and four side boards used as a box to contain lubricating oil, pressure sensors mounted at the top of the box to sense pressure difference of the lubricating oil.
In Fig. 3, it shows the setup. When doing the experiment, the bearing is immersed into the lubricating oil, so that pressure sensors can detect the pressure difference between the front and rear side of bearing.

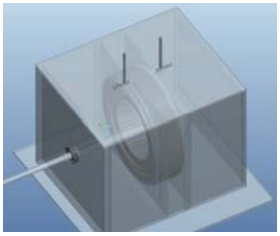


Fig. 3 Design of setup.

Validation

Validation Plan:
Use a acrylic board to locate the x-y coordinates of the testing tubes and use the scales on the tube to locate the z coordinate. Holes are drilled on the board along the axial direction. Two testing tubes coming out from one pressure gauge are plugged into the box to measure the pressure difference of two positions.

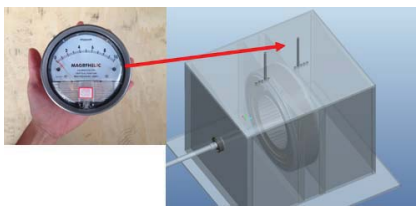


Fig. 4 Pressure measurement setup

Simulation

Simulation Process:
ANSYS Fluent is used to simulate the pressure distribution. Since the roller distributes periodically in the bearing, one element of tapered is analyzed in simulation model.

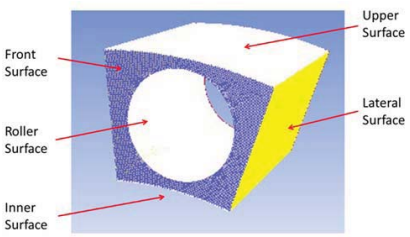


Fig. 5 Mesh on an element of bearing

•Assumptions: Laminar flow is applied in this model.
•Rotation Speed: 1800 RPM

•Boundary Conditions

Surface	Boundary
Upper Surface	Stationary Wall
Inner Surface	Moving Wall
Front Surface	Pressure/Velocity
Rear Surface	Pressure/Velocity
Roller Surface	Moving Wall
Lateral Surface	Periodic

•Engine Oil (300 K) Properties:

✓ density(kg/m3)	884
✓ specific heat (kJ/Kg-K)	1910
✓ viscosity(N-s/m²)	0.468
✓ thermal conductivity (W/m-K)	0.144

Simulation Result:

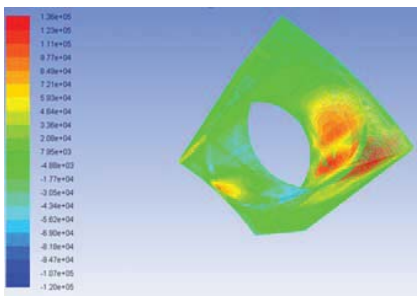


Fig. 6 Static Pressure distribution at 1800 RPM

Acknowledgement

•Liu Shijiang, *GE Power & Water*
•Zhou Ying, *GE Global Research*
•Prof. Xu Kai, Prof. Vincent Chang, Prof. Wang Lipo, Pro Zhang Qiang, and Prof. David Hung from *UM-SJTU Joint Institute*

Reference

[1]. Liu, Shijiang. Shanghai General Electric Company. (2013, Aug). Lubrication system for high speed coupled TRB. Available e-mail: timliangjumin@sjtu.edu.cn Message: RE: Capstone project of Joint Institute from SJTU.
[2]. http://www.zcwz.com/gonghuo/

Programmable Test Automation Solution for HP LaserJet(Phase II)

Sponsor: Jupiter (Chien) Lin **HP**
Mentor: Kenny Guo ***HP***
Team Members: Fan Zhang, Meng Xue, Jiexin Hou, Si Tang, Rongkuan Xie
Instructor: Prof. Vincent Chang

Problem Statement

This project aims to create a product with several input ports and output ports to connect and disconnect multiple PCs and LaserJets. The whole system is controlled by EM relays so all the processes are conducted automatically.

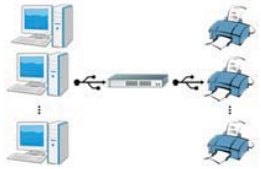


Fig. 1 Whole System

Concept Generation

The total project can be divided into three sub-functions.
Stage1: Input: Commands from PCs are created and will be sent to control center.
Stage2: Control: Control center will connect / disconnect EM relay according to the input commands.
Stage3: Plug-in / out: EM relays will connect / disconnect USB cables.

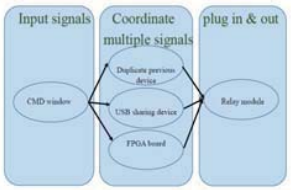


Fig. 2 Work Flow

Design Description

We use USB hubs to extend the number of USB ports of PCs so every PC has enough USB ports to connect all the printers.
Since each printer is connected to all the PCs via a USB cable, we use USB shares to integrate all these cables into a single one and connect it to printers.
EM relays are the core components. They are used to connect and disconnect the USB cables.

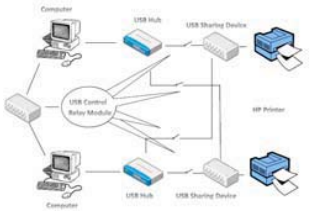


Fig. 3 Design Description

Modeling and Analysis

We have built a 2-4 model. This system connects 2 PCs and 4 printers. We used two laptops to control 2 printers, 1 mouse and 1 U disk. After connecting all the devices, we typed commands in the terminal window and laptops can control all the 4 USB devices properly and all the PCs can control all the printers as we want.

Validation

Validation Process:
Part I: We uses 4 U disks to do the recognition test. The model we choose is still 2-4. We use 2 PCs to connect 4 U disks to check whether the connection is proper. We have tried for 200 times and failed 1 time with a warning of not recognized USB device is detected.
Part II: We use 3 printers to do the data transmission rate test. We printed picture and virtual-text file both via the system and connecting PC and printer directly. We record the time to judge whether the system will lower the transmission rate.

Table. 1 Transmission Rate (picture)

	Cut	Cut	Cut	Direct	Direct	Direct
Size	648k	648k	648k	648k	648k	648k
Time	45.53s	45.61s	45.63s	45.48s	45.56s	45.73s

Table.2 Transmission Rate (text)

	Cut	Cut	Cut	Direct	Direct	Direct
Words	407	407	407	407	407	407
Time	9.96s	10.25s	10.13s	9.91s	10.11s	9.82s

Validation Result:
•The multi-multi functionality works well on the 2-4 model.
• Recognition failure rate is only 0.5% and meet the standard of our goal.
•Crash rate is below 1% and meet the requirement.
•Data transmission rate is almost the same as USB cables which are not cut so the efficiency is high.
•Heat dissipation and electric insulation is good.
•The system is enduring. It can work for more than 3000 hours.

Conclusion

Our product aims to finish a product that can connect several computers and USB devices. It has the following functions:

i) It uses EM relays to control the connection / disconnection of USB cables.
ii) We can choose to connect certain PC and printer as we want just by typing a simple command.
iii) After typing the command, all the processes are conducted automatically by the system so no manual work is needed.

Acknowledgement

Sponsor: Jupiter (Chien) LIN and Kenny GUO from Hewlett-Packard Company
Vincent CHANG from UM-SJTU Joint Institute
Shane JOHNSON, Kai XU and Chengbin MA from UM-SJTU Joint Institute

A Feasible Gamma Correction Tool Developing for HP Laserjet

Sponsor: Fox Zhu, ***HP Co.***
Mentor: Justin Tang, ***HP Co.***
Team Members: Jingren Zhou, Enda Zhang, Dingwen Li, Yezhou Zhang, Yuqi Cao
Instructor: Prof. Vincent Chang

Problem Statement

Due to the nonlinear system of laserjet printers, the pictures printed in paper will appear darker or brighter compared with the original one stored in computer if not conducting gamma correction. The project goal is to design a software tool for gamma correction to map the pattern stored in the printer to grey level and then select the specific patterns in the printer for linear relationship between grey level and the Luminance.

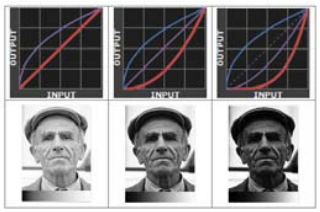


Fig. 1 Example of Gamma Correction

Concept Generation

In order to achieve the goals of the project, we analyzed the desired function of the software and got five concepts generated, which are data de-noising, coordination transformation, fitting with multiple fitting algorithms, tail optimization, and anti-function algorithm.

Design Description

In general, firstly, the gamma correction tool prompts user to select an input file as original data. Then the tool performs denoising process for the original data. After denoising, the data is used to implement the coordinate transformation. The new data generated by coordinate transformation is put to the process of tail optimization. The processed data finally is used to do the inverse fitting and the anti-function is generated.

Modeling and Analysis

The software environment is joint compilation of Matlab and C++. Thus the program can use both C++ and Matlab's library. The final delivery is an exe independent file, which can run without Matlab running.
In order to meet the criterion of fitting algorithms, we developed four different fitting functions via Matlab and C++. They are polynomial fit, Chebychev approximation, interpolation spline fit and cubic spline fit. UI design is based on Matlab GUI function.
The best fitting algorithm of our software is selected based on the minimum residual. Here is a data flow chart of our program:

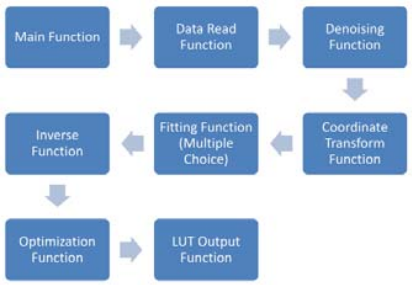


Fig. 2 Data flow chart

Validation

The quality of printing is the most important criterion we need to test.
We used HP standard color scanner to test the correctness of our gamma correction lookup table. Possibility of wrong correction and linearity of gamma line will be our two test factors. Then we typed out the PQ pattern with our tool and observe in human eyes.

The result of out tool and the result of the already made tool are shown in figure.

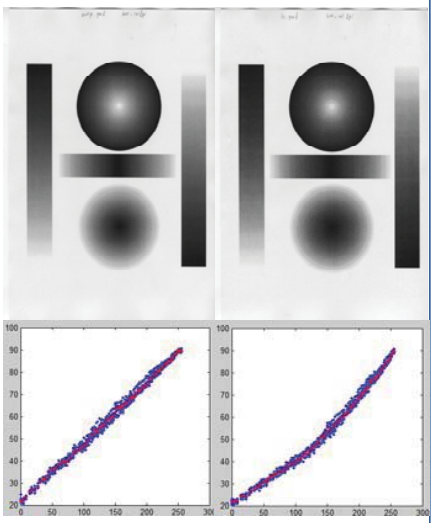


Fig.3 Comparison of Gamma Correction
Left: Our Version Right: Old Version

Conclusion

The software designed by our team will be user-friendly in output and operation, multiple in fitting and inverse function algorithm to get the best curve and well-performed in handling large amount of data sets required for laserjet printers. The design will fulfill the requirements to be a useful and independent tool, conduct better fitting and process the data provided by users.

Acknowledgement

Justin TANG, HP Laserjet Department
Fox Zhu, HP Laserjet Department
Prof. Vincent Chang, Shanghai Jiao Tong University Joint Institute

Reference

Reference:
http://www.cambridgeincolour.com/tutorials/gamma-correction.htm

Chinese PQ Pattern Design for HP LaserJet

Sponsor: Fox Zhu, ***HP***
Mentor: Justin Tang, ***HP***
Team Members: Xianghan Pei, Zili Lin, Shuai Zhang, Yue Zheng
Instructor: Prof. Vincent Chang

Problem Statement

HP Company wants to expand the market share of LaserJet in China, and HP is trying to localize the products, considering the print quality of Chinese and Chinese typical photos. HP hopes our team could design a set of PQ patterns containing Chinese elements. (Note: PQ means print quality)

Concept Generation

We select the specific type of our patterns. Our project needs to design the test pages which consider not only the Chinese character, but also how often the type was printed in the Chinese market. Finally, we get the following types.

Design Type	
Office Document	Business Letter
Magazine Page	Enumeration
Art PPT	Photo
Financial Magazine	Technical Drawing
Modern PPT	Magazine Cover
Advertisement	Academic Paper

Design Description

To meet Engineering Specifications, we first set page size as A4/A3 and color mode as greyscale/RGB in Adobe Illustrator/Photoshop, once creating a new document. After finishing the design, we export PQ pattern as ai file and tif file. Here are the steps for detailed design. (We set art PPT as an example)

Step 1: Subject

- Determine subject
  Art PPT with ink & wash painting

Step 2: Layout

- List commonly used layout

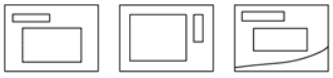
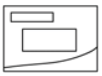


Fig. 1 Three Commonly Used PPT Layouts

- List criteria according to ES to select the best one (Fit reading habit, enough space for content & picture)



Step 3: Background

- List criteria and select the best one (Ink & wash painting, average color distribution, match layout)

Fig. 2 Background Pictures

- Combine background and layout

Fig. 3 Art PPT Template

Step 4: Content

- Add proper content and finally get PQ pattern

Fig. 4 Art PPT

Validation

Validation Process:

Our validation are all based on the engineering specifications raised before. For each PQ pattern we design, we match them with the specifications to check whether it meet the requirement.

Validation Results:

There are total 12 PQ patterns to be validated, so that we cannot put all the validation results here. Therefore, we choose two of them as examples here, a color photo pattern and a mono enumeration pattern.

1. Photo

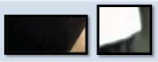
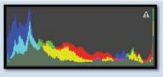
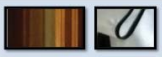
Specification	Detail Description	Example in PQ
Style	Photo	
Size	A4	
Resolution	300 dpi	
Color Mode	24 bits RGB	
Format	psd & tif	
Cost	Cost for portrait and infinite copy right (Undetermined)	
Picture Resolution	300 dpi	
Color Distribution	Cover almost all color in RGB. Also, both RGB (0, 0, 0) and RGB (255, 255, 255) can be tested	
Line	Both straight line and curve are covered	

Table. 1 Validation for Photo

2. Enumeration

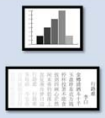
Specification	Detail Description	Example in PQ
Style	Enumeration	
Size	A4	
Resolution	600 dpi	
Color Mode	8 bits greyscale	
Format	ai & tif	
Cost	No cost, all pure designed	
Font	Most used front are contained	
Character Size	All size are contained	
Direction Picture Resolution	Horizontal & Vertical 600 dpi	
Color Distribution	Black and grey (between white and black)	
Line	Both straight line and curve are covered	

Table. 2 Validation for Enumeration

Conclusion

Our goal is to design Chinese PQ pattern to help HP Company be more competitive in Chinese market, and till now, we have made good progress and have done a great job.

Acknowledgement

Fox Zhu and Justin Tang, from HP
Vincent Chang, from UM-SJTU Joint Institute
Ardo W. Hintoso, from UM-SJTU Joint Institute

OpenCL Accelerated Face Detection (Phase II)

Sponsor: Fleming Feng & Evelyn Yan, ***Intel***

Mentor: Nanhai Zou, ***Intel***

Team Members: Xiuli Pan, Jifan Zhu, Sen Cao, Xingmo Liu, Zhang Chen

Instructor: Prof. Vincent Chang

Problem Statement

Face detection works to locate human faces in images or videos. The project goal is to use OpenCL, a programming framework that allows hetergeneous computing, to accelerate face detection so that it can be applied to more applications.

Figure 1 An Application Using Face Detection

Concept Generation

Sub-function concepts are generated based on the functional decomposition of a face detection program. Then the best combination of these concepts is selected.

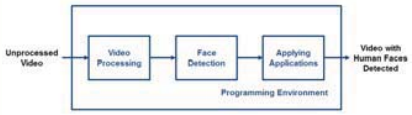


Figure 2 Function al Decomposition

- **Video Processing**
  Preprocess the input, including extracting frames and so on
- **Face Detection**
  Locate human faces
- **Applying Applications**
  Implement application programs

Design Description

- **Preprocessing**
  The input video is turned into frames of images. These images are then turned into gray scale.
- **Image Segmentation**
  Each image is segmented into 4 sub-images equally. Also, the original image is resized to $\frac{1}{4}$.

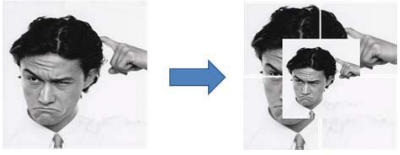


Figure 3 Image Segmentation [1]

- **Task Allocation**
  The computation that face detection module does on one image refers to one task. All the tasks are arranged in a 2-D matrix so that they can match up quickly with GPU cores.

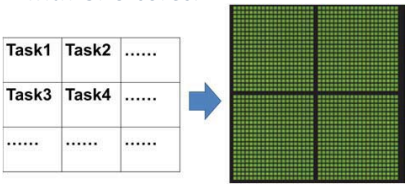


Figure 4 Task Allocation

- **Face Detection Module**
  It uses a cascade of classifiers to detect human faces in given images. The positions and sizes of detected faces in corresponding images are the output.
- **Adding Effect**
  Based on the output of face detection module, effects can be added by doing further computation on the region of interest.

Figure 5 An Example of Adding Mosaic

- **User Interface**

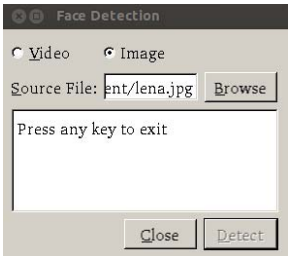


Figure 6 User Interface

Validation

- **Application Innovation**
  Collect users' scores on the innovativeness of the applications.
- **Functionality**
  Collect users' scores on the degree of satisfaction for the functions.
- **Accuracy**
  Use a video source as input and calculate as follows:

$$Accuracy = \frac{\#correctly\ detected\ faces}{\#wrongly\ detected\ faces + \#total\ faces}$$

- **Efficiency**
  Test it on 480p videos.
- **User Interface**
  Collect users' scores on the degree of satisfaction for user interface.
- **Stability**
  Use different sources as input and calculate as follows:

$$Stability = \frac{\#success\ run\ times\ without\ cracks}{\#total\ run\ times}$$

- **Reliability**
  Use images as input and calculate as follows:

$$Reliability = \frac{\#correctly\ detected\ images}{\#total\ images}$$

Validation Results:

	Specification	Expected Value	Practical Value
√	Application Innovation	>=90	90
√	Functionality	>=90	95
√	Accuracy	>=90%	90%
√	Efficiency	>=25fps for 480p videos	25fps for 480p videos
√	User Interface	>=90	90
√	Stability	>=95%	98%
√	Reliability	>=95%	96%

Table 1 Validation Results

Note: √ means specification reached,.

Conclusion

This project improves the performance, especially efficiency, of face detection in digital video by using OpenCL. Some applications are also proposed and implemented to broaden the usage of face detection.

Acknowledgement

Fleming Feng, Evelyn Yan and Nanhai Zou from ***Intel***.

Prof. Vincent Chang from **UM-SJTU Joint Institute**

Reference

[1]http://www.comicbooktherapy.com/wp-content/uploads/2013/10/levitt.png

Pre-Feasibility Analysis Software for 6FA CCHP

Sponsor: Bing Zhang, ***GE***
Mentor: Jack Pan, **GE**
Team Members: Xiaobo Hu, Jiawei Qian, Junhua Yang, Sibo Wang, Yiran Lu
Instructor: Prof. Vincent Chang

Problem Statement

To sell engines, GE sales ask the engineers to do the feasibility analysis according to the customer requirements. Repeated calculations and comparisons are needed and much more time is spent on the case analysis. The process needs improvement.

Figure 1 Problem Description

Concept Generation

This project is to develop a VBA program for sales to do the pre-feasibility study to simplify the time-consuming process between sales and engineers.

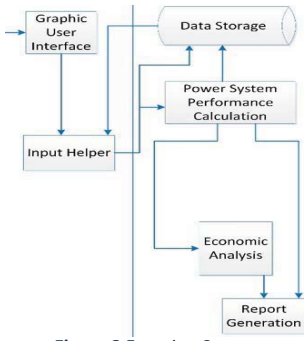


Figure 2 Function Structure

GUI: Multi-tab label switching
Input helper: Input everything, automatic input and history input
Data storage: Excel
Performance Calculation: Complete VBA program
Economic Analysis: Static and Dynamic Analysis
Output: Electronic version

Design Description

User inputs all requirements and conditions through the graphic user interface to do power system performance calculation. Calculation results will be analyzed and stored.

After all, a report consisting of power system performance and economic analysis results is generated.

- **User Interface**
  An excel sheet and a user guide
- **Input Helper**
  New, History and Smart Modes
  Reduce operation time
- **Power System Performance Calculation**

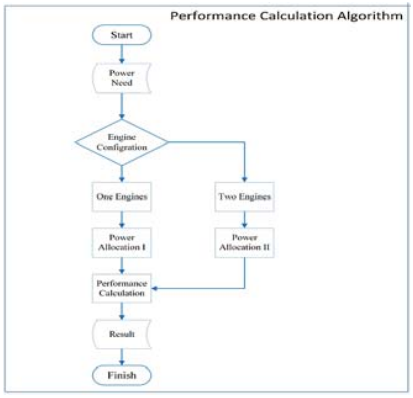


Figure 3 Performance Calculation Algorithm

- **Economic Analysis**
  Return on Investment (ROI)
  Payback Period (PP)
- **Report Generation**
  Performance and Economic Analysis

Development

Figure 4 Graphic Interface Decomposition

Figure 5 Interaction between Pages

Algorithm of calculation is designed according to the process of GE. The algorithm follows the GE rules to determine the performance of the system. And economic analysis uses the standard indicators.

Validation

- **UI Satisfaction:** Twenty investigations about the degree of use-feel satisfaction toward user interface.
- **Operation Deduction:** Test it with the input samples from sales in GE.
- **Output Correctness:** Test it with Multiple sets of data.
- **Time of Calculation & Volume of Memory Usage & Software Size:** Test these specifications on 5 computers with standard test configuration.
- **Protection& Ease of Configuration & Maintainability:** Evaluated by comparative analysis.

Validation Results:

	Specification	Value
√	UI Satisfaction	85%
√	Operation Times Deduction	20%
√	Time of Calculation	4s
√	Output Correctness	90%
√	Volume of Memory Usage	150MB
√	Software Size	10MB
√	Protection	True
√	Ease of Configuration	High
√	Maintainability	High

Table 1 Validation Results

Conclusion

This program solves the problem that lots of time has been wasted in the process of case submission and case handling. In the viewpoint of GE, the software can save them a lot of time. To make the software better, it's necessary to do some optimization so that further improvement and maintenance can been done easily.

Acknowledgement

Bing Zhang and Jack Pan from *GE*.
Prof. Vincent Chang and Dr. Shane Johnson from UM-SJTU Joint Institute

Plasma Drilling System

Sponsor: Pengju Kang, ***GE***
Mentor: Saijun Mao, ***GE***
GE Global Research
Team Members: Weihong Lou, Jiada Chen, Yiheng Luo, Haowen Jiang, Dong Nan
Faculty Advisor: Prof. Kwee-Yan Teh **Instructor:** Prof. Chengbin Ma

Problem Statement

Plasma drilling is an emerging technology for efficient rock fragmentation. The project goal is to study and demonstrate plasma drilling technology by: 1. Generating concept design and layout for system with subcomponents. 2. Building a complete plasma drilling system with generated concept designs.

Fig. 1 Drilling using high energetic electrical plasma [1]

Concept Generation

Sub-systems are generated according to the function needed by the plasma drilling system. After survey and analysis, three main sub-systems are to be designed as components for plasma drilling.

User Requirements	Engineering Specifications
Breakdown within the rock	Output voltage: ~400 kV
	Pulse rise time ~0.3 μs
Long service life for electrodes	Electrode service life > 100 h
Safety	Good insulation
High energy efficiency	Electricity loss in cable < 20%
	Probability of solid breakdown > 70%

Design Description

The design has a pulse generator to generate high voltage pulse, a drill bit to hold electrodes which conduct the high voltage pulse to the rock where electrical breakdown formed, and a circulating system to remove the rock fragments out. Steps that show how the system work are:
Step 1: Pulse generator generates high voltage pulse.
Step 2: High voltage pulse transmitted to the drill bit.
Step 3: Drill bit conducts the high voltage pulse to rock and explode it.
Step 4: Circulation system removes The rock fragment out of the system.

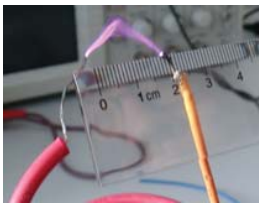


Fig. 2 Plasma arc generated by pulse generator

Modeling and Analysis

A model is built to simulate the drilling process conducting on a gypsum sample. The model involves drill bit dimension, drill mud model and circuit layout solved by PSPICE A/D. Theoretical guidance provided by the model to our design process.

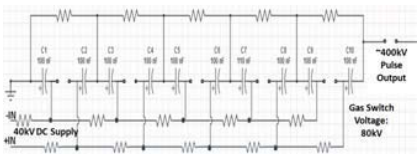


Fig. 3 Concept design on high voltage pulse generator

Validation

Validation Process:
Use remodeled Marx Generator together with Zero Voltage Switch(ZVS) to be high voltage pulse generator.

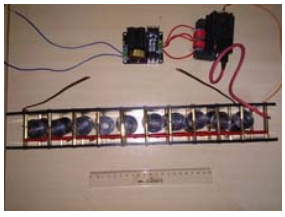


Fig. 4 Combination of Marx Generator and ZVS as pulse generator

In the component of the drill bit, copper is used to be the electrodes and the holders of them. Base of the drill bit is chosen to be acrylic.

Material of the drill stem, derrick and pipes are acrylic, aluminum and PVC, respectively.

Fig. 5 Circulation system together with drill bit structure

The drill bit drills on gypsum sample with high voltage pulse generated by Marx Generator. Circulation system using air as the drill fluid blows the gypsum powder out of the system to a glass tank.

Validation Results:

- The value of voltage is around the accepted level compared with our simulation result.
- The drill bit breaks the gypsum sample successfully and gypsum powder created.
- Powder retrieved in the tank by circulation system as expected.

Conclusion

Our first version design meets all of the engineering specifications, but further improvement is required. Discussing with our sponsor and remodeling, the final version of our design works even better. A air pump added to our circulation system to increase the blowing pressure, so that it works more efficiently.

Acknowledgement

Sponsor: Pengju KANG from GE
Mentor: Saijun MAO from GE
Pengcheng ZHU from GE
Kwee-Yan TEH, Chengbin MA and Vincent CHANG from UM-SJTU Joint Institute
Tianhua CHEN from UM-SJTU Joint Institute

Reference

[1] http://commons.wikimedia.org/wiki/File:Plasma_drilling.JPG

Development of a Large-Range Active Encoder for Precision Position Measurement

Sponsor: Prof. Peisen Huang
Team Members: Yizhe Cao, Yiqing Sun, Zhaoyang Xiong, Rongqian Zhang, Hui Zou
Instructor: Prof. Chengbin Ma

Problem Statement

Our team develops a method to get accurate position of a moving object through absolute encodes, which can directly measure the absolute positions of a moving object, thus largely decrease the possible accumulation errors. The desired resolution is one micrometer.

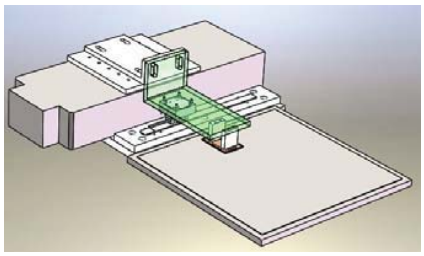


Fig. 1 Overall Structure
Image from Zhang Junbin, JI graduate school

Concept Generation

Four sub-system concepts are generated and several solutions to concepts are created from which we choose the best to determine the final decision.

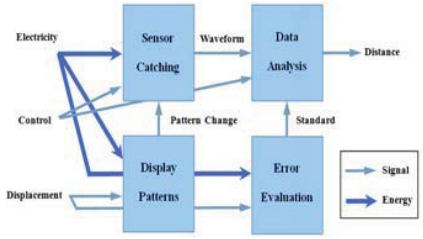


Figure. 2 Functional structure

Design Description

The display panel is where the display pattern will show image. In the real demonstration, a certain display bar pattern will be presented by coding. When we need to measure distance, the motor will drive the linear grating and the sensor together to a certain place. Then the NI board will send a trigger signal to tell the sensor to begin scanning the display panel.

After the sensor responds to the display pattern according to the luminance in the scope, it will transmit the analog signal to NI board. The board will then convert the signal into digital one by complex analysis and compare it with the encoder library to determine the position; therefore, we can obtain the distance. In terms of the validation, the linear grating is able to measure the length accurately. By means of comparing the two numbers can we determine whether our result is valid.

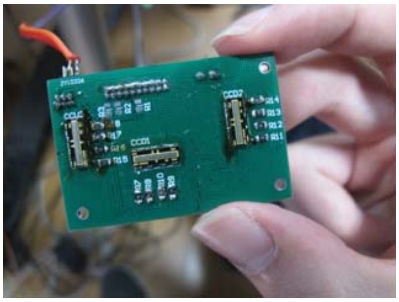


Fig 3. Sensor with 3 CCDs

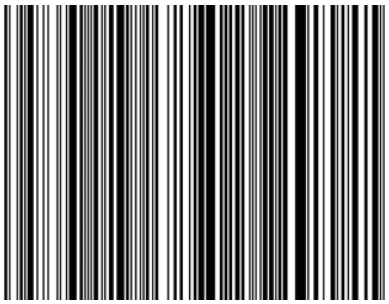


Fig 4. Coding Pattern in X-axis

Modeling and Analysis

The simulation system contains a display and three CCD sensors. Although in the prototype, we use only two sensors to detect x or y direction movement, the third sensor is parallel with first one in order to calculate angular deflection.

We optimize the accuracy of calculating displacement by using linear interpolation during data collecting.

Validation Plan

To validate our result, we use the linear grating system as our validation system whose resolution is smaller than 1um. The linear grating system tests the accurate displacement of a moving object in one dimension. On the prototype, the whole validation system is located besides the display panel. We take the display panel into two non-equal parts, one of which aims to match the linear grating.

Fig. 5 Validation System

Conclusion

In this project, we use a larger display to significantly increase the range of measurement. We have achieved the following tasks: selection of a suitable display, control of desired patterns on the display, selection of protection glass on the surface of the display, and construction of an active encoder. The construction of the active encoder involves the design of signal processing circuits and signal processing programs in Labview.

Acknowledgement

PEISEN HUANG and CHENGBING MA from UM-SJTU Joint Institute
JUNBIN ZHANG, JIAN GAO, ZONGHAO CHEN and ZHENG HUANG from UM-SJTU Joint Institute Graduate School

Auto-Pilot Control System for Small Unmanned Aerial Vehicle (Quad-rotor)

Sponsor: Prof. Chengbin Ma
Team Members: Sheng Hu, Lingxiao Jia, Yulin Shi, Xuan Yang, Li Yu
Instructor: Prof. Chengbin Ma

Problem Statement

Search and detection are always crucial for any rescue operation after disasters. Associated with this mission are some difficulties such as possible dangers for human search teams, inefficiency and detailed image capture. In this project, we designed and implemented a quad-rotor UAV with autopilot system to achieve search and detection while doing trajectory navigation.

Concept Generation

Our UAV could be divided into several functions such as control, protection cover and monitoring.
First, we divided control function into several sub functions including stabilization, orientation, and positioning. Our UAV can behave well only when these three functions work together.

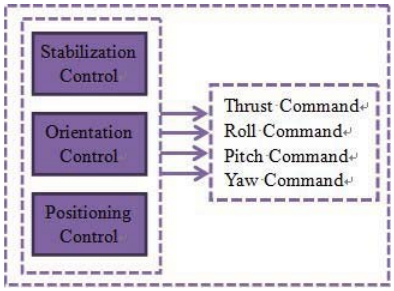


Fig. 1 Control Function

Next are protection cover and monitoring. We use protection cage to prevent UAV from crashing, and video recorder to monitor the image captured in air.


Fig. 2 Protection Cover

Design Description

The autopilot system is based on a MCU called Lisa/M v2.0. An Inertial Measurement Unit (IMU) is used to measure the flight attitude (accelerations and rotation rates), which consists of an accelerator, a gyroscope and a magnetometer. quad-rotor. A PID controller is applied to stabilize the attitude. A GPS receiver and a barometer are used to help the quad-rotor to hold in a target 3D position automatically. Fig.3 shows the hardware configuration.

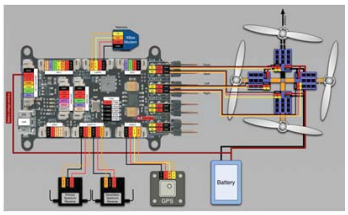


Fig. 3 Hardware Configuration

Once the quad-rotor is able to hold in one position, navigation is just about the work to change the target 3D positions continuously and smoothly. A flight plan is adopt to generate the consecutive 3D positions according to manually drawn navigation trajectories.

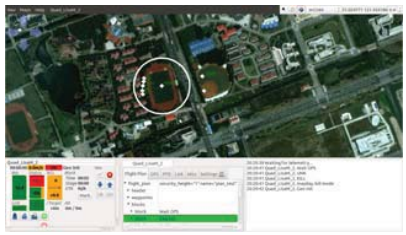


Fig. 4 Flight Plan in GCS

Validation

The most critical engineering specifications are the response rate, attitude control accuracy, and communication bandwidth and delay. We fully utilize the paparazzi system to help us with the testing.

Validation Process:

Response rate: This was measured by checking the telemetry message sent back by the UAV.

Control accuracy: Instead of theoretical analysis, the best way to check is through actual flight test, from which we can see if our UAV controls well under severe conditions.

Communication bandwidth and delay: We tested the bandwidth by maximizing the transmitting rate and measuring the throughput. At the same time, we monitored the delay through software.

Validation Results:

- The maximum response rate we measured was 100Hz, which is far beyond the specified 50 Hz.
- According to the testing we have done, the error was just around 10%, which is exactly what we expected.
- The testing results of the communication systems showed that the maximum bandwidth of Xbee can be 200kbps and is far above 100 kbps in average. The delay is around 30ms, which is much shorter than the specified 100 ms.

Conclusion

Our quad-rotor UAV provides an effective and efficient platform to achieve search and detection through automatic trajectory navigation. The basic functions include flight control, protection cover and monitoring, and they work together as a whole system. All the requirements and specifications are satisfied.

Fig. 5 Autonomous Flight

Acknowledgement

Chengbin Ma, Assistant Professor at Shanghai Jiao Tong University

Auto-Pilot Small Unmanned Aerial Vehicle (Fixed Wing)

Sponsor: Prof. Chengbin Ma
Team Members: Rongshen Xu, Jiqing Jiang, Peilun Xie, Yuqing Ying, Yifan Zou
Instructor: Prof. Chengbin Ma

Problem Statement

Unmanned Aerial Vehicle (UAV) can carry out tasks with no human pilots on board. The project goal is to develop a small UAV which can: 1. work in harsh conditions, 2. send back necessary information, 3. cost around 3,000RMB.

Fig. 1 Civil Application

Concept Generation

Sub-system concepts are generated according to the functions that the design need to achieve. Then optimized solutions are chosen.

Sub-problem Solution Concept

Ground control station	Position system	Platform	Data Link	Safety link (manual control)
Commercial system	GPS(commercial)	EPP + Hydraulic motor with aileron	Zibee	PCM receiver
DIY system	GPS(civil)	EPO + Electrical motor with aileron	Wifi	PPM receiver
Open-source system	Bei Dou	EPO + Electrical motor no aileron	Bluetooth	2.4 GHz receiver

Fig. 2 Selected Concept design

Design Description

Our UAV is a plane which can do autopilot flight according to control signal and flying plan. It can send back necessary information. Lisa Board is the main controller for the whole plane, which receives position signals from GPS and sends necessary information to Paparazzi control system through XBee module. Similarly, the Paparazzi system can send information to the plane through Xbee. Also, manual control can be achieved through the 2.4GHz Receiver.

Fig. 3 3D Overview of Platform

Fig. 4 Design Solution

Modeling and Analysis

The project consists of two parts: control part and platform. For control part, we use Lisa /M v 2.0 board as our autopilot board connected with Xbee S2B module, which serves as data link to exchange information between board and control station. In addition, we use Neo 6M as our GPS module. In order to well accomplish task, the communication range should be greater than 3km and the accuracy of GPS should be less than 5m. Other parameters can be displayed on control panel. For platform, we choose *SKY WALKER* model plane. We strengthen the plane to avoid unexpected rolling when we do test.

Validation

We need to test communication range and accuracy of GPS on campus first. When two Xbee S2B modules were 3.2km apart from each other, the information was still sent smoothly. Moreover, the accuracy of

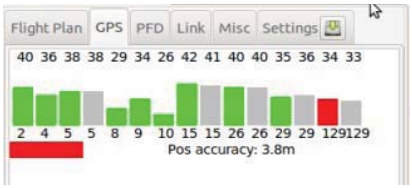


Fig. 5 GPS Accuracy

GPS is about 3.8 m, which was sent back through Xbee module. Then we put Lisa board on the platform. To ensure safety, we tested manual control before autopilot flight with the Flying plan. Controlled by manual operation through Lisa board, the plane flied smoothly. We can observe all parameters in control Panel. Plane could also fly according to flying plan.

Fig. 6 Control panel

Conclusion

According to potential problems and needs, we well generate customer requirement and our engineering specification. We have successfully completed the component design configuration. We also did test to validate our design. The test results demonstrate that our design meets all the engineering specifications. The most important feature of this small UAV is cruising accurately along a route without any ground control instructions. The future team can work on interaction between two small UAVs.

Acknowledgement

Chengbin Ma, Assistant Professor at Shanghai Jiao Tong University

Display Panel of Electric Vehicle(Phase II)

Sponsor: Prof. Mian Li, Prof. Chengbin Ma, ***National Instruments***
Team Members: Ke Dong, Lei Hong, Xin Xu, Yuting Shi, Shenghe Zhao
Instructor: Prof. Chengbin Ma

Problem Statement

Green Driving is among the most important concept on Electric Vehicles (EV). In this project, we are required to design a display panel based on the on-line information obtained by monitoring the dynamics of the EV. Parameters reflecting driving habits are calculated with data collected by sensors. Warnings will be given if user doesn't drive efficiently. Application to a prototype EV is required to improve Phase One's work into a practical stage.

Fig. 1 Electric Vehicle

Concept Generation

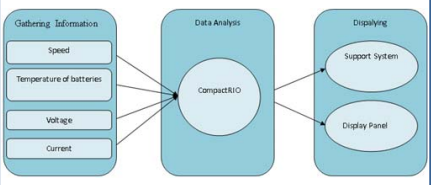


Fig. 2 Basic Structure

The project is divided into three subsystems. The first phase is to gather information from sensors and control monitor. Then information is transmitted to CompactRIO for data analysis, after which data is sent to display panel. Finally, front panel designed by LabVIEW shows the parameters.

Design Description

Both Rear Panel Design and Front Panel Design are implemented by LabVIEW.

Rear Panel Design (Block Diagram)
Instantaneous acceleration, average power, and average speed are stored.
Speed and Driving Mode:

$$linear\ velocity(km/h) = rotational\ velocity(rpm) * 2\pi * r(m) * \frac{60}{1000}$$

Remaining Distance:

$$Remaining\ distance = \frac{Remaining\ battery\ charge}{inst\ energy\ consumption}$$

Front Panel Design
General: General necessary information of a vehicle. If battery temperature is above 70℃, the alarm will be set on to remind the driver about the abnormal situation.

Fig. 3 General Part

Green Driving:
Idling Warning: To remind the driver to stop the motors if the idling time is too long.
Green Driving Judgment: As long as the average energy consumption is less than 1087 Wh/Km and sudden acceleration is less than 20 times per 10 km, it can be regarded as "green driving" and the leaf on the panel will turn green.

Fig. 4 Green Driving Part

Map: Panel is connected to a site map and serve as a car navigation.

Fig. 5 Map Part

Validation

Response Time of System
We focus on the response time of CompactRIO system. The first method is to use a random input vector from data input and calculate the time difference between input and output on CompactRIO. The second method is to use corner test vectors.

Online Data Accuracy
Margin errors from control monitor and voltage sensor are all less than 5%. Driving distance error band will be a little larger than 5%.
Temperature value will be less than the real value since we put the temperature sensors outside the battery.

Software Performance
In simulation, all the data displayed on the panel are correct and the text files storing the historical data all have a good performance.

Conclusion

The objective of our project is to design a panel that is user-friendly and oriented in the idea of green driving to help EV users drive in an efficient way.

Acknowledgement

Chengbin Ma, Assistant Professor at Shanghai Jiao Tong University
Mian Li, Assistant Professor at Shanghai Jiao Tong University

Development of an Optical System for Laser Drilling Breakthrough Detection with Illumination

Sponsor: Dr. Hongtao Li, ***Siemens*** SIEMENS
Team Members: Pengfei Li, Shuai Shaui, Ye Qin, Shijia Li, Xianheng Guan
Faculty Advisor: Prof. Huan Qi **Instructor:** Prof. Shane Johnson

Problem Statement

A series of holes are drilled on the surface of turbine blade for heat dissipation. Due to its variable wall thickness, unfinished holes or over-drilling always occur, which takes extra cost and time. The laser is separated into many short pulse, thus, it is significant to determine which laser pulse causes breaks through.

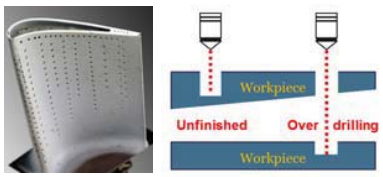


Fig. 1 (a) High pressure turbine blade [1] (b) Schematic laser drilling process

Concept Generation

- A camera to capture images
- Co-axial LED illumination
- Real-time image processing

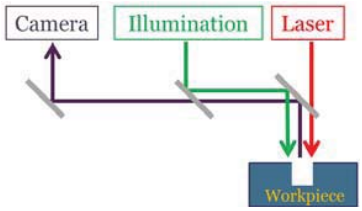


Fig. 2 Concept design of illumination system

Costumer Need	Engineering Specification
Adequate brightness	Lumen (lm) > **300** Diameter of lens (mm) < **25** Focus of lens (mm) > **20** Beam splitter emissivity
Feedback precisely	Image processing algorithm
No ghost image	Reflectivity
Light weight	Weight (g) < **1,500**
Not expensive	Cost (RMB) <**10,000**

Design Description

The design has a beam splitter with the antireflection film to partially reflect the LED ray, a protecting black box to prevent the light path from being polluted by the ash as well as the parasitic light. After the beam splitter, there exists a supporter to fix the filter. The beam splitter, combined with an enveloping box and the filter supporter are fixed with a top cap of the black box. The top cap is also the supporter of the LED light which has the function of adjusting the position and the angle as well, inside the top cap, a lens is placed to converge the spray of the light. Meanwhile, 4 holes is drilled to match the fixing screws of the laser beam machine.

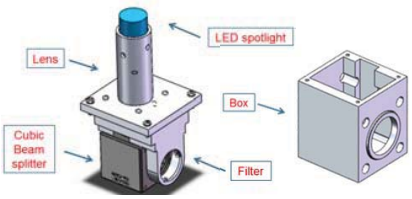
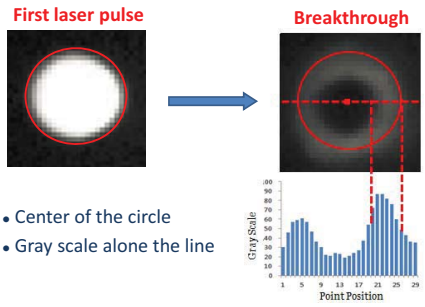


Fig. 3 Detail design of illumination system

Image Processing

Gray scale gradient method:



- Center of the circle
- Gray scale alone the line

Validation

Validation Process:

- Drill a series standard holes on a workpiece with illumination system
- Observe the holes by microscope to determine degree of breakthrough
- Improve algorithm on the base of feedback of image processing.
- Drill a hole and capture images.
- Run algorithm on captured images.
- Compare results with standard piece.
- Conduct repetitive experiment after algorithm improvement.

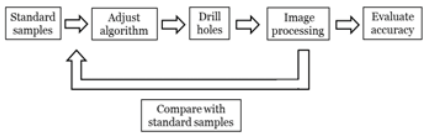


Fig. 4 Flow chart of test plan

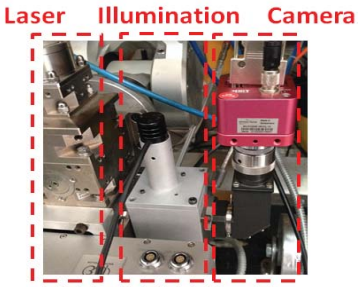


Fig. 5 Set up of illumination system

Validation Results:

- Co-axial illumination
- Enough brightness to be captured
- Improve the image quality
- Light weight (760 g)
- Not beyond budget (9500 RMB)

Conclusion

After the test on the prototype, the co-axial illumination system can improve the quality of the captured images, which is helpful for the image processing. The prototype meets the customer requirement and the algorithms works well.

Acknowledgement

Sponsor: Dr. Hongtao Li and Mr. Lin Yang from Siemens.
Prof. Huan Qi and Prof. Shane Johnson from UM-SJTU Joint Institute
Mr. Hongbo Zhao and Mr. Xiang Ren from Laser Lab, UM-SJTU Joint Institute

Reference

[1] *http://www.yxlon.com/Applications-zh/Cast-parts-zh/Turbine-blades-zh*

Photoacoustic Ultrasound (PAUS) for Co-Registered Imaging of Bone Structure and Vasculature

Sponsor: Shawn Ma, ***Covidien*** COVIDIEN
Team Members: Song Guo, Yao Hou, Chen Li, Tianxiang Xu, Yuhan Zhang
Faculty Advisor: Prof. Sung-Liang Chen **Instructor:** Prof. Shane Johnson

Problem Statement

Some diseases, such as cancer, cannot be easily detected in early stage. Both the two existing imaging techniques, photoacoustic and ultrasound imaging are not able to detect the osseous and vascular structure simultaneously. This project is to combine these two techniques to build the dual modality system and reconstruct the 3D image of human tissue.

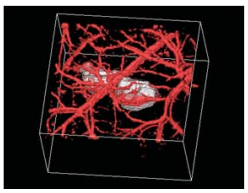


Fig. 1 3D image of human bone and vasculature [1]

Concept Generation

Sub-system concepts are converting the thermal energy caused by laser and energy of ultrasonic wave into digital signals. And a phantom should be designed to simulate the human tissue, since phantom can be easily used for validation.

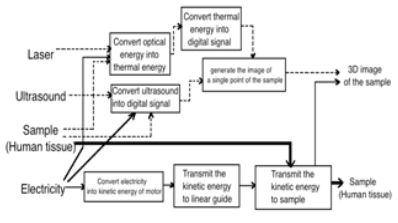


Fig. 2 Detailed structure function

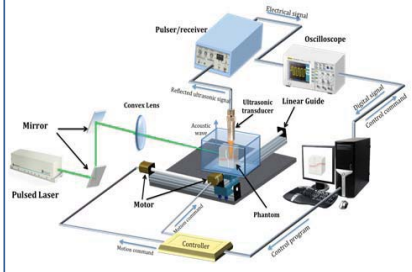


Fig. 3 Concept Diagram

Design Description

The design uses two step motors to move the phantom in XY plane. Three mirrors lead the green laser to shoot from the side of phantom to heat up the blood. The transducer receives the thermal signal reflected from vessels and also sends and receives the ultrasound signal reflected from the bone. The two signals of laser and ultrasound can alternately appear on the oscilloscope. Using labview, the signal can be transformed into data in Matlab. By dealing with the data of depth, the 3D image can be shown on the laptop screen.

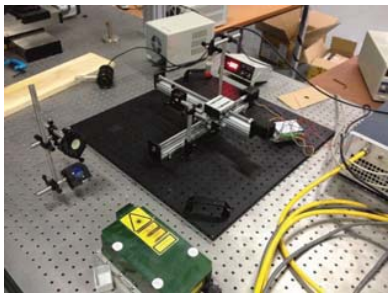


Fig.4 The whole set-up system

Modeling and Analysis

A matlab model is built to transform the depth data into 3D image. It firstly transforms the raw data into 2D image. The following graph shows a 2D bone profile of the phantom. Same modeling method can be used to transform 2D image to 3D.

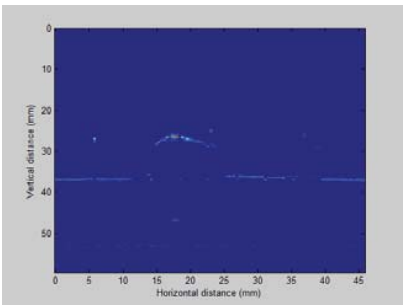


Fig. 5 2D bone profile

Validation

Validation Process:

For step length, a ruler was set along the track and then the running time was set for 100. Then the system ran. When it stops, the distance between starting and end can be measured.
For loading bearing, a 10kg object was put on the track and then system can be started. If the track can run normally and no deflections happen, it can meet this specification.
For data processing speed, a timer can be used to measure.
Some other specifications can also be verified using easy experiments.

Validation Results:

According to validation part, most specifications can be met.

- ✓ Transducer frequency>=10MHz
- ✓ Wavelength of laser>=523nm
- ✓ Motor speed>=1200mm/s
- ✓ Step length<=50um/step
- ✓ Load bearing>=10kg
- ✓ Weight<=100kg
- ✓ Cost<=500000RMB
- • Time for data processing<= 30min

√ means having been verified and · means to be determined.

Conclusion

Photoacoustic and ultrasound imaging techniques can be used for detecting osseous and vascular structures simultaneously. The key to achieve this goal is to set up the dual modality system. And also, the accuracy and speed of the detection is very important to form the images.

Acknowledgement

Sponsor: Shawn Ma from Covidien
Shane Johnson, Sung-Liang Chen and Huan Qi from UM-SJTU Joint Institute
Hongkun Lai and Xunjie Cai from UM-SJTU Joint Institute

Reference

[1]http://labs.seas.wustl.edu/bme/Wang/index.html

Full-Field Blood Perfusion Measurement Using New Infrared Techniques--Feasibility Study

Sponsor: Dr. Shane Johnson & Prof. Lipo Wang, UM-SJTU Joint Institute
Team Members: Dongyi Zhou, Weihao Li, Xiangxing Lv, Yang Liu, Ying Wang
Instructor: Dr. Shane Johnson

Problem Statement

Blood perfusion is the volumetric blood flow rate to a capillary bed, which is closely related to the extend of disease or body damage, and thus important for a reliable diagnosis. The only way so far to analyze blood perfusion is Laser Doppler Imaging, but infrared imaging technology may provide a cheaper and faster alternative according to the existing research. This project is to investigate the feasibility of using infrared techniques to analyze blood perfusion based on a heat transfer model and simulation experiments.

Infrared Image Analysis

Thermal images of a human wrist were captured by IR camera (FLIR, D7000) at 25 Hz sampling rate shown in Fig. 1 (left) with a picture taken by an optical camera (Fig. 2 right).

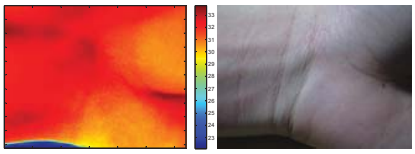


Figure 1. Infrared image (left) and optical image (right) for one experimental subject.

The region where the cardiac pulse can be palpated is indicated as Region of Interest (ROI), where thermal response due to heartbeat can be detected prominently. A motion tracking algorithm shown in Eq.1 is applied to eliminate the tiny movement of the wrist (see Fig. 2).

$$D_{n+1}^{(p,q)} = \sum_x \sum_y I_{n+1}^{(p,q)}(x,y) - I_n^{(p,q)}(x,y) \quad \text{(Eq. 1)}$$

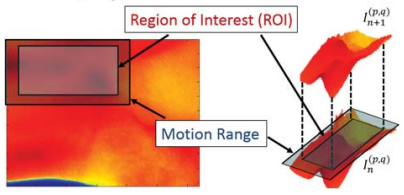


Figure 2. Region of Interest and Motion Range indicated in thermal image.

Electrocardiogram signal and transient temperature response of a small local area were plotted together shown in Fig. 3. Average amplitude and frequency were later on calculated by Eq. 2-3.

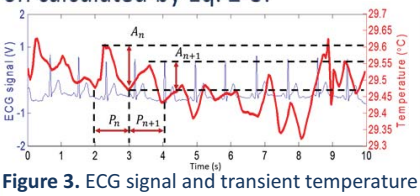


Figure 3. ECG signal and transient temperature response within a small square.

$$Average\ Amplitude = \frac{1}{N}\sum_n^N A_n \quad \text{(Eq. 2)}$$

$$Average\ Frequency = \frac{1}{\frac{1}{N}\sum_n^N P_n} \quad \text{(Eq. 3)}$$

Finally, temperature distribution (Fig. 4a) and frequency distribution (Fig. 4b) are obtained.

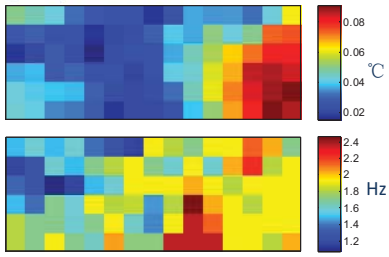


Figure 4. Temperature (a) and frequency (b) distribution within ROI.

Heat Transfer Model

An 1-D analytical model and 3-D computational model are built to investigate the effects of heartbeat regulation on the thermal response on human skin. The inlet mass flow rate was governed by Eq. 4 [1]:

$$\dot{m}(t) = 0.04 * \{1 + 0.3 * (\exp(-7 * sin^2(\pi t)) - 0.5)\} \quad \text{(Eq. 4)}$$

The blood flow in the vessel is fully developed laminar (Re<2300). The skin temperature distribution is described as the following Eq. 5:

$$\frac{T_{s,x} - T_\infty}{T_{m,i} - T_\infty} = \frac{U}{h_{out}} \exp\left(-\frac{UP}{\dot{m}C_p}x\right) \quad \text{(Eq. 5)}$$

A numerical simulation is carried out on blood vessel and tissue system (Fig. 5) using FLUENT 14.0.

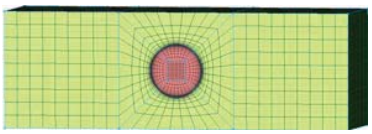


Figure 5. Region of Interest and Motion Range indicated in thermal image.

The steady state conditions are firstly solved with the maximum and minimum possible mass flow rates (from Eq. 4) to obtain the highest possible temperature fluctuation on the skin (Fig. 6). The highest possible temperature fluctuation is within 20mK. Results from the transient state simulation reflects a lower temperature fluctuation (<10mK).

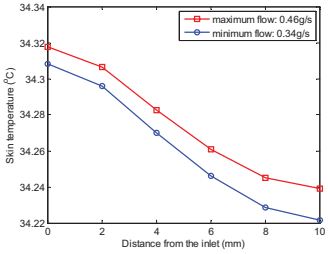


Figure 6. Skin temperature distribution on the skin that is closest to the blood vessel.

Conclusion

- The temperature periodic change at some local area on human skin has approximately the same frequency with heartbeat.
- It is theoretically possible to use infrared imaging techniques to measure the blood perfusion rate; however, a high resolution (at least 20 mK) is necessary.

Acknowledgement

Yaofei SUN from School of Mechanical Engineering
Yuliang Deng from Shanghai Center for System Biomedicine.

Reference

[1] Garbey, M., Merla, A., and Pavlidis, I., 2004, "Estimation of blood flow speed and vessel location from thermal video," Computer Vision and Pattern Recognition, 2004. CVPR 2004. Proceedings of the 2004 IEEE Computer Society Conference on, vol. 1, pp. I-356. IEEE, 2004.

Design of Low-Scaling Home RO System (Phase II)

Sponsor: Chen Wang, ***GE*** GE imagination at work

Team Members: Lingjun Fan, Rui Huang, Shaofeng Ou, Xintao Zhou, Ziyan Zhang

Faculty Advisor: Prof. Vincent Chang **Instructor:** Dr. Shane Johnson

Problem Statement

As one of the most important parts of our life, drinking water determines the life quality to a great extent. Therefore, to purify the water for drinking remains the top demands for most people. As an efficient solution, reverse osmosis (RO) system can filter tap water and generate pure water safe for drinking. However, the scaling, as the form of $CaCO_3$ due to the high water hardness, causes two main challenges that may decrease the efficiency -- low recovery rate and short lifetime.

Figure 1. Comparison between new and used membrane

Concept Generation

Concepts are seperated into two major stages -- restrain and remove scaling, with two kinds of methods -- chemical and physical ways.

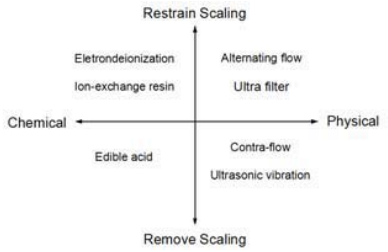


Figure 2. Concepts classification

After combining engineering specifications and customer requirements, the final concept is chosen as edible acid washing system.

Design Description

As the most safe and stable edible acid, citric acid is applied in our design. When the recovery rate has decreased to 10%, citric acid loop will be launched to wash off the scaling.

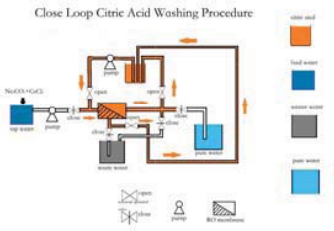


Fig. 3 Close loop for citric acid

After washing, the loop will be set to normal mode and generate pure water again.

Design Set-up

Pedestals and containers are designed to test the RO filter elements individually. In addition, the set-up saves space and can support several kinds of testing.

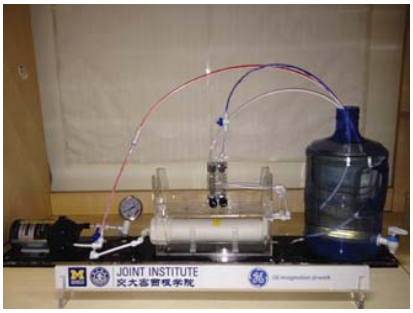


Fig. 4 One set-up

Test Plan

To determine the concentration, driving pressure and working time of the citric acid washing system, test plan is made as following:

Test	$CaCl_2$ Concentration (g/L)	Citric Acid Concentration (g/L)	Pressure (psi)	Working Time (min)	Acid Washing Time (min)	Cleansing Acid Time (min)
Aging Test Line	0.18	N/A	65	1200	N/A	N/A
Line 1	N/A	20	20	300	300	N/A
Line 2	N/A	10	20	300	300	N/A
Line 3	N/A	40	20	300	300	N/A
Line 4	N/A	20	10	300	300	N/A
Line 5	N/A	20	30	300	300	N/A
Line 1	N/A	0	P0	1200	5 every 60	N/A
Line 2	N/A	C0	P0	1200	5 every 60	5

*C0 & P0 will be obtained by Acid Pressure & Concentration Test

Aging Test

Acid Pressure & Concentration Test

Regular Acid Washing System Test

Figure 5. Test Matrix

Validation

Through aging test for over 10 hours, five RO filter elements are polluted to the recovery rate of 10%. After fitting, the recovery rate curve shows:

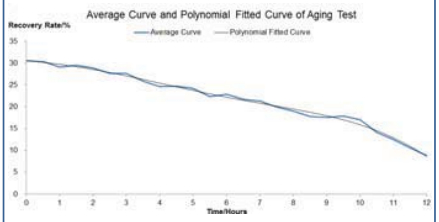


Fig. 6 Fitted recovery rate distribution of RO filter element after aging

By adding citric acid with different combination of concentration and driving pressure, test results are disposaled into the following chart:

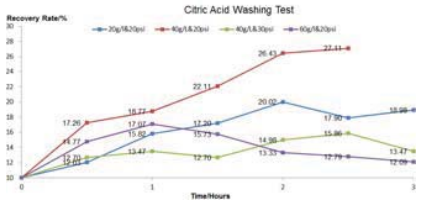


Fig. 7 Recovery rate distribution using different concentrations and driving pressures of citric acid

Conclusion

The result of regular washing system shows that the citric acid is a safe and high-efficient method to solve the scaling problem and improve the recovery rate of the RO system.

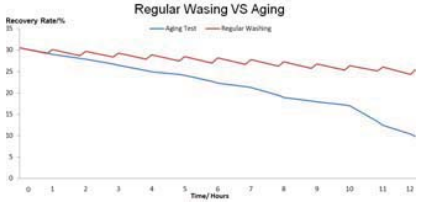


Fig. 8 Contract between normal aging and regular washing system

Acknowledgement

Chen Wang from GE
Dr. Shane Johnson and Prof. Vincent Chang from UM-SJTU Joint Institute
Prof. Liu Ping from Chemistry Department

J-Eye: Head Mounted Display Device

Sponsor: Prof. Wenjie Wan, UM-SJTU Joint Institute
Team Members: Daxiao Xu, Bo Zhang, Haiyue Zhang, Xuesong Peng, Zheng Gong
Instructor: Prof. Shane Johnson

Problem Statement

A Head Mounted Display (HMD) device is a display device, worn on the head, that has a small display optic in front of one (monocular HMD) or each eye (binocular HMD)[1]. The project goal is to make a radiation free HMD device, by designing an optical system.

Requirements

Reducing electromagnetic radiation is concerned in the first priority of J-eye. J-eye should be convenient to use and comfortable to wear. J-eye also needs a reasonable price. The use-method should be simple. See details in table 1.

Table 1 Requirements

Customer Requirements	Engineering Specifications
Comfortable & Convenient	Size: 2x3x2cm (image-receiving part) Weight: 40g (image-receiving part)
Clear	Resolution: 300x300px
Easy to use	Steps to use J-eye: 3 steps
Reasonable price	Cost: RMB 2000
Low radiation	Circuits embedded: 0cm^2 (image-receiving part)

Design Description

The function structures and concerns are described as following:

Video Generator: Video source, could be iPhone or iPad

Projector: Convert video signals from the video generator into optical signal.

Lens System: Tamper optical signal into long fiber bundles.

Fiber Bundles: Transmitting the optical signal.

Lens: Enlarge the image.

Mechanical Structure I: Capsulate the lens system and projector.

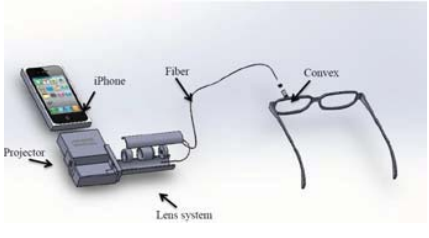


Fig. 1 Overall Structure of J-eye

Mechanical Structure II: Fix the lens part on the glasses.

The concept of design is as Fig. 1. The real model and planform can be seen as Fig.2.

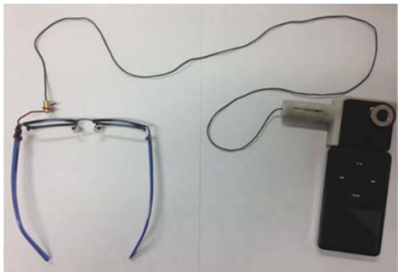


Fig. 2 The Planform of J-eye

Modeling and Analysis

The design of lens system is kind of like a telescope. The magnification and total length are considered as very important. The focal length of the two lenses in lens system is f_1 and f2. According to the Telescope model, the magnification and the length of the system is

$$M= f_1/f_2 \ ,L= f_1+f_2$$

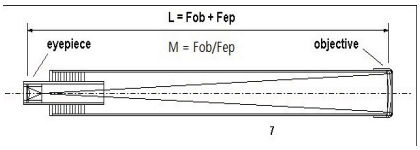


Fig. 4 Telescope Model[2]

The final design of lens system is as Fig. 5

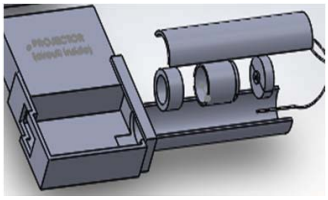


Fig 5. Lens system design

Manufacturing plan

In this project, manufacturing plan is mainly for mechanical structure3D printer is a good and cheaper way to fabricate the complicate part.

Fig.6 shows the designed structure and the printed one.

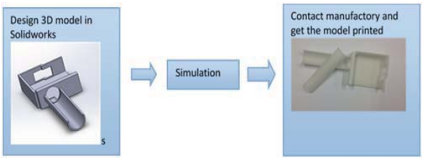


Fig. 6 Manufacturing flow

Validation

The field of view can be calculated by equation. The result tells J-eye is big enough for the user to catch the image.

The expected weight of the glasses part is below 40 grams as determined in the design review 2.

It is considered to do no radiative harm to users. Locating a radio near J-eye (around ten centimeters in distance) in a room isolated from electrical radiation and set the waveband of the radio to AM. The result tells J-eye is radiation free.

Conclusion

The idea of J-eye comes from the recent trend of Head Mounted Display equipment. Tens of HMDs are present in the market, which showed us a fantastic way of phoning, taking photos. J-eye is supposed to achieve the similar functions while getting rid of the radiations of present HMDs.

Acknowledgement

Sponsor: Prof. Wenjie Wan from UM-SJTU Joint Institute
Instructor: Shane Johnson from UM-SJTU Joint Institute

Reference

[1] http://en.wikipedia.org/wiki/Head-mounted_display
[2]http://www.funsci.com/fun3_en/tele/tele.htm

ishare

Instructor: Vincent Chang

Team Members

Ditian Liu, Yijun Pan, Jingyuan Peng, Zeyu Wang Li Zhonghan

Needs Statement

Taxi is considered to be a very expensive way to go out. Besides, taxi resource is not always adequate, especially in the rush hours. So, our company want to solve these problems by sharing taxis with others. In this way, we can not only save our money but also reduce the emission. Our company, "ishare", will provide a platform for Shanghainess people to share the taxi.

Business Idea

"ishare" is a for-profit company that provide taxi-sharing service for Shanghainess people. Through our APP, users can form a group with the people who are near you and going to the same destination. Then the group will choose a meeting point and meeting time. At last a taxi will come and pick you up. Safety is our No.1 focus and we also ensure the response time of our service is the shortest. Our goal is to save our customers' money and time.

Figure 1 : Logo of ishare.

Mission and Value

The mission of our company is that *ishare makes taxi sharing popular and regular*. Actually, *for the present extremely heavy traffic and comparative limited taxi resource, our company intend to provide the sharing taxi way with high effectiveness, convenience yet safety and meaningfulness. We aim to pursue stable customer relationship, accept feedbacks from customers and drivers punctually, in order to discover opportunity of taxi Sharing as much as possible.*

The vision of our company is that "to both improve traffic condition in cities and save money and time for taxi trip". As for a more vivid description, as people choosing our company, they will no longer worry about calling a taxi. Valuable time and considerable money will be saved, and will be a great experience that making friends with people that living in the same city, thus people continuously using our APP.

Hedgehog concept

The hedgehog concept of our company is that we will be the most professional, influential taxi-sharing service company, with high profit per taxi share. To be the best in the taxi-sharing industry, we will use identity registration system to ensure the safety of passengers, and we will develop a 2-minute fast-matching system to save time for passengers. To gain profit, our company chooses to collaborate with taxi companies, which will also help us promote "I share" ideas in the city. Our team is strongly passionate about our services, and we believe we will achieve our goals.

Company Building

To build a our company, we first need to design a website and an APP for our product. We design both mobile terminal APPs for drivers and customers.

For customers' APP, it can match the people around you who are going to the same or nearby destination.

For drivers' APP, it's function is to tell drivers where the customers are and how much tips you will get.

Secondly, we need to negotiate with all the taxi companies in shanghai and cooperate with them to combine this huge amount of taxis and build a "shanghai ishare taxi union".

Then, we are going to advertise our company. We have an advantage in advertising that we can put our advertisement on all the ishare taxis.

Finally, we will rise some activities to spread this sharing living attitude and green life style to the public. Through this, we want to realize our social responsibility.

Here shows the APP design for our product

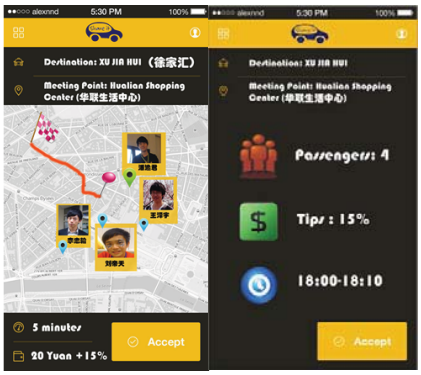


Figure 2 : App design for ishare

Conclusion

Overall, we want to build the most influential taxi-sharing company, to provide citizens with more efficient and convenient way of travelling as well as promoting "I share" ideas in target cities. To achieve our goal, we have designed a taxi sharing app and have done some researches on similar companies. Throughout the whole process, our team learns lots of leadership and company management skills, and we have tried our best to apply the knowledge into the practical company.

Acknowledgement

Dr. Vincent Chang, Professor at Shanghai JiaoTong University

Pharos

Instructor: Vincent Chang

Team Members

Shijia Li, Yazhe Hu, Hao Zheng, Hanlin Shi, Tianhao Zhou

Needs Statement

We are required to form a team and come up with a plan on how to build a company in this course. Therefore, we started our company, Pharos using the business skills taught in lectures.

Business Idea

Our company built a website that provides information and services for oversea colleges application. Students can read articles, watch viedo materials on our website, and they can even chat with the authors. Our aim is to build connections betweens students and successful applicants, which will not only benifit the students for their application, but also their future career. What we focus is graduate education application, so our customers are mainly undergraduate students. Our company is nonprofit, students can improve their skills of writing and have a better understanding of themselves during the procedure..

Mission and Value

Our company's mission is that Pharos should be a website where students can learn useful skills which can benefit them throughout their future career. In other words, we will let our student win in their whole career instead of only one or two application. In addition, our value is that we will always focus on improving our students' soft skills. Our company's vision is that "In the future, students will not need to waste their money in a single application. Instead, they only invest their future by using Pharos." Our vivid description is that students will frequently visit our company's website no matter they need to write an application or not, because they want to improve themselves and be more competitive. Like in Figure 1.

Figure 1 : The reason why we are better.

Hedgehog Concept

What our company do is continuously building a bridge between the successful applicators and students who tends to apply for overseas education. What motivates us to do this without charging anything is that we are deeply passionate about helping others especially the students like us. In addition, we believe that we can succeed in this area because we have advantages of resources - lots of our friends and school mates are successful applicators who have valuable experience in the flesh. As for our economic engine, we will maintain the platform by sponsorship and the voluntary donation from our customers. Hedgehog concept is shown in Figure 2.

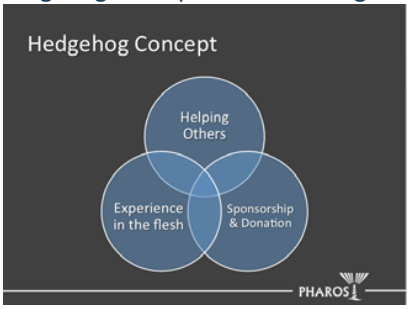


Figure 2 : an example of an idea on company's website –"Idea Market"

Company Building

As a website-based company, we apply our engineering background knowledge to construct an "overseas-application service" website, with the functions of posting articles and holding online 1-to-1 chatting service etc. This website will be the main tool for us to contact with our customers and our volunteers. By posting the articles and videos of our mentors and getting feedback from customers, we build an interactive platform. Whether charging or not will be decided by the mentors. Because our company is nonprofit, we will only request 5% out of the fee that customers paid for mentors. This money will be used only to support the operation of our company. At the beginning, our company will have two departments, which are IT department and marketing department. IT department will take charge of the maintaining and development of our website, while marketing department is in charge of finding mentors and advertising on social network to popularize our company.

Conclusion

Our company is a nonprofit platform to help students who are willing to apply to oversea colleges. We use articles, videos and online chatting with experienced applicants to help students' application. Our mission is to help students familiar with application and help them consider their future career when they are applying. Our company is a better choice for students comparing with existing companies and DIY in three aspects: time cost, money cost, and benefits for future career. We are better in all these aspects, and applicants can really get benefits from our company.

Acknowledgement

Dr. Vincent Chang, Professor at Shanghai JiaoTong University

Supermarket Online Ordering System

Instructor: Vincent Chang

Team Members

Jiada Chen, Weihong Lou, Handong Wei, Jiesheng Zhang

Needs Statement

In this course, students are asked to form a project team and be entrepreneurs to start their own company. Therefore, we created a company based some of the important concepts and strategies learned in classes.

Business Idea

QLess is a company that aims to combine the advantage of offline supermarket chains like Wal-Mart, and that of online shopping stores like Yi Hao Dian, so as to form a novel shopping habit for customers. The supermarket chains have good reputation for goods quality, and online shopping stores are convenient and cheap in goods. The combination of these two aspects would be a great favor for the public.

Figure 1 : The logo of QLess company.

Mission and Value

The social mission of our company is that our company should save customers' time and money by bring highest quality goods with most reasonable price to customers' house. Our company's success is based on every satisfactory shopping experience offered by QLess to the customer. Our product mission is to improve the selling performance of supermarkets so that they can compete with online stores. Our economic mission is to operate the company on a sustainable financial basis which allows the growth in the quantity of the supermarket joining us and the quality of our services.

The mission of our company is to improve people's life by saving their time and money. The more we can save for customers, the more successful we QLess can be.

SMaC Recipe

Our company only focuses on improving the selling performance of supermarket chains. The supermarket has high reputation for goods and complete after-sale services, which are exactly the shortcomings of online stores. Also, our company only sells goods that can be contained by the shopping bags. This recipe is solely for the convenience of delivery. We do not want to add difficulty to delivery services due to the new shopping habit created by QLess. In addition, we should retain the conventional shopping experience, which is familiar to customers. In order to stick to this recipe, our company particularly designs a 3D online shopping system. This system can to the most extent demonstrate the real goods customer would see in the supermarket. At the same time, customers can know exactly how many goods they have bought, and easily add or drop goods by a click. This system can be specialized according to the requirement of different supermarkets.

Figure 2: QLess 3D online shopping system

Company Building

In order to form the real QLess company and make run our business model, we need to firstly recruit talents to establish the website for the online ordering system. This website should include the discount information of those supermarket chains which are near to the place the customer come to our website. This is a way of attracting everyday customer flow for the website. On the basis of a high customer flow, we need to negotiate with supermarket chains to convince them of the profitability of joining our online ordering system. Once they agree to form a partnership with us, we will design the 3D online system for them and put it online. We gain the income by charging the partnership fee, and 1 % of the total charge per customer bill. A reliable delivery system should be established either by the supermarket itself, or by certain mature delivery company in the market. The more supermarkets we can have partnership with, the more successful our QLess can be in the future.

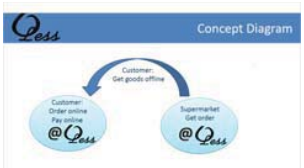


Figure 3: The concept diagram

Conclusion

Our final design can attain of initial purposes of building a company to bring the best goods with most reasonable price to the public. Also, supermarket chains can definitely benefit from our business model.

Acknowledgement

Dr. Vincent Chang, Professor at Shanghai JiaoTong University

Amour

Instructor: Vincent Chang

Team Members

Gongxiang Gao, Yao Hou, Robert Li, Yangtian Li, Erfan Xue

Needs Statement

Our modern society has put more effort in making a life of a handicapped easier. As for examples, elevators in subway stops, ramps next to staircase, and etc. are all very good example of how the government is being more considerate. However, these are all physical assistance for the disabled, and a lot of their nontangible needs are not fulfilled, such as finding a life partner, their true love.

Company Idea

Our company is a nonprofit organization that offers to help the handicapped to find a match. We are a matching center specifically made to include the disabled in our program. Most of our services will be based on call-on service, online service, and most of all, services brought to our customers from our agency. Therefore, our customers' privacy can be better preserved and specific services can be provided.

Figure 1 : the business model of our idea (Online-based database, with one-to-one call on services, to ensure our service quality, as well as protect the special need of the disabled.)

Core Purpose

We are to seek parallel right for the disabilities to pursue love.

Core Value

Our Core Value is specially designed for services on handicapped people.
Put ourselves in each client's position.
Face right up to our client's problems.
Hospitality and Respect.
Social responsibility.
Create social impact.
Be proactive.

SMaC Recipe

Since our company mainly focuses on solving marriage problem for disabilities, except for some core team members, about 80% of our workers will be student volunteers. In terms of service, we will combine call-on service with website service, and call-on service is provided to help those disabilities who have trouble in surfing the Internet. In addition, we will keep trace of each new couple's life twice a year in the following three years to know about their situation after marriage. To create a positive social impact, our company will deliver a report to the community and the municipal monthly. Besides, we will keep active contact with other charity organizations, and hold relative forums to discuss every quarter.

Financial Model

As a non-profit organization, how to provide wonderful services and also, survive in this world is a major concern. The following chart shows how we are going to achieve the financial balance.

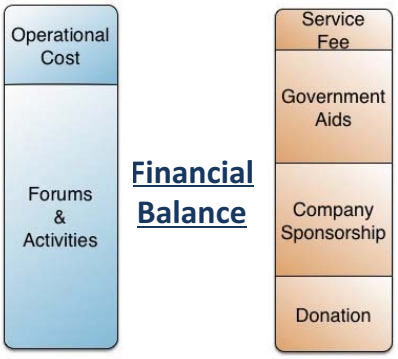


Figure 2 : the left is the costs, whereas the right one is the income.

From the chart, we can see that our income is mainly from government support and social donations. As to the costs, we will spend most of our fund on holding forums and activities where our potential customers can have more chances to find their love.

Envisioned Future

We imagine a day, that with our services, it will no longer be a problem for the disabilities to find their life partner. People, no matter what challenged, shall be able to find their Mr./ Mrs. Right through our platform. The marriage rate of the disabilities will rise significantly. More and more handicapped brothers and sisters can find their lifelong love, and "Complete Love" will become a millstone for the social impact towards the disabilities.

Acknowledgement

Dr. Vincent Chang, Professor at University of Michigan - Shanghai Jiao Tong University Joint Institute

Guys' Generation

Instructor: Vincent Chang

Team Members

Zili Lin, Hanwen Ren, Bihan Zhu, Dan Wang, Ziyue Xia

Needs Statement

Nowadays, online-shopping becomes more and more popular. There are too many rebate networks for online shopping and different networks have different rebates for a certain product in the same store. Since customers want to save time as well as get the cheapest price at the same time, we need to build a rebate network researching website to collect comprehensive information of goods from all rebate networks.

Business Idea

According to these needs, we create a website called *Rebate Monster* in order to benefit all the consumers who are fond of shopping online nowadays. Rebate Monster is a database that cover the rebate information of goods from all of the rebate networks. Then, consumers would no longer need to spend their valuable time searching several rebate networks to get the cheapest thing they want any more, they can just use the search engine in Rebate Monster to help them find the most reasonable price. Also, consumers don't need to worry about the accuracy of the information as we would update them constantly.

Figure 1 : The logo of our website

Vision

Core Values: "We would respect all the consumers and think on their sides." We would use our great passion and earnest attitude to build *Rebate Monster* in order to benefit all consumers most.

Core Purpose: "Make online shopping timesaving, cheaper and more convenient." We would use *Rebate Monster* as a tool to totally change people's mind about online shopping. They may fall in love with this new kind of shopping method very soon.

Target BHAG:"Become the most influential rebate information collection websites." We would be the first rebate network searching website as well as the strongest one. Not only do we find this field, but also we would defend it.

Vivid description: "The information in our website is accurate and up to date. Our website would satisfy all the desire of consumers and be popular among Chinese online shoppers very soon." Finally, we will be the No.1 in this field and all online-shoppers would regard our websites as one of the top sites they love most.

SMaC Recipe

Our company covers data from all rebate networks and use feedback system to grade them. What's more, we will keep the information updated from time to time so that the consumers can get the newest price of a certain product. To provide the best service, we will also walk on customers' shoes. When making decisions, we will consider the benefit of customers, rebate networks and *Rebate Monster* to realize three-win to ensure that our company can have a better development for a long term. In order to promote our website, we will cooperate with famous company.

Company Building

Our main goal is to become the first choice for customers who use rebate networks. The first step for our company is to build up a website called *Rebate Monster* with an app which can install on customers' PC and mobile phones. This step need to include some IT engineer and we can just use the human resource in the school for this. The second step is to cooperate with the companies. We will first build relationship with rebate networks, then, try to get the advertisements and investments from some famous companies like Baidu or Tencent. It will ensure that our company get a basic financial source as well as a good reputation.

Figure 2 : An example of the searching result Page of Ferrero chocolate

Conclusion

Rebate Monster can really help all the online shopping consumers by providing a quite convenient searching engine. Our website can indeed create a new kind of online shopping method. Then, online shopping would no longer be a time consuming issue. Eventually, our website would change people's thinking of online shopping completely.

Acknowledgement

Dr. Vincent Chang, Professor at Shanghai Jiao Tong University

Green Chic

Instructor: Vincent Chang

Team Members

Nima Jowkar Deris, Shengqi Fan, Junming Liu, Tong Xie

Needs Statement

As the environmental damage caused by manufacturing companies are getting increasingly large these years, there is a need calling for the green household supplies. Also people want a modern and elegant house hold products. The question is how to answer these two needs of people? Green Chic is the answer.

Business Idea

We start a company called *Green Chic* which makes the environmental friendly household supplies. We are not just satisfying people's temptation for chicness, but also manufacturing our products with the least possible amount of environmental damage. To make sure our company makes the most environmental friendly products, we do all the process of designing, manufacturing, selling & marketing without any intermediate company

Fig 1. Green Chic's Logo

Vision

. Core Values

Green Chic provides the household supplies with best quality but least environmental damage. We are going to be a pioneer in the industry & also respect elegance and treasures creativity.

. Core Purpose

To adapt elegant modern life to environment.

. Twenty-year BHAG

Green Chic is going to be the dominant player in household supply field &and lead to an environmental friendly lifestyle throughout the world. It is also going to hold the most advanced technologies of the industry.

. Vivid Description

We will give a new life style to all the people around the world, in two or three decades our brand is going to be named one of the Saviors of our today's environment that transformed human's modern life to a new different era.

Hedgehog concept

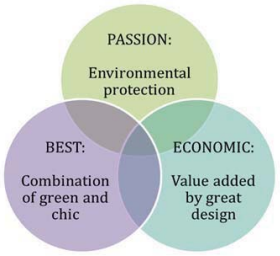


Fig.2 Hedgehog Circles

We believe by spreading our products and ideas, people will care more about their environment. The environment damage can be minimized with everyone's effort.

Now in the market, there are companies only focusing on fashionable household supplies or only on environment friendly products. Our company can be best at combining these two together, by recruiting great engineers to develop environmental friendly material and energy saving technics, as well as great designers to ensure the products are elegant and stylish.

Our main economic engine is the value added by great designs. There are few people willing to donate help for environmental protection directly, but our customer can donate their help by buying our products without even knowing they are helping.

Company Building

There are already several famous brands in household product industry which is very difficult to compete with. In first decade we focus on some few massive retail stores in major cities of the world. After our brand introduced among people, we start to open more massive retail stores in other major and small cities.

we will carry out a lot of advertisements in first years to publicize our company among people. Our company's advertisements let people know they can only make a contribution to environmental protecting process as at the same time the can enjoy an elegant life.

To attract customers & take their attention from famous brands we provide different customer services such as nonsense return policy, member card system & special services for all of our employees and their members.

Conclusion

Green Chic can provide an answer to our needs statement which was adapting elegance & environment. We designed this company to make sure all the process of designing, manufacturing & marketing of a company can be green & chic together. Through the whole process of this project we learned how to face up to our needs and be more realistic.

Acknowledgement

Dr. Vincent Chang, Professor at Shanghai JiaoTong University

Family Plus

Instructor: Vincent Chang

Team Members

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Needs Statement

Nowadays, with the economic development of China, more and more young people leave their hometown for better work. Fast change in electronic products lead to communication gap between young and their parents. An easy-use product is needed for old people.

Business Idea

We start a company called *Family Plus* which specializes in family-use social networks. We focus on the current situation of Chinese family, especially those living in different cities. Parents tend to view the moments of their family while don't know how to use the digital devices. Thus we provide a digital photo frame that can be updated though web connection. Young people can use mobile application to update its content for their families.

Figure 1 : logo of Family Plus

Mission and Value

In order to expand the presence of the company, three missions should be developed. Our social mission is to spread the family love through China, which is also the main purpose of the product. Therefore, better humanized design is sought to achieve the mission. Besides, the product mission is to enforce more families to get accessed to the operating of the electric album. To reach the mission, we value the simplicity of the product. The third mission is the economy mission，which is that most families can afford the price of the album. So, low-cost marketing is valued to reduce the price.

Figure 2 : Simple is beautiful – UI and digital frame of Family Plus

SMaC Recipe

To make our product win in this fast changing world, we came up with some simple principles that we hope to persist on. First we will keep the frame as simple as possible. Only a power button will be designed on it, so that elder users can share the best moments of their children, without any efforts at all. This is the original reason for us to found this company, and what makes us persist, dedicate, and strive to win. Moreover, we will stay away from video functions and focus on the photos. Video function will need more storage and largely add the cost.

Company Building

Family Plus consists of a group of experienced and ambitious employees. There are three main departments in the company including software department, sales department, and logistic department. The software department develops and updates software of Family Plus, which could ensure customers to use the latest and finest mobile application. The sales department promotes and sales the Family Plus related product. There are many strategies for the promotion such as family combo during traditional holidays such as Spring Festival and Mid-autumn festival, which have strong family reunion atmosphere. The third department is logistic department which is in charge of the supply chain and production flow. Meanwhile, this department will evaluate customer feedbacks and provide suggestions for the whole company.

Conclusion

The ultimate goal of our product is to close the spiritual distance between family members. Especially for those old people who stay at home alone without any child. We can definitely provide a simple way for the elderly who are poor at using electronic devices to see how their children are and what their children are doing. We want to give the elderly a feeling that their children are still close to them and deeply love them, even if they cannot share their life face to face. The feeling of users will always have the top priority level in the research and development process of our company.

Acknowledgement

Dr. Vincent Chang, Faculty Director of Corporate Relations & Lecturer at Shanghai Jiao Tong University

Idecoration

Instructor: Vincent Chang

Team Members

Peihao Ding, Zongtai Luo, Ran Tian, Dilin Zheng

Needs Statement

The world is becoming more and more intelligent all the time. And the young are in favor of smart things, including intelligent decoration. However, there are few of intelligent decoration companies in China. So, there are great needs of intelligent decorations in China.

Business Idea

We build a company called Idecoration. The core purpose of our company is to make people experience convenience, comfort and intelligent in their own home by using intelligent decoration. And the goal of all company is to make more and more people know about intelligent decoration, and buy our products. To make our goal come true, we are going to build an innovative decoration experience center, and people can experience and buy our innovative decoration in it.

Figure 1 :a example of innovative decoration

Mission and Value

Mission:

The mission of our company is to make people have a new and better life style.

Value:

To do so, Idecoration focus on innovation and humanization. In the traditional home, people spend too much time on cleaning their homes and take care of their homes

With the help of artificial intelligent, we hope to make the house able to take care of people. Home is a place where can make you feel smart and **comfortable. Idecoration intend to provide intelligent house furniture to make your** home become a dream home.

Hedgehog Concept

What we are deeply passionate about:

Offer a better and smart home to customer and bring the most advanced and complete home decoration into everyone's home.

What we can be the best in the world at:

Idecoration is a intelligent house decoration retail company which is the best in user experience around the world.

What drives our economic engine:

Idecoration making profits by per customer experience. The experience center will attract customers and build our reputation.

Idecoration is an intelligent house decoration company which concerns most about user experience and make profits per customer experience.

Company Building

Idecoration is born to bring intelligent homes to families in China. Idecoration will consist of professional and passionate people. We are good at communicating and will find out what our customers want through the best human experience in the world. At the very beginning, we will focus on finding intelligent furniture companies. We will help them popularize their products as well as get sponsors from them. We will have the most integrated and diversified intelligent housing system in our user experience center, which is exactly the ideal intelligent home. Additionally, we may seek house agents so that we can have best channels for sale. In this way, we will define what an intelligent home is like and make more and more people know, accept and desire an intelligent home and hence the intelligent decoration become a real industry in China. After that, we will devote to simplifying the operations of intelligent housing systems unceasingly to enclose more potential customers of all walks including the old and the disabled. Let along comfortable, convenient, sweet and warm, your home will automatically serve you like an emperor because it knows what you are thinking. Idecoration is bringing you an intelligent life.

Conclusion

The idea about Idecoration is based on the passion to make people have a smart home. We analyzed the current situation about the Intelligent Furniture market and the manufacturers in China. The company has a big potential to be top in this market. We used the knowledge learned from the course to finish the conceptual design about the company. In the future, we believe that our company will be a star in the market.

Acknowledgement

Figure 1 is from: http://www.hgtvremodels.com/smart-home 2013/package/index.html

Dr. Vincent Chang, Professor at Shanghai JiaoTong University

The Innovative Solar Dryer

Instructors: Dr. Shane Johnson

Team Members

Xiang Gao, Jiahao Lai, Yunchang Liu, Sunming Qin, Minzhi Xue, Xian Zhang

Problem Statement

Trying to prevent our wet clothes from the contaminated city air, we are determined to create an innovative clothes-drying device, efficient and environmentally-friendly. Our aim is to achieve "zero energy consumption".

Concept Generation

Effective combination of solar furnace, thermal battery, clothes bag, and linkages propelled by motors makes our idea practical.

Design Description

Our device mainly consists of three parts: clothes bag, solar furnace, and thermal battery. City air is pumped through the air purifier to the solar furnace, being heated. The hot air then runs into the clothes bag to dry the wet clothes. Meanwhile, the thermal battery stays contacted with the solar furnace during the process so that the thermal energy is stored in the battery. When the temperature of the furnace drops below a certain point, the battery is separated from the furnace. With the energy stored in the battery, we are able to dry wet clothes even in rainy days or at night.

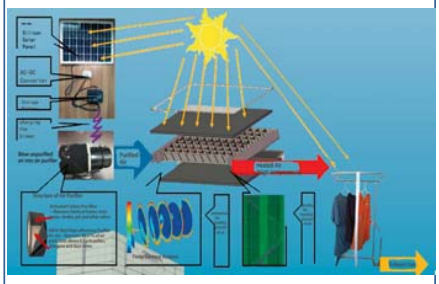

Fig. 1 Conceptual design of system

Fig. 2 CAD drawing of solar furnace

Modeling and Analysis

To achieve the highest thermal conductivity, we chose aluminum to fabricate the main structure of the prototype. Based on the finite element analysis of, SolidWorks® Pointwise and Fluent, we simulated the process of heat transfer. Air is being heated while passing through the furnace. The temperature of the air rises about 20 to 30 degrees Celsius while maintaining a flowing velocity around 3.5 meters per second. For simplicity, we choose the cylinder model to approximate the actual case. The first model is shown in Fig.3.

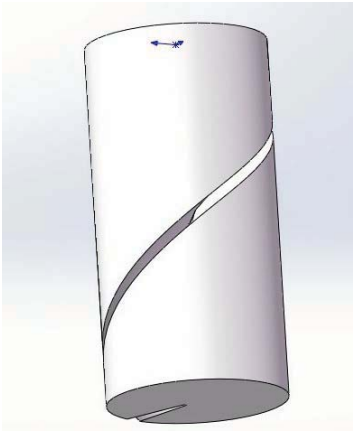

Fig. 3 SolidWorks to simulate air inside tube

Validation

We used Pointwise® to make further analysis of the simulation. We set two boundary conditions: one is a uniform heat flux on the shell of the tube and the other is a difference of pressure between inlet and outlet to simulate the effect of sunshine and air pumper. The first model by SolidWorks® is a buck of fluid within a swirling baffle and it is shown in Figure 4

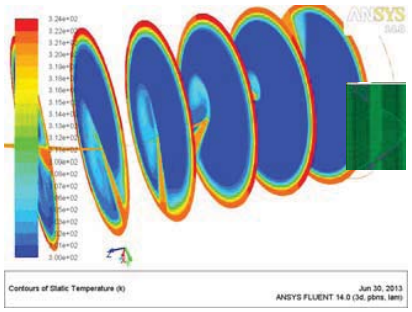

Fig. 4 Final mesh analysis

However, in reality, the situation may be influenced by variation of different parameters such as air humidity, solar intensity and so on. But basically, this model can be used to analyze.

Conclusion

Our final prototype can successfully solve the initial problem. Not only does it make drying clothes more efficient , but it also prevents the pollution. It makes it possible to dry wet clothes even in rainy days or at night. By this innovative, efficient and environmentally-friendly drying device , we make "zero-energy consumption" possible. At last, we hope to bring the "Energy Idea" into our daily life and the way we live.

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