Smart Faucet Co.

Final Report

Shareholders:

Duygu Güler -CEO

Cem Uran – Product Manager

Fulya Çevikel –Financial Manager

Ali Metehan Erdem –Graphic Designer

Cahit Taha İspir – Hardware Designer

Ümit Eronat – Software Designer

10.05.2011

Table of Contents

List of Figures

,

Executive Summary

Smart Faucet Co., established in 2010, offers a totally new aspect to the existing sensor faucet systems: temperature controlling with a simple hand movement without touching it.

Our target market is mainly the public building and area constructions, where there is a hot water main, such as hotels, stadiums, hospitals, universities, cinemas; which is mainly consisted of project-based market.

Smart Faucet Co. is aiming for the 10% of the sensor faucet market within five years. As a small-scale newly founded company, in the first few years we will try to get a place in the market and get our company to be trustworthy. All in all, our aim in five years is to settle the company and with a strong sales department increase the sales while becoming profitable.

Based on the size of our market and our defined market area, our sales projections for the first year is 890 faucets; which will increase with the promotions and advertisements to 5,000 in the second year and reach to 10,000 in the fifth year. In the first year, our aim will be mostly about marketing and stability; which will bring our company to a profitable level in the following years. We expect to be in the profitable range by the end of the second year and reach about 3,800,000 cash income at the end of year 5. We will be working with the distributors only especially in the first five years until we get our name heard.

The management team is consisted mostly of young engineers with innovative ideas. Such a team is one step further as it is open to new ideas and growth since it is easier to take risks in a newly founded small scale company.

The environmental technology is getting more important all through the world recently and such water and energy saving projects will be more important in the future. Also in Turkey this market is not fully-developed yet, so we are planning to get into the market with such an opportunity, which may pave the way for international marketing after first five years.

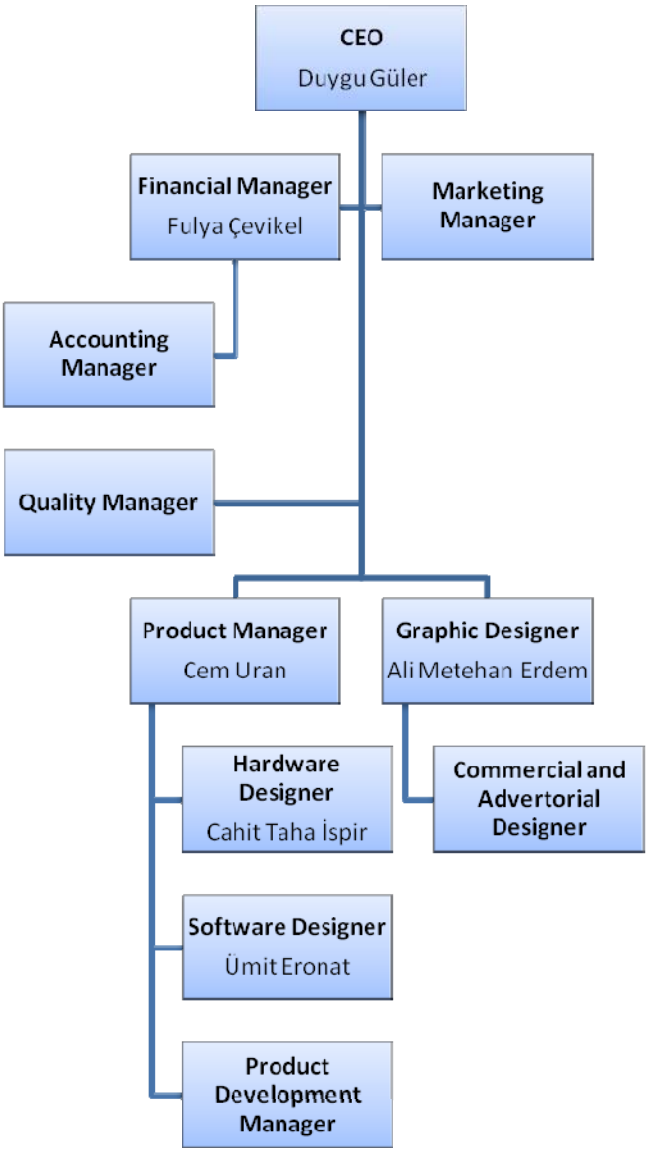
The vision of our company is: “Producing faucets with the temperature adjustment option through a complete touchless system; thus creating the unique and most favorable ones over any other electronic faucet.”

Our mission is: “With fresh minds and innovative ideas we aim to provide healthier and cleaner touchless faucet systems with new features while keeping the aspects of quality and reasonable prices in mind.”

,

Company Organization

Organization Chart



,

Job Descriptions

The CEO is in charge for all operations and decisions taken in the company. She decides about the product development and investment plans and analyzes the final reports. She is responsible for the general progress of the project.

The Financial Manager takes decisions about the business; develops a business plan, a financial plan and a marketing plan. She is responsible for everything about the financial aspects of the company. This person is in high contact with the product manager and the communications and design manager, as they need to give and take information, and later reports the job done to the CEO. In the future, the company may need to do the accounting management separately so these positions are considered for any future needs.

The Marketing Manager is not yet present in the company, however, hiring one in the future may be useful for developing pricing strategies according to the customer demand and satisfaction. This person will report to the CEO.

The Product Manager, who is also a hardware designer, creates a project development plan and decides on the design, the technical properties and specifications of the product. He collaborates with the Hardware Designer and the Software Designer. With the Hardware Designer they build, test and modify product prototype after developing the hardware within the specification boundaries. The Software Designer helps him about the computer-code related part of the project. The final work is reported to the CEO after everything is brought together. After some years, it will be better to work with a Product Development Manager in addition to these jobs.

The Graphic Designer creates a logo and a webpage for the company, he basically deals with the visual and the commercial part of the company and the project. After the design is completed by the Hardware and Software Designer, he develops a 3D model of the product. He is in interaction with the Product Manager, gets information from him and works accordingly. Later he reports his final work to the CEO. In the future we may hire someone for the commercial and advertorial management to run these jobs better and stronger.

,

Short Description of the Project

Smart faucet is aimed to cover the need for % 100 hygienic faucet controls. Both switch on, off and water temperature can be controlled by smart faucet with completely touch-less controls. This is essential to maintain a hygienic environment in public used restrooms, as many people use the same faucet day by day.

Smart faucet will turn on automatically as you put your hands in front of it and stop the water flow when you get your hands away from the sensor. The product will be smartly designed; not allowing water to flow mistakenly if it is not intended, and also will terminate unnecessary water flow after using it. The water temperature control will be easy to use; there will be sensors placed on the side of the faucet which will let the user adjust the temperature accurately with simple hand movements.

The hand gestures have a simple logic; if you move your hand towards the back of the faucet it will heat-up the water, and when you do the opposite it will cool down the water. The speed of the hand gesture will also have an effect on the temperature adjustment, fast gestures will make rapid changes on the temperature and slow gestures will be used to sensitive adjustments in order to fulfill the users' requirements accurately.

Design

As we have discussed earlier, smart faucet is designed at its best to serve the user. There are 3 sensors in order to recognize the hand movements successfully, an electric motor to adjust the water temperature level according to the user's desire, a LED display to show the current water temperature level, and a microcontroller which does all the necessary functions. The system will be powered by a battery for simplicity, and easy usage.

The working principle of water temperature control due to hand gestures will be explained here in order to easy the understanding of the coming parts in the report. The hand will be placed on the side of the faucet where the sensors are, and the optimal distance from the faucet is 5-15 cm. The infrared sensors we chose are allowing us to work with only infrared light, hence the color of hands, lighting of the environment, and any similar issue will not be a problem. This is because the sensor has a built in day light filter, which operates only with infrared light, hence only the infrared light that bounces back from the hand when the hand is in front of the sensor. The infrared component of human body or light bulbs on the environment will be negligible and will be compensated with the software. Another issue is the speed of the hand gesture, and this will not be an issue as well.

,

The sensor is fast enough to recognize the hand gesture, as we are only checking if there is a hand or not, and do not require a detailed data like the distance or the angle of the hand.

The smart software design easily manages the sensors, electric motor, and the LED display with a smart and easy to use algorithm. When the user makes a hand gesture in front of the sensors, the speed and the direction of the hand gesture will be detected. According to this input, the microcontroller will rotate the electric motor at the required direction and motor. According to the current location of the motor, hence the level of water temperature, the LED display will show the corresponding temperature level. For example, if when the users move their hands to the left, the water temperature will increase, and the speed of the hand will determine how warmer the water will get. Finally, the LED display will show the water temperature level for user to safely adjust the water temperature furthermore. The figure below demonstrates the hand gestures.

Figure 1: Sensor Algorithm

The next part to mention is as important as the functionality of smart faucet which is the interface design. The smart operating principle of smart faucet also comes with a smart user interface. In order to serve the user in the most successful way, we designed the interface of our product in the following way.

In our product which is Smart Faucet, there are two main parts. First one is for the sensors and indicator LED. This part designed for the users to adjust the temperature by his hand movements so that it should be close to the faucet to be reachable and controlled easily. Size and weight of this part should be designed such that the platform and the faucet would form completeness. Second part is the main board. It consists of main circuit, water moderators and motor. Water temperature adjustment is done mainly in this part. All assemblies related to this part are enclosed by a box which weight and height would be minimized. This box will be under

,

the table of the faucet so it will not be seen by the user. However, design of this box would be efficient to reduce any risk of defect that can occur, and would be efficient for people who install the product.

For the sensor platform, we used chrome to reflect the unity of the platform with the faucet. In addition, it is light, substantial and noncorrosive material. The platform with its components which are sensors and LEDs are resistant to the temperature up to 150 C^0.

Since the main box is not in the user's field of view, it is plastic in order to reduce the weight and avoid any corrosion caused by moisture under the faucet table. The material of the box is resistant to any impact and resistant to high temperature up to 80 C^0. First water moderator which is used to adjust water temperature is selected such that the necessary torque to rotate the adjustment leg is about 0.7 kg/cm which is quiet smaller than the torque of the motor. Second water moderator is very suitable for the temperature sensing because it has one side which can be closed. Therefore, we can put the temperature sensor there and can close that side of moderator. Besides, in order to protect the electrical components from any water leak and moisture, additional smaller boxes will be provided for the motor and the PCB.

As a conclusion, there some crucial points in our product that determined according to our tests on the prototype and further researches on the subject. The response time of the sensors are in the 0.5 to 1 second, and the hand should be 3-7 cm away from the sensors, therefore, we designed the sensor platform such that the hand movements can be adjusted with nearly no mistake. While considering the ideal distance between sensors, we have taken account of serving such user-friendly interface. The shape of the platform and the placement of the water temperature indicator LED are very attractive for users. Also, the material we use is very suitable for such application. Moreover, main box is designed and materials of this box selected to increase the efficiency in top level. The temperature range will be 10-70 C^0 so that the main box designed such a way that the components in the main box will not be affected by the temperature changes of water. In this report, the requirements and how the industrial design is made in the most efficient way are discussed deeply about all assemblies and components of our product.

Corporate Identity Designs

The Corporate Identity Designs are at the Appendices: Figure 5, Figure 6 and Figure 7.

Official Web Page, Twitter, and Facebook accounts are at the Appendices: Figure 8, Figure 9, Figure 10, and Figure 11.

Technical Specifications

Main Block Diagram

Here is the main block diagram of smart faucet. It consists of a main block consisting of the microcontroller and the printed circuit board with all the electronic circuitry enclosed, the rest of the blocks are placed outside this waterproof enclosure. Servo motor is mechanically attached with the water moderators and together they are fixed to the enclosure safely. The temperature sensor is placed in the water pipes through a water outlet that is not used for the functioning of the faucet. The final blocks are the movement sensors and RGB LED blocks which are placed on the chrome sensor panel to the side of the faucet.

Block Name	Voltage(V)	Current(mA)	Special Parameter
Mov. Sensors	5	0.40-0.100	Operating Distance - 5-10 cm & 9Kohm Output Impedance
Temp. Sensor	5	15	Sensitivity - 10mV/1K & 2.2Kohm Output Impedance
RGB LED	5	100	N/A
Servo Motor	5	1000	Torque - 6.8kg/cm-s
PIC & PCB	5	25	16F877A at 20Mhz & Max. 10Kohm Input Impedance

Figure 2: Smart Faucet Parameters

Microcontroller & PCB

We use PIC 16F877A as a microcontroller and together with the printed circuit board, it will be placed in the “main box enclosure” which will only consist of the electronics of the product. From this box, cables will go out to all of the remaining blocks.

Movement Sensors

Movement Sensor is a combination of an Infrared LED and a phototransistor. This combination allows us to build a movement sensor which will notice the hand when the IR light is reflected from the hand to the phototransistor. Phototransistor is working only in 850-950nm hence is not affected by the visual light in the environment. With 3 movement sensors placed side by side, we are able to sense the movement direction, speed of the hand and also the distance from the faucet as well. These sensors are placed in the “sensor panel”, which is fixed on the side of faucet.

,

RGB LED

RGB LED is placed on the front and top of the sensor panel and is a combination of red, green, and blue LEDs, in a single body. This allows many color options and visually looks much better rather than 5 regular LEDs placed side by side.

Temperature Sensor

The temperature sensor is placed in the water outlet which is not used for the faucet to function. It will be safely placed and will have direct contact with the water, hence allow reliable measurements and adjustments. The temperature sensor will be placed together with the mechanical components.

Servo Motor

Servo Motor will be rotating the water-temperature adjustment valve, water moderators, hence will be fixed to the “mechanical box” which is containing all the mechanical components and the “main box” which contains the electronic components. This motor has a built-in motor drive, and is controlled by a 50Hz PWM signal with pulse width between %5 – %10.

,

Business Plan

Marketing Plan

As a small-scale newly founded company, in the first few years we will try to get a place in the market and get our company to be trustworthy. For this reason, in these years our aim will be mostly about marketing and stability; which will bring our company to a profitable level. During this period, in sense of advertising and introducing us to the market, we will try many different ways. Also after some years, we are planning to have a retailer of our own and increase our gross margin while lowering other costs. All in all, our aim in five years is to settle the company and with a strong sales department increase the sales while becoming profitable.

Price

Price floor is not less than 200 TL and prices of some faucets start from 200-250 TL. The price ceiling is around 1000 TL and there are luxurious faucets at the ceiling price as well. The market is around 350-600 TL for electronic faucets. There are many different types of faucets which basically do the same thing but differ in quality and design. The sensor faucet to be used in the production will cost about 250 TL and the installments including transportation per piece will cost around 350 TL. We will add 10-15% revenue to the cost and set the price at most at 450 TL. As this is in the market range, according to the demand, if large number of products is ordered, we may change the revenue percentage to 8-10%; and this may also be applied when selling to the distributors and wholesalers, as we will be selling in large amounts. Agent commissions will be covered by the price flexibility similar to large amount sales - they will take 3% commission. The final price will be around 450TL after the agent's commission, and the discount for large amount sales will take care of the commission of the agent without increasing the price of the faucet. We will only sell in large amounts to distributors; hence there won't be any misbalances.

When we take the inflation rate to be at most 7% for the next 5 years, at the end of first year it will be 481, second year 515, third year 551, fourth year 590, and fifth year 631 TL. During these five years, if the increase in the price will affect our profit, we will lower the price according to this plan:

Lowering the purchasing price of the faucets by negotiation or bulk purchase deals after getting our names heard in the sector.

Bulk purchase of the components (about at least 5% discount for yearly amount of purchases).

,

SWOT Analysis

Strengths: Optimistic and flexible Open to new ideas and growth Risk bearer Young and innovative with a unique project	Weaknesses: Not well-known in the sector Not producing the faucet from scratch
Opportunities: Environmental technology is getting more important Sensor faucets are getting more popular A new aspect to the existing sector	Threats: Competition is getting tougher in the sector Without well advertising the risk of being kept in the background in the sector

Financial Plan

The monthly and yearly sales assumptions are as follows:

Months	Year 1	Year 2
January	20	300
February	20	300
March	20	300
April	30	350
May	30	350
June	40	400
July	40	400
August	60	400

,

September	80	500
October	100	500
November	150	600
December	300	600

Figure 3: Monthly sales for the first two years

Years	Sales
1	890
2	5,000
3	6,000
4	8,000
5	10,000

Table 2:

Figure 4: Yearly sales for the first five years

Expected cash flows for the first five years and the summary of financial projections can be found in Appendices, Table 3 and Table 4. Also a chart illustrating the expected gross profits and net incomes can be seen in Figure 4.

,

Developments in the Project

We examined our developments in the project namely in 2 subheadings: fall and spring. In order to provide better understanding of all the reports and tasks in detail we showed our work separately in the development plan. Smart Faucet Co. is constituted by 6 members 2 of electrical and electronics engineering, 2 of industrial engineering, 1 Computer-Science and 1 communications and design students. There are some reports that we are obliged to state and there are some meetings and sub-reports we decided to do on our own. All the meetings and obligatory reports are stated in development report so that we can follow both past and future tasks. All of the past and future tasks, their timings and their contents are explained with the content of tasks, the people who are responsible for them and the date that we finished the tasks.

Fall Semester Plan

1.1. Main Institutional Works
1.2. Research on Possible Technologies
1.3. Literature Survey and Comp. Report
1.4. Determining the Weekly Meetings
1.5. Product Definition and Specification
1.6. Market Research
1.7. Cost Analysis
1.8. Preliminary Design
1.9. Organizational Plan
1.10. Expenditure Plan
1.11. Sub-assembly Specifications
1.12. Software Module and Task Specification Report
1.13. Marketing Plan
1.14. Financial Plan
1.15. Corporate Identity
1.16. Final Business Plan
1.17. Development Plan
1.18. Product Definition including QFD
1.19. Preliminary Presentations
1.20. Web-pages
1.21. Final Presentation

,

Spring Semester Plan

2.1. Ordering Required Parts
2.2. Software Analysis
2.3. Electronic-Hardware System Analysis
2.4. Progress Report I
2.5. Implementation
2.6. Industrial Design & Report
2.7. Mechanical Design & Report
2.8. Software & Hardware Integration
2.9. Preliminary Presentation
2.10. Production Planning
2.11. Testing and Corrections
2.12. Progress Report II
2.13. Quality Certification
2.14. Preliminary Interview
2.15. Production Phase Improvement
2.16. Web Site and Corporate ID Improvement
2.17. Industrialization
2.18. Marketing and Advertising
2.19. Progress Report III
2.20. Final Presentation
2.21. Final Report
2.22. Final Interview

Changes on the Prototype

There are 3 major changes in the smart faucet. These changes do not affect the functioning of the product, however, are crucial for getting much more precise and stable results. The upgraded components are the sensors and the LED display, and also an additional component which is the temperature sensor. **ECP forms to these changes can be found at the Appendices.**

The previous sensor worked on a wide wavelength range which also included the visual light. This caused major problems since it had a large noise, which made it hard to implement and keep the system stable. In order to solve this problem we chose to build our own sensor using an infrared LED and a phototransistor, which is more or less the working principle of our previous sensor. By building a new sensor, we were able to choose the specifications ourselves. The infrared LED emits light and when user places their hand in front of it, the light is reflected from the hand and gets to the phototransistor. As the light which bounces from the hand increases, the voltage that the phototransistor leaks gets larger. In order to read this data by

,

the microcontroller, we also added an Opamp to amplify the signal by 10. The new sensor works only in a small infrared range (850-1000 nm), which is perfect for us. This eases the implementation and also makes it, hence the whole product, more precise and stable.

The second change is the LED display which used to be a line of LEDs that go from red to blue and show the water temperature level accordingly. Instead of using this both for optimizing the circuit design, and to improve the interface design, we decided to use a triple RGB LED. This is basically looks like a single LED; however it contains red, green, and blue diodes inside. This allows us to get any color using a single LED.

The third change is the temperature sensor that we added in order to create a closed feedback system that will guarantee the change of water temperature as the users adjust it with hand gestures. For example; first we will know the current temperature of the water, secondly we will know how many degrees we want to change the temperature, and finally we will be able to check if the change in the temperature is exactly we wanted and make further adjustments if necessary to get to that temperature.

With all these upgrades on the prototype we will be able to implement an even smarter faucet, which will be much more precise, stable, and error-free. It will also have a better interface design, which is very important for luxury faucets.

Upgrades to the Design

We also have some design improvements which are found crucial to include. These are mainly constraints for proper working of the faucet. We have decided on these constraints according to our experimentations on the prototype and further research on the subject.

Firstly, the response time of the temperature adjustment will be 0.5 to 1 second, according to the current factors. For example; water temperature and pressure changes might cause adjustment/response time to take longer.

Secondly, the optimal distance of hand from the side sensors is 3 to 5 centimeters. Of course this distance can be shorter, but it will be harder to use that way. We have experimented that the distance can be increased up to 7-8 centimeters without having a major functioning problem.

,

Thirdly, the water temperature is required to have some constraints both for safety and usage. The usual temperature range of the water will be 10-45^{o} Celsius. The temperature of the water will be limited to 50^{o}Celcius.

Finally, the LED display will be blue if the temperature is in the range 10-25^{o} Celsius, green if it is in the range 25-35^{o} Celsius and red if the temperature is in the range 35-45^{o} Celsius. In the range 45-50^{o} Celsius, the red LED will blink to indicate that the water might be too hot for safety issues. In all of the temperature ranges, the intensity of the color will get denser or lighter according to the current temperature's place in the range.

Professional and Ethical Issues Report

IP Policy

IP which is also known as Intellectual Property, is a term related to ethic issues like copyrights, patents, trademarks, geographic indications of source and industrial design rights which cannot be violated in order to provide even working environment to every innovative ideas. Since new ideas can be constituted in many categories we must examine our project not in every category but in the matter of protecting the rights of software and hardware. In order to get the rights of the companies with innovative new ideas Turkish Patent Institute gives patent to these new ideas which also our company is going to get. Getting patents both for hardware and software is going to provide our company the rights to be unique about our idea and our product, Smart-Faucet. There are no patents on our subject, which is the adjustment of water temperature with electronic sensors sensing the hand movements. With this fact, we have designed both our hardware and our software.

The entire software code was written by Ümit Eronat, Software Designer of Smart Faucet Co., and design of the algorithm was assisted by Cem Uran, Product Manager of Smart Faucet Co., and Cahit Taha İspir, Hardware Designer of Smart Faucet Co. The original code and the algorithm was designed completely by Smart Faucet Co. team only, with no additional help from anyone else nor according to any outside source.

The entire hardware was designed and implemented by Cem Uran, Product Manager of Smart Faucet Co., and Cahit Taha İspir, Hardware Designer of Smart Faucet Co. The hardware design was designed completely by Smart Faucet Co. team only, with no additional help from anyone else nor according to any outside source.

The hardware and software designs of Smart Faucet do not infringe any copyright issues and belong to Smart Faucet Co.

,

Non-disclosure Agreement

In order to protect the rights of our product we need a patent which we do not have yet, so we made a non-disclosure agreement as a substitute. Non-disclosure agreement is also known as confidentiality agreement, confidential disclosure, and proprietary information agreement.

Non Disclosure Agreement with SmartFaucet Co.

This agreement is entered into this 09th of May 2011 and between Smart Faucet Co. with offices at Ankara, with offices of DISTRIBUTOR at Ankara and Istanbul.

WHEREAS Smart Faucet Co. possesses certain ideas and information relating to “Patent Pending” of the design of “Smart Faucet” that is confidential and proprietary to the "Confidential Information" of Smart Faucet Co.; and WHEREAS the DISTRIBUTOR is willing to receive disclosure of the Confidential Information pursuant to the terms of this agreement. NOW THEREFORE, in consideration for the mutual undertakings of Smart Faucet Co. and the DISTRIBUTORS under this agreement, the parties agree to the below terms as follows:

Disclosure. Smart Faucet Co. agrees to disclose, and the DISTRIBUTOR agrees to receive the Confidential Information.

Confidentiality.

2.1 *No Use*. The DISTRIBUTOR agrees not to use the Confidential Information in any way or manufacture or test any product embodying Confidential Information, except for the purpose authorized by the Smart Faucet Co..

2.2 *No Disclosure*. DISTRIBUTOR agrees to use their best efforts to prevent and protect the Confidential Information, or any part thereof, from disclosure to any person other than the DISTRIBUTOR's employees that have a need for disclosure in connection with the Smart Faucet Co.'s authorized use of the Confidential Information.

2.3 *Protection of Secrecy*. DISTRIBUTOR agrees to take all steps reasonably necessary to protect the secrecy of the Confidential Information and to prevent the Confidential Information from falling into the public domain or into the possession of unauthorized persons.

Limits on Confidential Information. Confidential Information shall not be deemed proprietary, and the shall have no obligation with respect to such information where the information:

Was known to the DISTRIBUTOR prior to receiving any of the Confidential Information from the Smart Faucet Co.;

,

Has become publicly known through no wrongful act of the DISTRIBUTOR;

Was received by the DISTRIBUTOR without breach of this agreement from a third party without restriction as to the use and disclosure of the information;

Was independently developed by the DISTRIBUTORS without use of the Confidential Information; or

Was ordered to be publicly released by the requirement of a government agency.

Ownership of Confidential Information. The DISTRIBUTOR agrees that all Confidential Information shall remain the property of Smart Faucet Co. and that the Smart Faucet Co. may use such Confidential Information for any purpose without obligation to DISTRIBUTOR. Nothing contained herein shall be construed as granting or implying to the DISTRIBUTOR any transfer of rights, any patents, or any other intellectual property pertaining to the Confidential Information.

Term and Termination. The obligations of this agreement shall be continuing until the Confidential Information disclosed to the DISTRIBUTOR is no longer confidential.

Survival of Rights and Obligations. This agreement shall be binding upon, inure to the benefit of, and be enforceable by (a) the Smart Faucet Co., its successors and assignees; and (b) the DISTRIBUTOR, their successors and assignees.

IN WITNESS WHEREOF, the parties have executed this agreement effective as of the date first written above.

Smart Faucet Co.	DISTRIBUTOR
Signature _____	Signature _____
Name _____	Name _____
Title _____	Title _____
Date _____	Date _____

,

The Expected Impact of the Project

Economical Impact

In Turkey this electronic faucet market is not fully-developed yet; there are few brands that produce its own products instead of importing some parts, in the economic sense it will be an opportunity of the market. People are getting more aware of the effects of bacteria, and as the sensor faucets started to be used widely with a nice appearance, the expectance of people and companies started to rise; it is highly probable that the demand will increase in years. Our future projections include the aspects of lowering the production costs and producing our own faucet from scratch, therefore, the economic impact of our project on the sector will be a new brand with reasonable low prices while offering high quality and simplicity within design.

Global Impact

Electronics faucets become popular all over the world and there's a large market according to the electronic faucets, however because of the unique qualities of the Smart Faucet it will become forward in the market. According to its uniqueness Smart Faucet also has hygienic qualities since it's touch-free. It has low cost high quality which allows Smart Faucet to prevent from being kept in the background in the sector.

Environmental Impact

The expected environmental impact of the project is that the environmental technology is getting more important all through the world recently and such water and energy saving projects will be more important in the future. Thus the current project will be helpful for saving water wasted while the temperature is being adjusted to the desired level and the possible future developments of our project may increase the positive effect of our product for the environment such as saving water and energy with the new technologies.

Societal Impact

Since the mission of the company is to provide healthier and cleaner touchless faucet systems with new features while keeping the aspects of quality and reasonable prices in mind with fresh minds and innovative ideas, apart from this project, the impact of the company and the product on the society would be continuous. That is, it is a small scale company which can take risks more easily than the bigger companies and the mission is to carry on the innovative ideas and to come up with similar projects concerning health and environmental issues, such companies have a positive effect on changing the world step by step, by presenting totally new ideas to the society and the industry. Furthermore, such companies have a positive effect on the economy of societies too. Although our product might first seem as a luxurious one, with the price within the market range and ease of use, it might have the impact of encouragement on the society to use innovative products and to create.

,

Conclusions

As Smart Faucet Co., established in 2010 with young engineers with innovative ideas, we have made a smart additional quality to the existing electronic-faucets and we have created Smart-Faucet systems which allow you to control the heat of the water without touching it, %100 touch-free and hygienic.

The management team is consisted of 6 members, Duygu Güler as CEO, Cem Uran as Product Manager, Fulya Çevikel as Financial Manager, Ali Metehan Erdem as Graphic Designer, Cahit Taha İspir as Hardware Designer, Ümit Eronat as Software Designer.

The target market of Smart-Faucet is mostly public areas like hotels, stadiums, hospitals, cinemas etc. and we aim to take hold for the %10 of the sensor faucet market within 5 years.

We know that the environmental technology's importance is getting higher all through the world nowadays as a result, the concept that Smart-Faucet is providing is going to be more important as well as the target market is going to get bigger every day. In Turkey the electronic-faucet market is not fully-developed yet, so we have the advantage to develop and get bigger with no big issues of competition and we aim the international market after first 5 years.

The vision of our company is: “Producing faucets with the temperature adjustment option through a complete touchless system; thus creating the unique and most favorable ones over any other electronic faucet.”

Our mission is: “With fresh minds and innovative ideas we aim to provide healthier and cleaner touch-less faucet systems with new features while keeping the aspects of quality and reasonable prices in mind.”

Since we have formed a company with an innovative and unique idea we need a patent in order to protect the rights of Smart-Faucet. However since we could not get the patent we made non-disclosure agreement instead.

,

At the end of two semesters we have completely finished the product:

- The hardware is completed in two versions, and in the final version all of the problems are solved and it is working smoothly.
- The mechanical enclosure of the product is completed. There is the “mechanical box” which contains the mechanical components and the “main box” which contains the electronic hardware.
- The mechanical components are completely done as well as in the mechanical and industrial design package. The mechanical components are fixed to the enclosure of the product and are ready to use.
- The interface of the product is completed with the chrome sensor panel.
- Temperature sensor is covered with plastic enclosure and epoxy, allowing full water-proof, hence solved the hardware problem for the sensor.
- The second version of the PCB is designed in order to fix the problems in the first version, and now is fully working.
- The performances of the sensors are enhanced, by adjusting the sensors and developing the software, the allowing the users to use the faucet much more easily and solved the problem of hand gesture sensing.
- Technical specification documents are prepared.
- All tests are completed, testing manual is prepared.
- Mechanical and electronic assembly instruction documents are prepared.

Even though the main algorithm and the hardware design are completed, performance improvements are left open since the product can always be developed further.

,

Appendices

Figure 5: Business Card Design

Figure 6: Envelope Deisgn

,

Figure 7: Letterhead Design

,

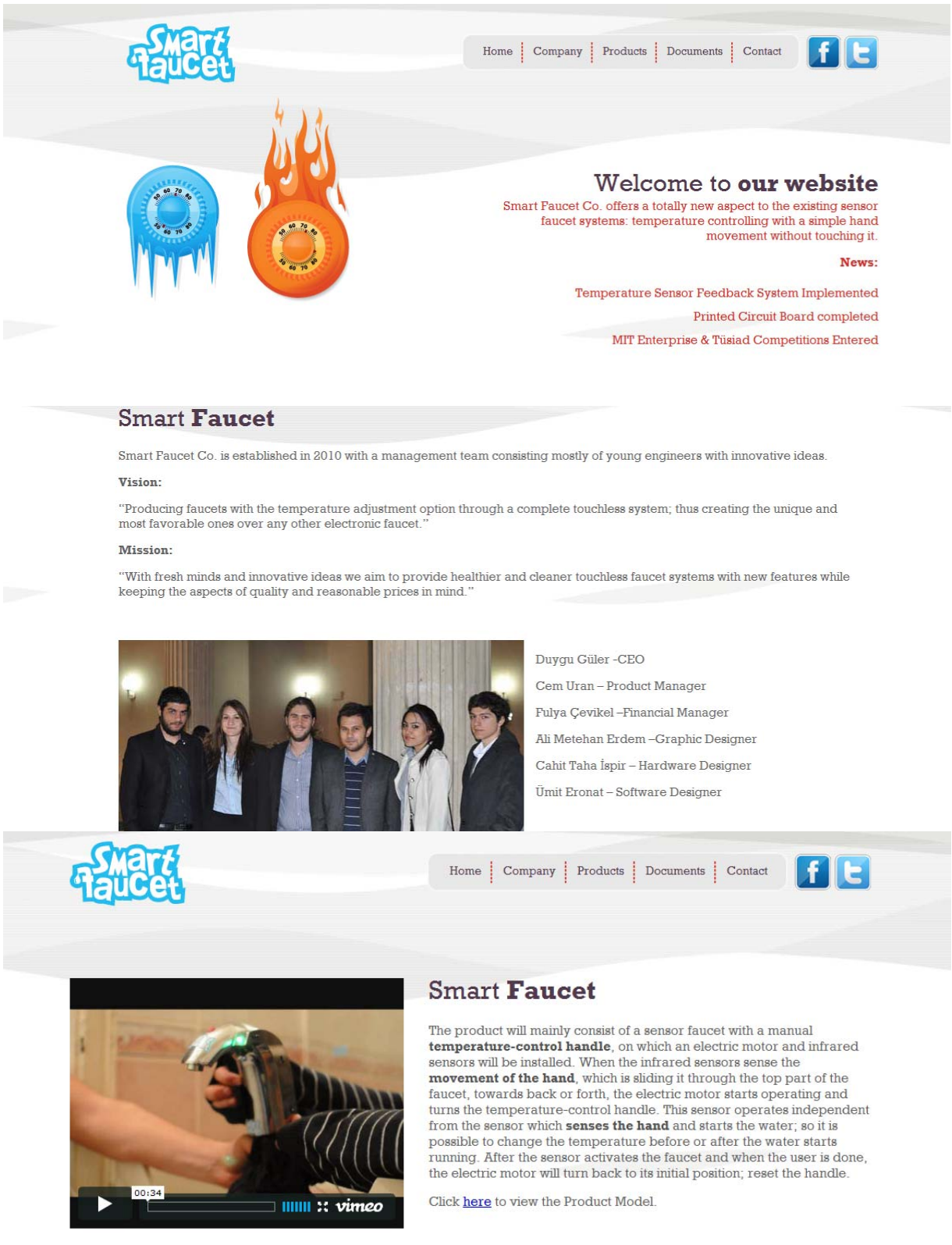


Figure 8: Smart Faucet Website Design

,

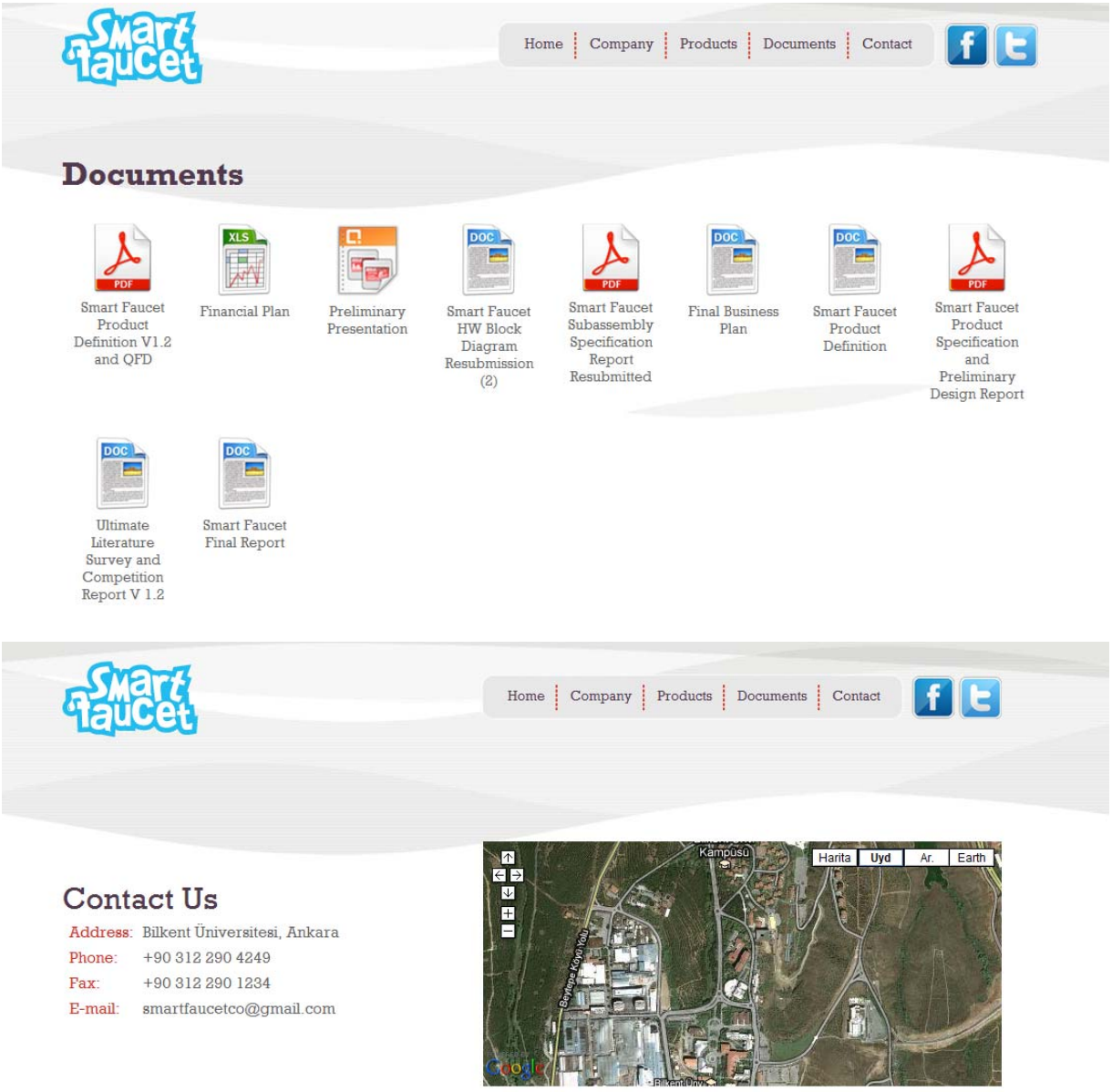


Figure 9: Smart Faucet Website Design

,

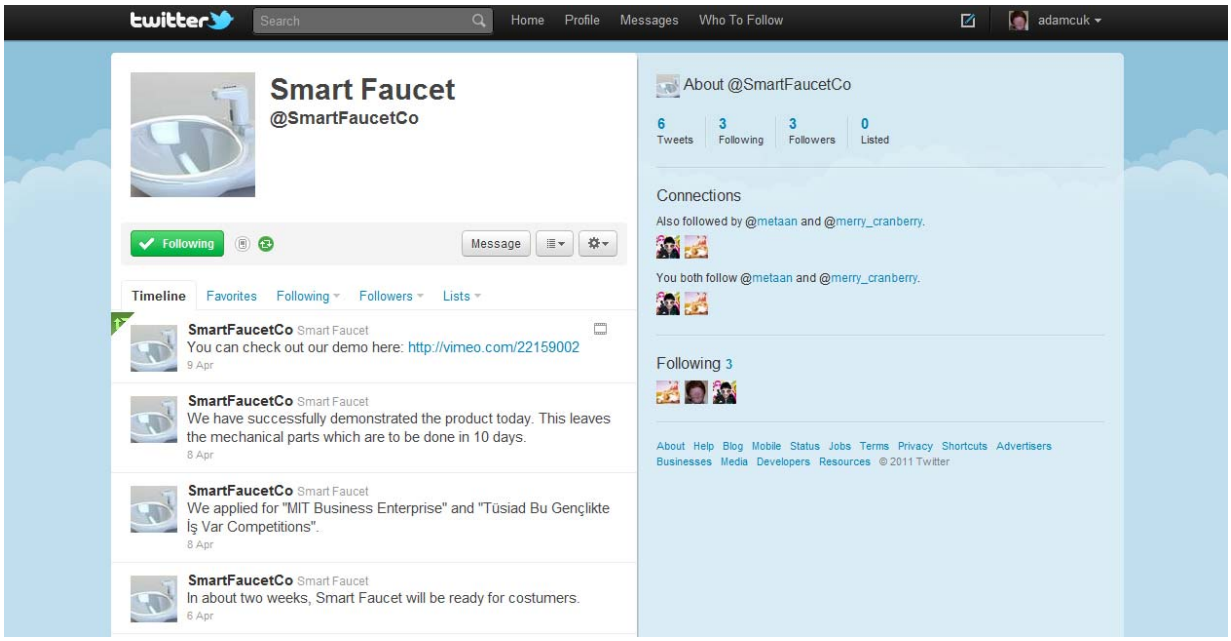


Figure 10: Smart Faucet Twitter Design

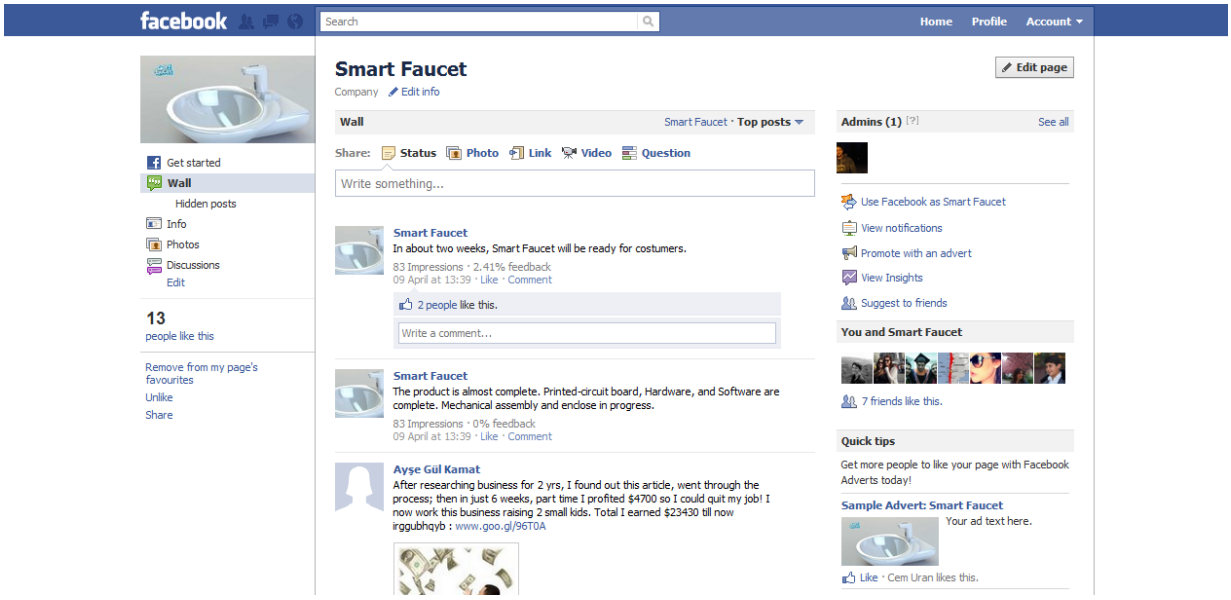


Figure 11: Smart Faucet Facebook Group Design

,

	Year 1	Year 2	Year 3	Year 4	Year 5
Operating Activities					
Cash Collections	198.000,00	1.959.000,00	2.796.000,00	3.960.000,00	5.323.500,00
Purchase of RM	224.850,00	602.500,00	1.231.650,00	1.594.600,00	1.213.800,00
Direct Labor	24.960,00	100.000,00	99.200,00	145.250,00	153.000,00
Mfg. Overhead	72.000,00	72.000,00	60.000,00	60.000,00	59.000,00
Selling and Admin	156.000,00	156.840,00	86.738,80	97.700,52	108.729,55
Net Cash operating	- 279.810,00	1.027.660,00	1.318.411,20	2.062.449,48	3.788.970,45
Investing Activities					
Machinery equipment	10.000,00				
Furniture and Fixtures	50.000,00				
Net Cash Investing	- 60.000,00	-	-	-	-
Financing Activities					
Share Capital	-	-	-	-	-
Long-term loans	500.000,00	-	-	-	-
Short-term loans	-	100.000,00			
Interest Paid	-	12.000,00			
Loans repaid					
Dividends paid					
Net Cash Financing	500.000,00	88.000,00	-	-	-
Net Change in Cash	160.190,00	1.115.660,00	1.318.411,20	2.062.449,48	3.788.970,45
Beginning Cash	-	-	-	-	-
Ending Cash	160.190,00	1.115.660,00	1.318.411,20	2.062.449,48	3.788.970,45

Figure 12: Cash Flow Projections for the First 5 Years

Summary of Financial Projections					
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues	400500	2400000	3084000	4400000	5850000
Gross Profit	10474,62	208846,2	454615,4	894153,8	1467692
EBIT	-157525	40006,15	355876,6	784453,3	1346963
EBITDA	-133525	64006,15	379876,6	808453,3	1370963
Net Income	-157525	28006,15	355876,6	784453,3	1346963
Net Cash from Operating Activities	-279810	1027660	1318411	2062449	3788970
Capital Expenditures	60000	0	0	0	0
Interest Expense	0	12000	0	0	0
Dividends					
Cash	160190	1115660	1318411	2062449	3788970
Ratios					
Gross Profit %	38,23529	11,49171	6,783756	4,920853	3,985849
Operating Expenses %	0,419476	0,07035	0,032016	0,024932	0,020638
Net Income %	-0,39332	0,011669	0,115394	0,178285	0,23025

Figure 13: Summary of Financial Projections

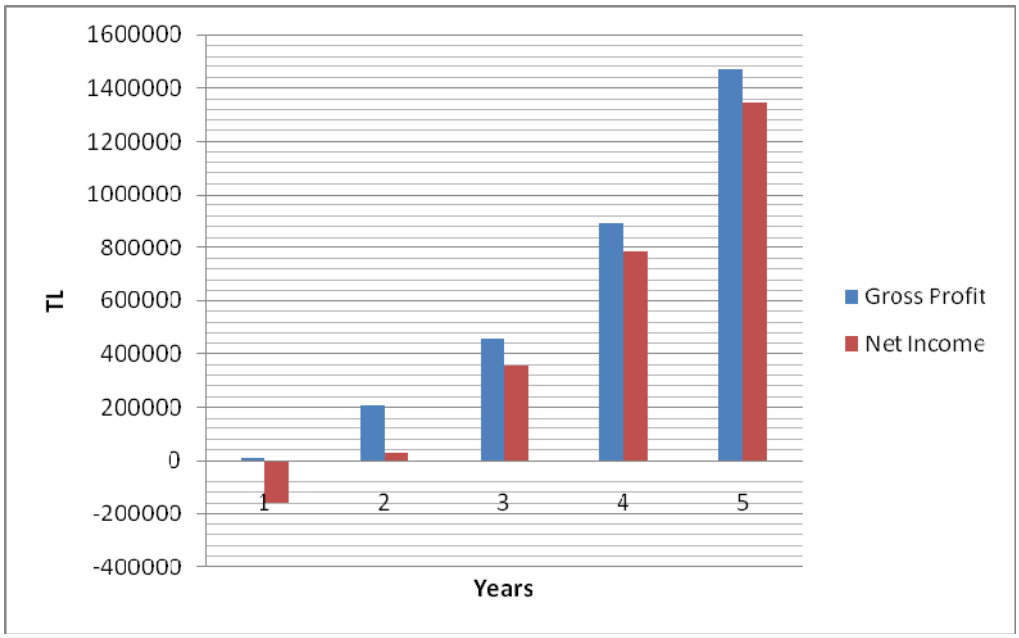


Figure 14: Estimated Gross Profit vs. Net Income

,

QFD

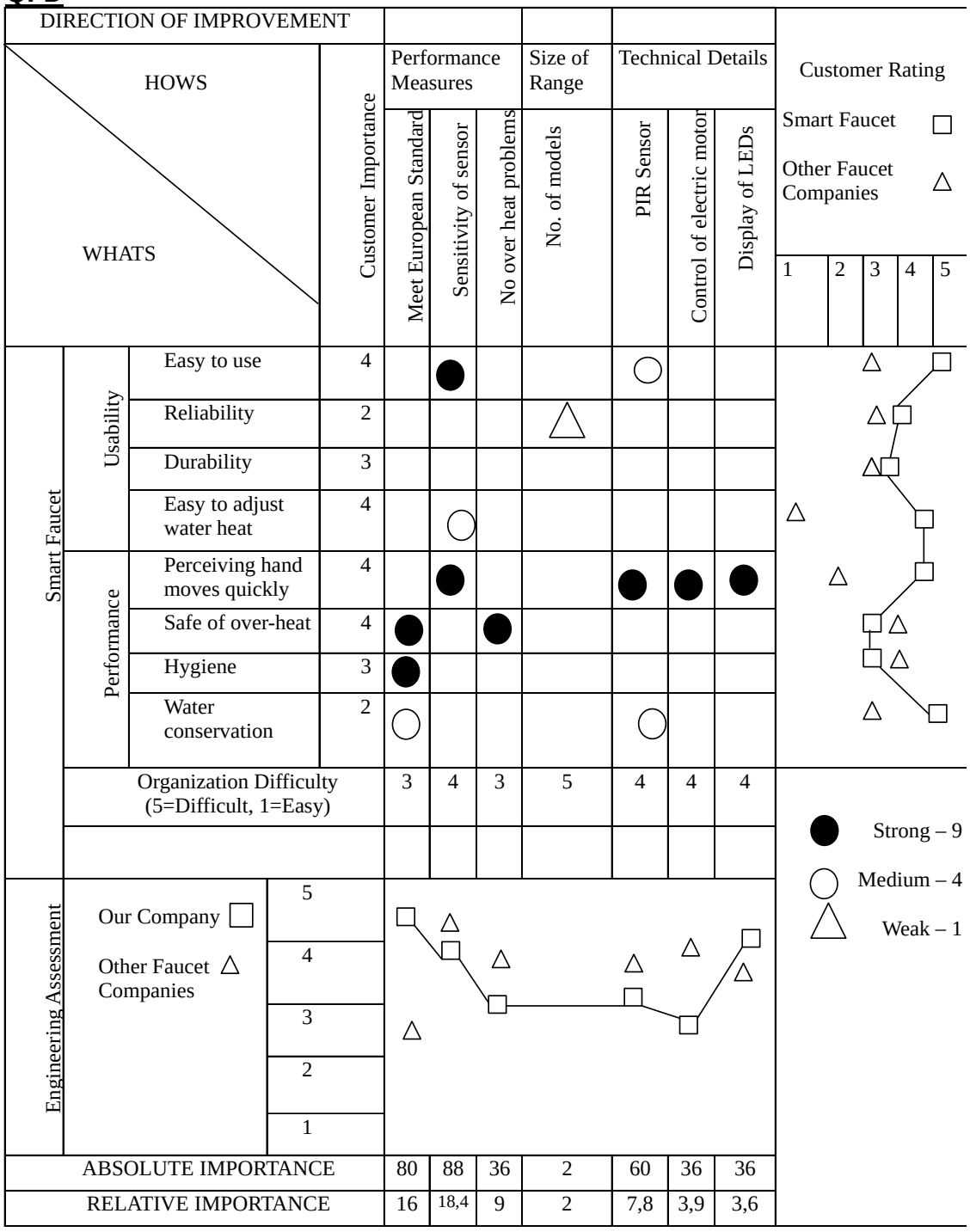


Figure 15: QFD

,

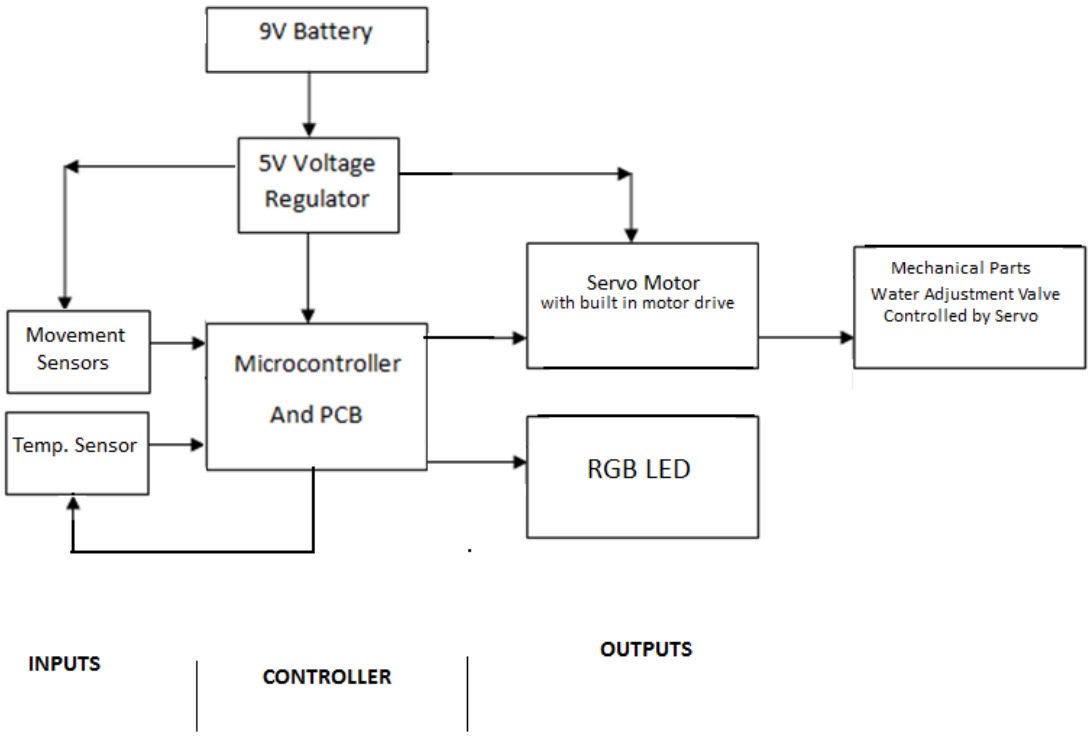


Figure 16: Block Diagram with Signals and Input / Output Directions

Block Name	Voltage(V)	Current(mA)	Special Parameter
Mov. Sensors	5	0.40-0.100	Operating Distance - 5-10 cm & 9Kohm Output Impedance
Temp. Sensor	5	15	Sensitivity - 10mV/1K & 2.2Kohm Output Impedance
RGB LED	5	100	N/A
Servo Motor	5	1000	Torque - 6.8kg/cm-s
PIC & PCB	5	25	16F877A at 20Mhz & Max. 10Kohm Input Impedance

Figure 17: Smart Faucet Parameters

,

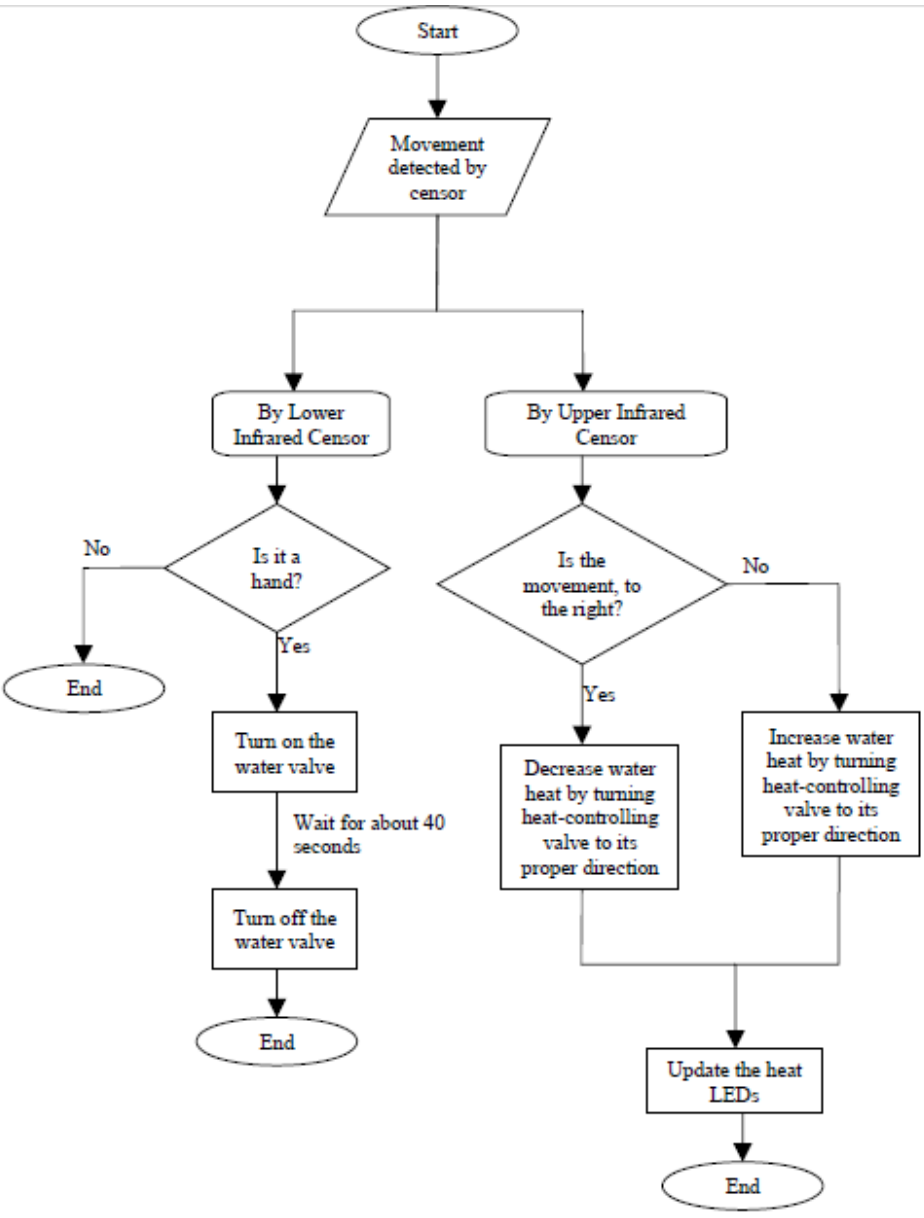


Figure 18: Flow Chart

,

Product Tree & Stock Numbers

SF-001-xxx: Electronic Parts

SF-002-xxx: Mechanical Parts

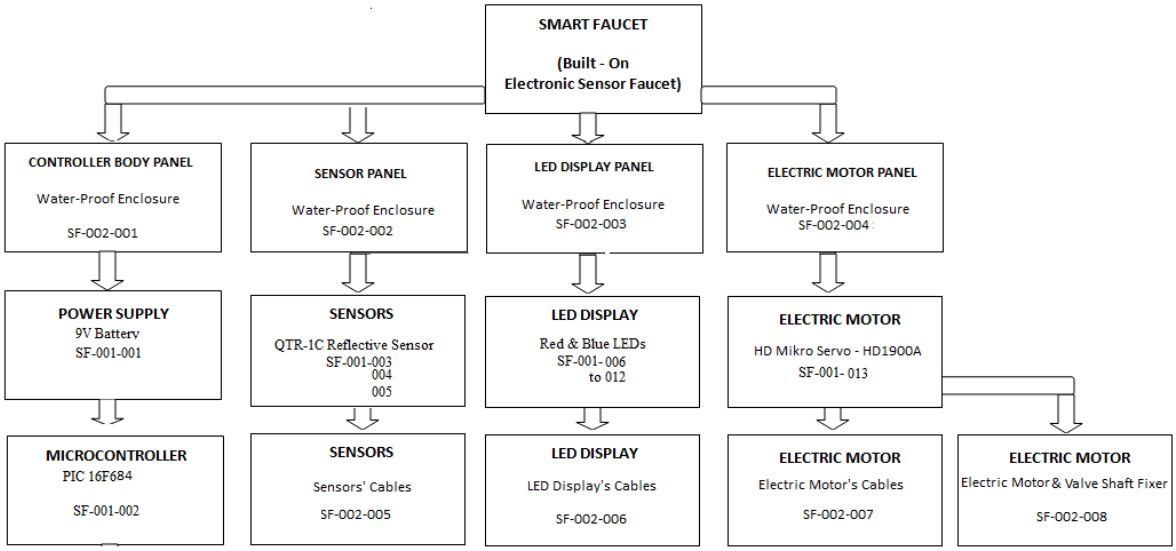


Figure 19: Product Tree with Component Details and Stock Numbers

,

Subassembly Specifications

LED Display

RGB Triple LED will be used to show the water temperature level. This will be placed on top of the faucet for user to see easily. The water temperature level will be indicated by the LEDs, red for hot and blue for cold water temperatures. In order to satisfy the safety requirements, the LEDs will be placed in a plastic enclosure to ensure there will be no water contact with the internal electronic devices. Important specifications are that it drains 25 mA, and power dissipation is 60mW. Also it works in -40 to 85^{o}.

Controller Body

This is the main block that is shown in the block diagram previously. This body contains the microcontroller, the necessary electronic components on the PCB board such as voltage regulator, capacitors, together with the connections in and out from the body. For safety, the controller body will be placed at the back of the faucet, away from the water flow, and the body will have waterproof enclosure to avoid and water leakage into the body.

PIC Parameters (16F684)

PIC is the main part of the controller body. The input from the sensor is 25mA which is optimal for the microcontroller, and the outputs will be in this range as well. As discussed previously this output signal will be enough to control the LED display, the sensors, and servo motor. For the inputs and outputs of the microcontroller, we would not require analog – to – digital converters, or amplifiers since PIC 16F684 has a built-in 10-bit ADC for 8 channels. The controller divides the 0-5V range to 1024 integers, and according to the input voltage, it gives the corresponding integer. This will let us handle the infrared sensor input data directly with the controller, without any component in between them. The software will determine the outputs for the servo motor and the LED display, and these components can also be controlled directly by the controller. The servo motor works with integer signals from the microcontroller (140 to rotate left, 150 to stop, and 160 to rotate right) hence we do not require a motor drive circuit. LED displays will be easily lit by the 25mA, 5V output of the microcontroller.

,

Movement Sensors

SFH-3100F phototransistors and IR LED couples will be used as sensors and will be placed on one side of the faucet. There will be 3 sensors placed with 4.5 cm in between them. These will be used to detect the direction and the speed of hand gestures so that the water can be heated or cooled at the required sensitivity. The working principle of the sensor is based on infrared technology; hence the visual light is not a restriction for the sensors, or the faucet. As in motion sensor lightings, complete darkness is not an issue or other specifications of the environment. The infrared LEDs signals are reflected back to the sensor hence the output is generated. The outputs will be given similar to figures below, when the hand is right across the sensor there will be a peak value which will allow us to place the sensors side by side and not care for the operating angle. Also the output is digital, which will be directly connected to the pins of the microcontrollers. For safety of the circuit, the sensors will have a waterproof enclosure

The interface of the infrared sensors will be as in the figure below. To the side of the faucet, the sensors will be placed side by side, where the hand movements will occur. They will be fixed on to the faucet, and will be covered for water-protection and good looking.

Figure 20: Sensor Interface

,

Electric Motor

We require 10N*2cm= 0.2Nm=200mNm of maximum torque. We will use a lower power consuming and small sized electric motor with a reducer. We will use a servo electric motor, which can generate a 3,8 kg/cm of torque, which will satisfy our requirements easily. Another important issue is the rotating speed of the motor, hence the speed of water adjustment. The motor rotates 60 degrees in 0.08 seconds which will easily handle our requirement. The adjustment will be done in a 180 degree axis, with one end cold and the other hand corresponding to hot water. The motor is working with 6 volts as we require, since our power supply is a 9 volt battery. We chose a lower power motor as it will be enough for us, and we require power consumption to be minimal not to suck up the battery. Since the motor will work for 1-2 seconds on average each usage, the energy consumption is not trivial.

Mechanically, the shaft of the motor and the heat valve of the faucet will be fixed with a metal piece, or directly with the internal shaft of the valve. For both parts, the rotation of the motor and the valve will be the same, [-90, 90] 180 degrees. The interface is shown below in the figure, where the motor shaft and the valve shaft will be fixed core to core. For safety, the motor will have a waterproof enclosure which will also hide the motor for a nicer look.

Battery

Our requirements for the whole system are 5 to 9 volts range, and 25mA to 250mA current range. The electric motor will consume most of the power with 1-1.5 Watts; and together with the microcontroller, LEDs, sensors, and other circuit components, total power requirement will be around 3 Watts. We will use a 9-V Alkaline DC Battery. It will outperform a standard 500 mAh which will satisfy our requirements.

,

Circuit Schematics

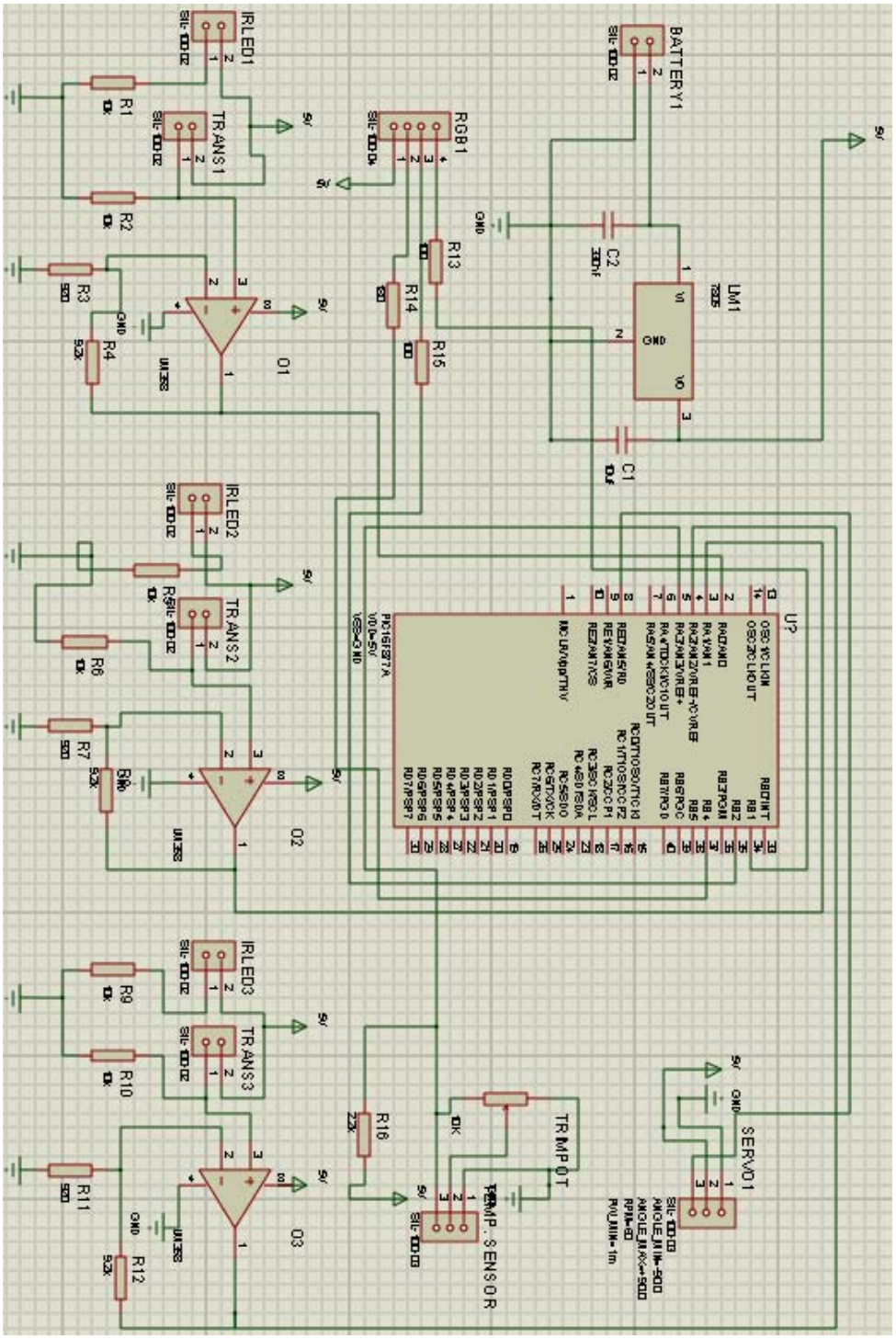


Figure 21: Circuit Schematics

,

PCB Layout

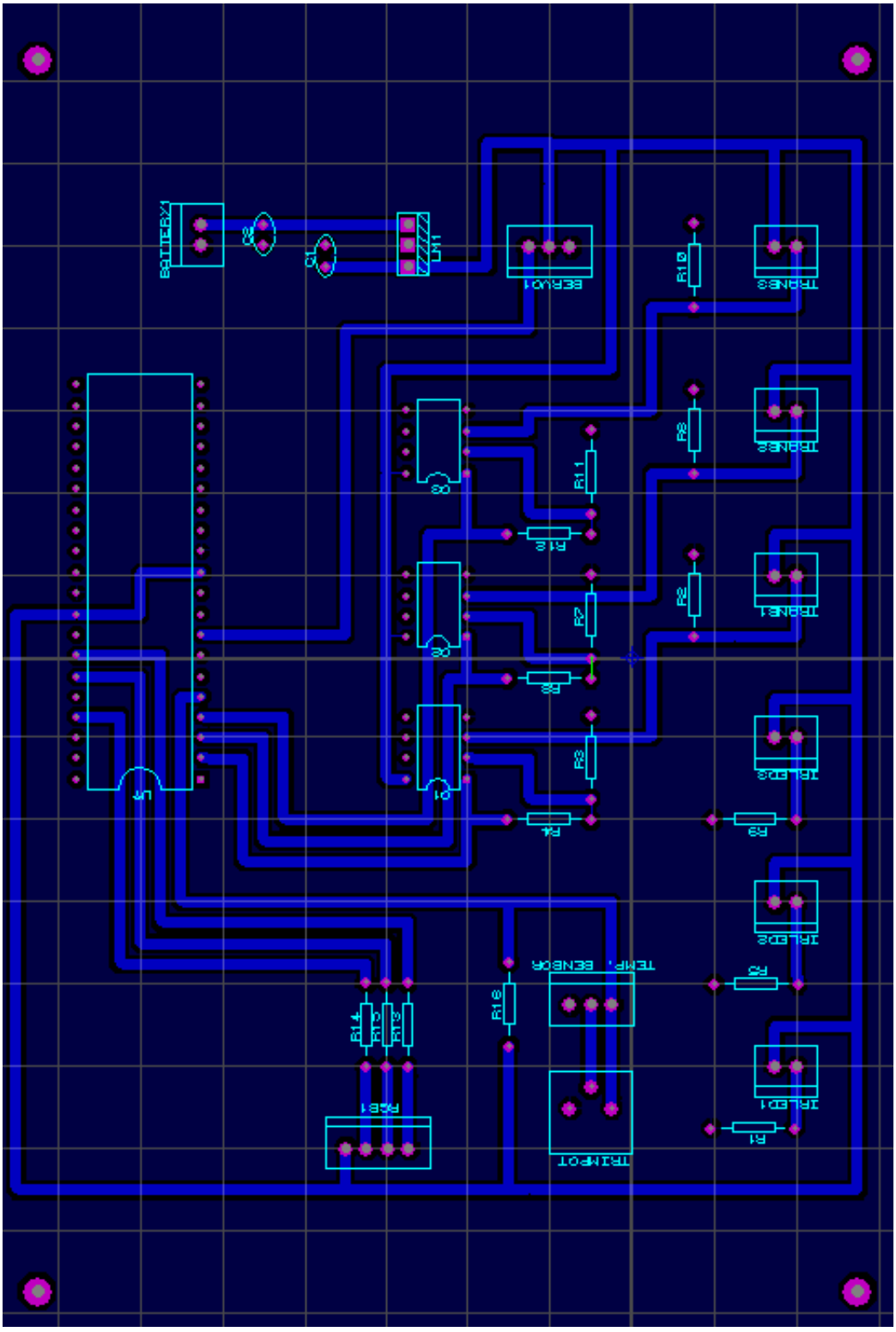


Figure 22: Circuit Schematics

,

3D Models of PCB

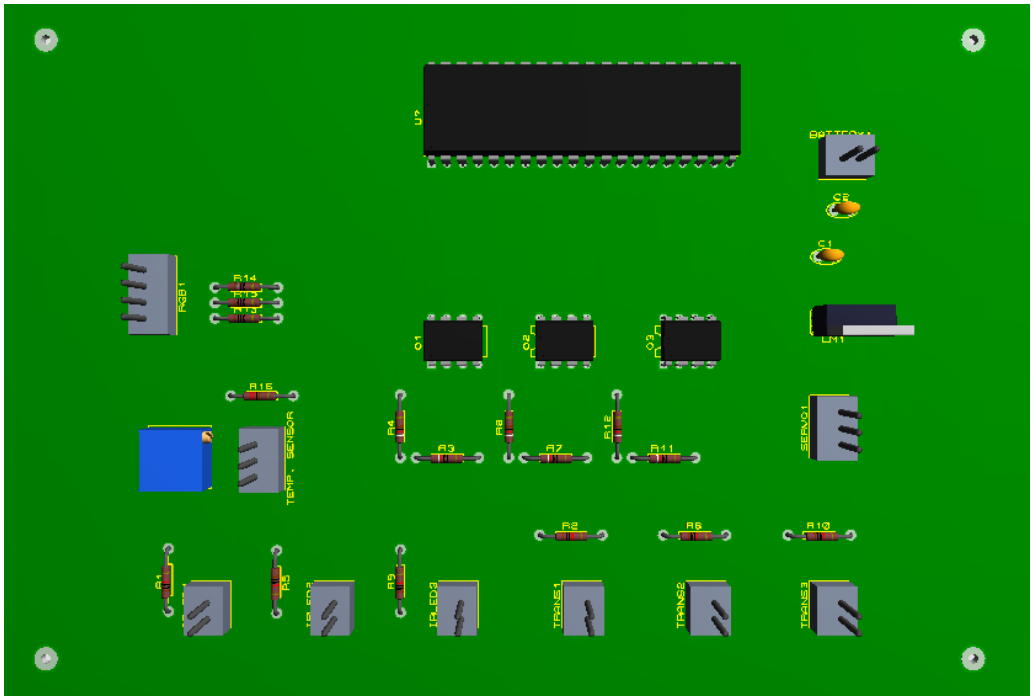


Figure 23: 3D Model – Top View

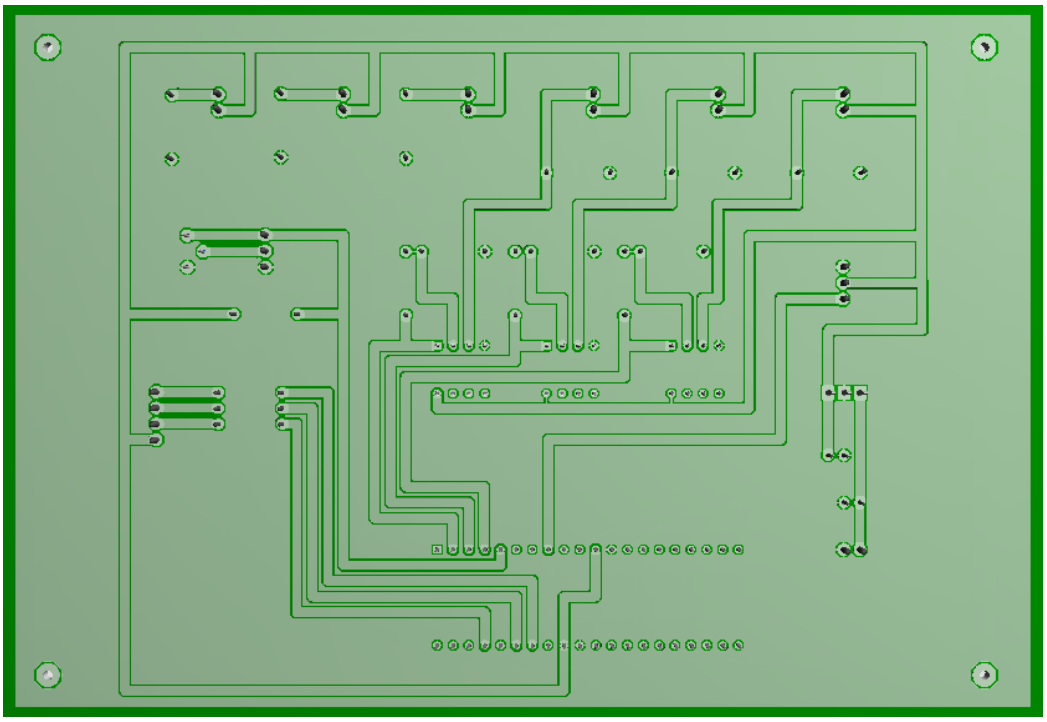


Figure 24: 3D Model –Bottom View

,

Bill of Materials

Circuit Body

QUANTITY	MODEL	DESCRIPTION	ASSEMBLY NO.
1	BATTERY	Eenergizer 9V	SF-01-01
1	PIC16F684	Microcontroller	SF-01-02
1	LM7805	Voltage Regulator	SF-01-03
2	LM358	Opamp	SF-01-04
3	RESISTOR1	9.2 Kohms	SF-01-05
3	RESISTOR2	920 Ohms	SF-01-06
6	RESISTOR3	10 Kohms	SF-01-07
1	RESISTOR4	1 Kohms	SF-01-08
3	RESISTOR5	100 Ohms	SF-01-09
1	CAPACITOR1	330nF	SF-01-10
1	CAPACITOR2	10uF	SF-01-11
1	SWITCH	Power Switch	SF-01-12
2	WIRE1	20 cm	SF-01-13
6	DUAL SOCKET	Male	SF-01-14
1	TRIPLE SOCKET	Male	SF-01-15
1	QUADRUPLET SOCKET	Male	SF-01-16
1	PLASTIC ENCLOSURE	Controller Body	SF-01-17
8	SCREW1	Male	SF-01-18
8	SCREW2	Female	SF-01-19
1	PCB	Circuit Board	SF-01-20

Figure 25: BOM for Circuit Body

,

Faucet Panel

QUANTITY	MODEL	DESCRIPTION	ASSEMBLY NO.			
1	FAUCET	GLP Tap Mixer Battery	SF-02-01			
1	CHROME INTERFACE	Panel for Sensors	SF-02-02			
1	RGB TRIPLE	Triple Output LED	SF-02-03			
3	SFH3100F	Phototransistor	SF-02-04			
3	IR LED	IR LED	SF-02-05			
16	WIRE1	40 cm	SF-02-06			
6	DUAL SOCKET	Female	SF-02-07			
1	QUADRUPLET SOCKET	Female	SF-02-08			
3	SCREW1	Male	SF-02-09			
3	SCREW2	Female	SF-02-10			

Figure 26: BOM for Faucet Panel

,

Controller Panel

QUANTITY	MODEL	DESCRIPTION	ASSEMBLY NO.
1	PLASTIC ENCLOSURE	Controller Body	SF-03-01
1	HD1900A	Servo Motor	SF-03-02
1	LM335	Temp. Sensor	SF-03-03
6	WIRE1	40 cm	SF-03-04
2	TRIPLE SOCKET	Female	SF-03-05
2	WATER MODERATOR	Water Moderator	SF-03-06
4	WATER CONDUIT	Water Conduit	SF-03-07
1	MAKARON	Temp. Sensor Isolation	SF-03-08
1	EPOXY	Temp. Sensor Isolation	SF-03-09
12	SCREW1	Male	SF-03-10
12	SCREW2	Female	SF-03-11

Figure 27: BOM for Controller Panel

,

Preliminary Sketches

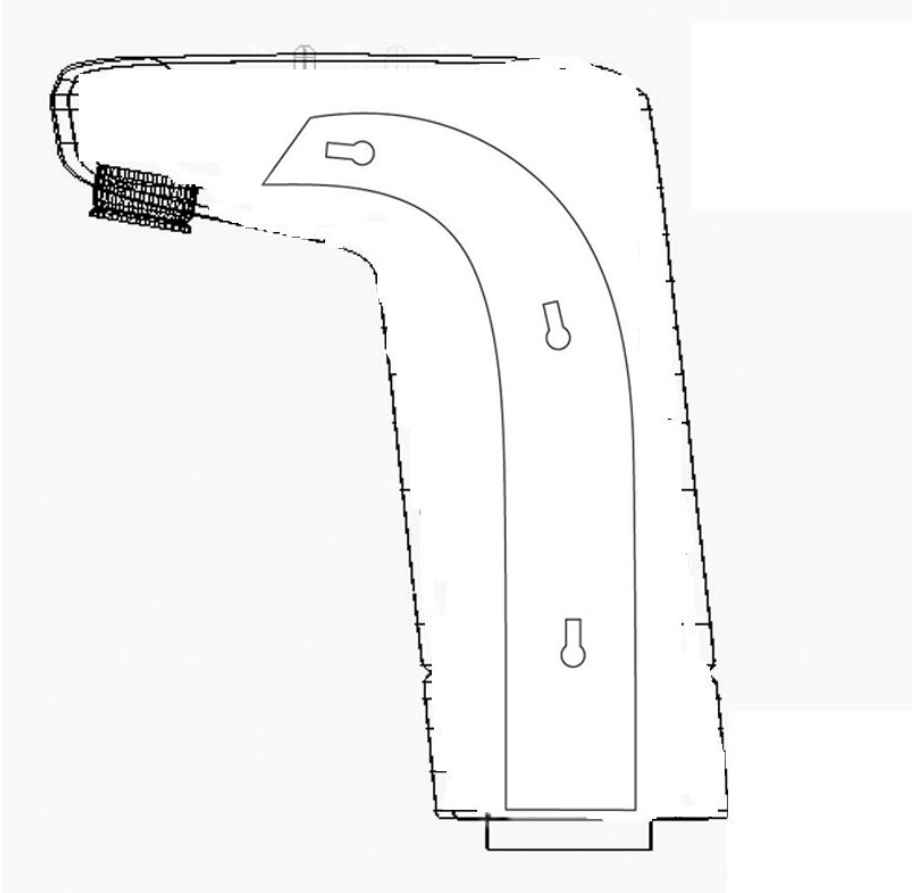


Figure 28: Preliminary Sketch

Prepared By: Cahit Taha İspir	**Checked By:** Cem Uran
Title: Preliminary Sketches	**Part:** N/A
Date: 18.03.2011	**Sheet:** 1 of 1
Size: A4	**Page Number:** 5 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

Final Drawings

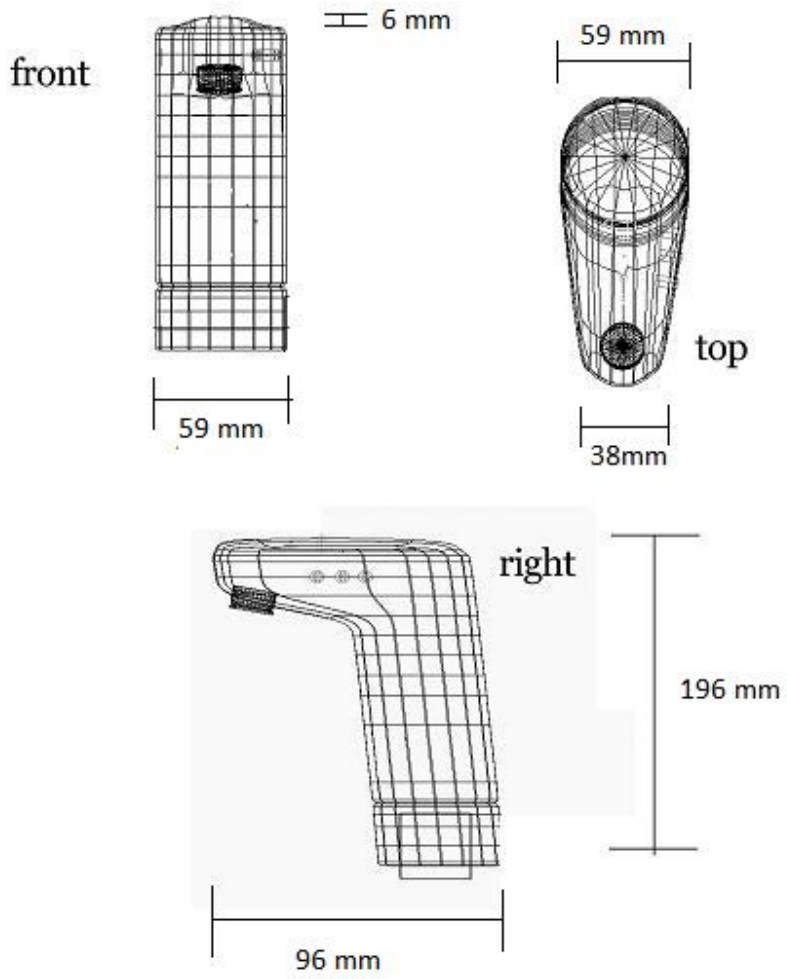


Figure 29: Drawing of the Faucet

Prepared By: Cahit Taha İspir	**Checked By:** Cem Uran
Title: Final Drawings	**Part:** Faucet
Date: 18.03.2011	**Sheet:** 1 of 3
Size: A4	**Page Number:** 7 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

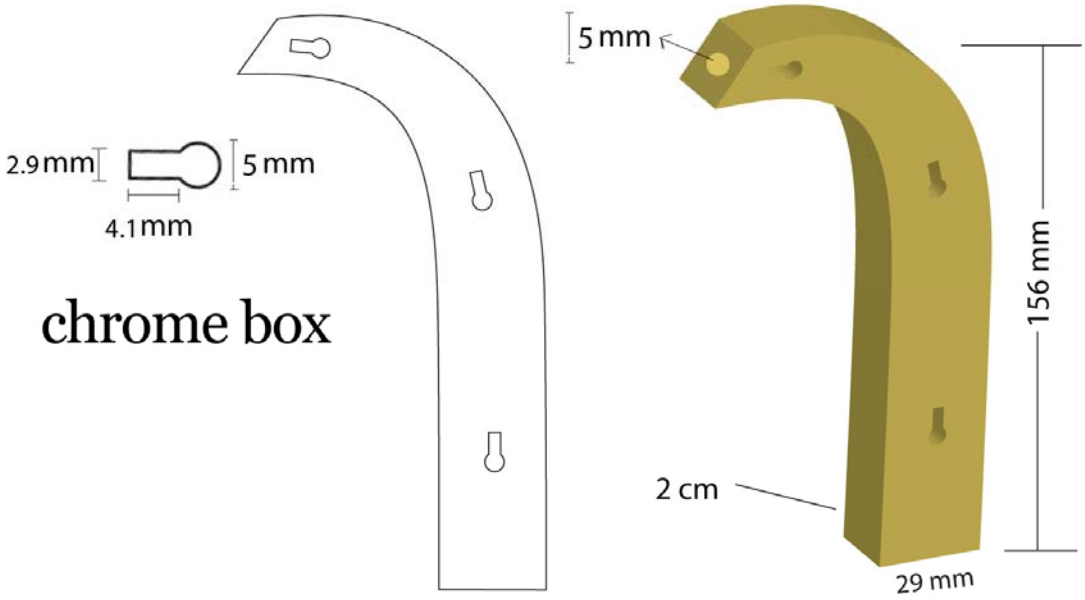


Figure 30: Drawing of the Chrome Box

Prepared By: Cahit Taha İspir	**Checked By:** Cem Uran
Title: Final Drawings	**Part:** Sensor Panel
Date: 18.03.2011	**Sheet:** 2 of 3
Size: A4	**Page Number:** 8 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

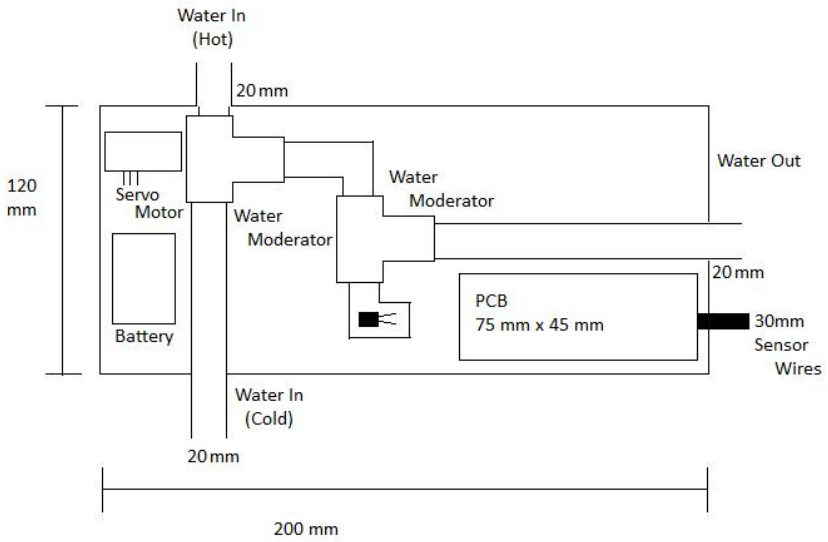


Figure 31: Drawing of the Main Box

Prepared By: Cahit Taha İspir	**Checked By:** Cem Uran
Title: Final Drawings	**Part:** Main Box
Date: 18.03.2011	**Sheet:** 3 of 3
Size: A4	**Page Number:** 9 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

Drawings of Mechanical Parts

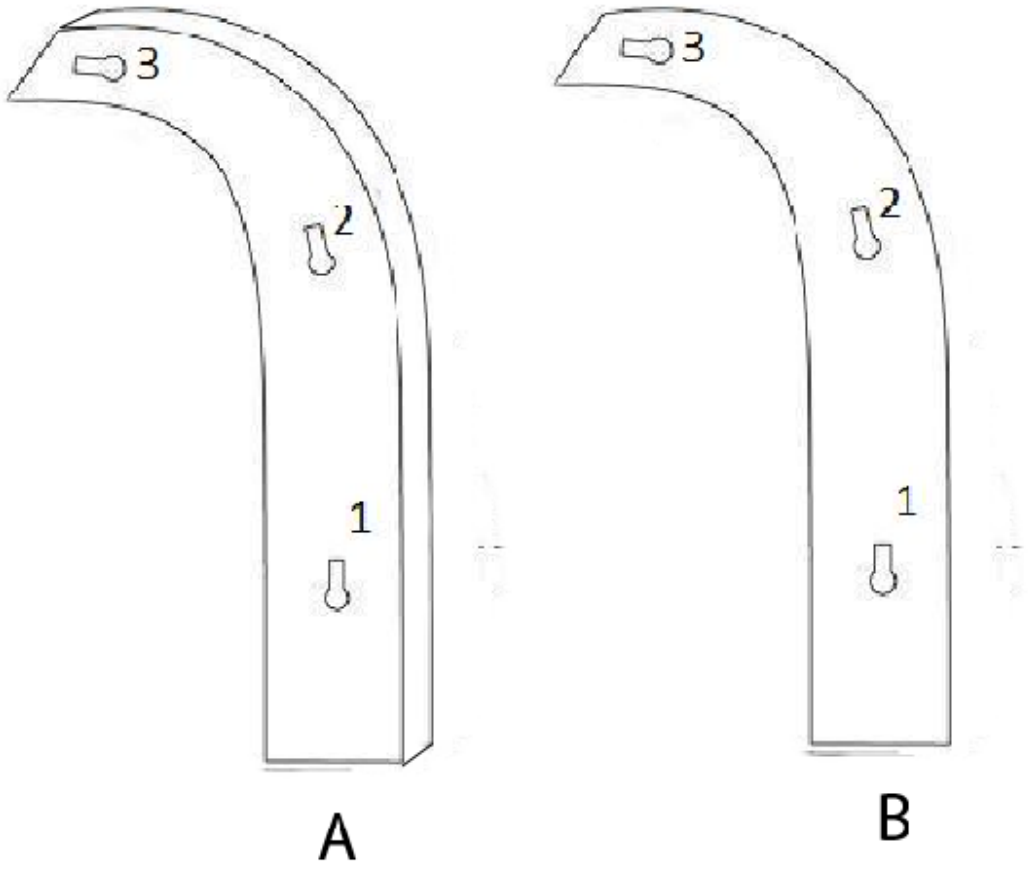


Figure 32: Sensor Panel Body & Cover on the Side of the Faucet

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Drawings	**Part:** Sensor Panel
Date: 07.03.2011	**Sheet:** 1 of 4
Size: A4	**Page Number:** 3 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

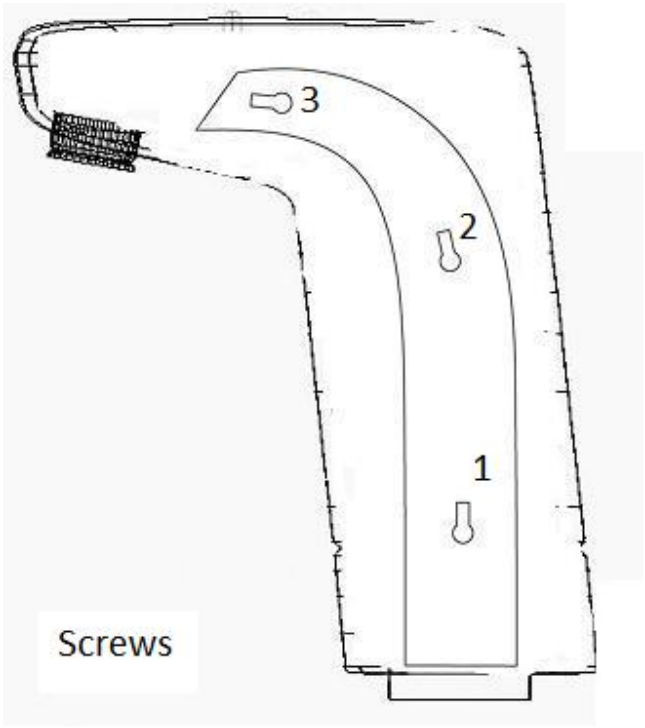


Figure 33: Sensor Panel Body on the Side of the Faucet

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Drawings	**Part:** Sensor Panel
Date: 07.03.2011	**Sheet:** 2 of 4
Size: A4	**Page Number:** 4 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

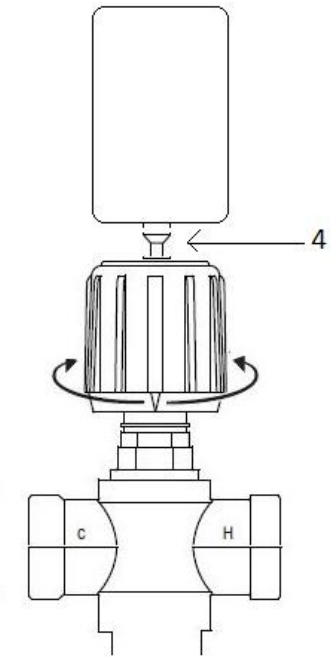


Figure 34: Servo Motor & Temperature Valve Mounting

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Drawings	**Part:** Servo Motor
Date: 07.03.2011	**Sheet:** 3 of 4
Size: A4	**Page Number:** 5 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

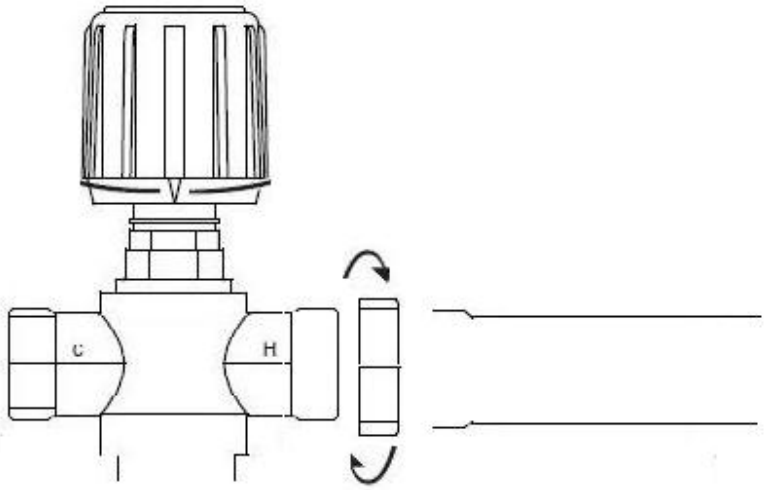


Figure 35: Temperature Valve Mounting to Water Pipes

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Drawings	**Part:** Water Pipes
Date: 07.03.2011	**Sheet:** 4 of 4
Size: A4	**Page Number:** 6 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

Assembly Instructions of Boxes

First of all, the sensor panel should be mounted on the faucet itself. In order to do this, screws (1,2, 3) are required as shown in Figure 2. After you have screwed them, you can place the cover of the sensor panel –A- on top of the screwed body –B- as in Figure 1. This way you have the sensor panel ready for sensors.

Next, some sort of glue, epoxy, or silicon is required to place the LEDs and sensors to be placed on their mounts. They should be properly placed so that they won't be blocked by the panel itself.

The next step will be mounting the servo motor to the temperature mixing valve. In order to do this, use screw (4) to mount the motor to the valve's midpoint as in Figure 3. This way they will be homocentric, allowing to rotate the valve easily. In order to achieve this, the next step is fixing the motor on to the main box using glue, epoxy, or silicon. Finally screw and close the main box for safety.

Finally, mount the water pipes to the temperature mixing valve and mount the other end to the Water-In parts of the main box. Use pipe screws and make sure that they are tight. The water input will then be connected to the closed main box through these Water-In pipes.

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Assembly Instr.	**Part:** Assembly Instr.
Date: 07.03.2011	**Sheet:** 1 of 1
Size: A4	**Page Number:** 7 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

Special Assembly Instructions

The sockets are the LEDs, temperature sensor, and IR sensors which are placed on the faucet by peers of infrared LED and phototransistor; hence they are about 40 cm away from the controller body which is hidden under the sink. So they have to be connected by two 40cm jumpers that will be connected to the sockets on the PCB. Also there is the RGB triple output LED which requires 4 connections, hence four 40 cm jumpers with the other end connected to the quadruplet socket. Lastly, the pins of the temperature sensor should be connected with two 40 cm jumpers to the PCB socket.

There will be 3 boxes (SF-01-17, SF-02-02, SF-03-01) that cover the components. First box (SF-02-02), which will be mounted near the faucet with 3 screws (SF-02-09), has 7 holes. RGB LED (SF-02-03) would be mounted on the top hole, infrared LEDs (SF-02-05) and transistor (SF-02-04) would be mounted to the holes near this box, and the cables (SF-02-06) would be go under the sink to the second box (SF-01-17) which contains the circuit board. In order to stabilize the board in the second box, 4 screws (SF-01-18) would be mounted between the box and the circuit board (SF-01-20). In addition to the cables come from the first box, also there are two 3 cable peers (SF-03-04) go to the third box (SF-03-01). These two 3 peer cables would be connected to the motor (SF-03-02) and the temperature sensor (SF-03-03) before isolating the temperature sensor. In the third box, the mounting between motor and the water moderator (SF-03-06) would be done by welding. Third box also contain 2 water moderator and 4 water conduit (SF-03-07). 2 water conduits of them are carrying the hot and cold water to the water moderator and this mixed water exists through the 3 water conduit to the second water moderator which the temperature is sensing and mixed water is transported by the fourth water conduit. The stabilization of the moderators and motors would be done by screwing with the corresponding screws (SF-03-10). For the temperature sensor there is one more step to be applied. The pins of the temperature sensor should be covered with isolating plastic piece (makaron) (SF-03-08 and SF-03-09), and it should be filled with epoxy in order to achieve full isolation from the water.

,

Data Sheets of Procured Mechanical Components

Temperature Mixing Valve Specifications:

Temperature Range:

C Model: 70°F–120°F (21°C–49°C)

Standard Model: 70°F–145°F (21°C–63°C)

Connections:

Straight-through design (HOT and COLD at same level).

Construction:

Nickel plated brass construction. EPDM o-rings. Made in

USA.

Operating Pressure: 150 psi (1034 kPa) maximum.

Operating Temperature: 212 °F (100 °C) maximum.

Patent Information: U.S. Patent No. 6,079,625.

Screw Specifications:

Screw Number	Drive Size/Type	Thread	Standard Length	Torque Setting in. lbs.	Products Using Retention Bolts
SD12-54	5/8 hex	3/4-16 UNF	3.00	n/a	26J1L

Figure 36: Screw Specifications

Prepared By: Cem Uran	**Checked By:** Cahit Taha İspir
Title: Datasheets	**Part:** Datasheets
Date: 07.03.2011	**Sheet:** 1 of 1
Size: A4	**Page Number:** 8 of 10
Smart Faucet Co.	Ankara / TÜRKİYE

,

Test Results

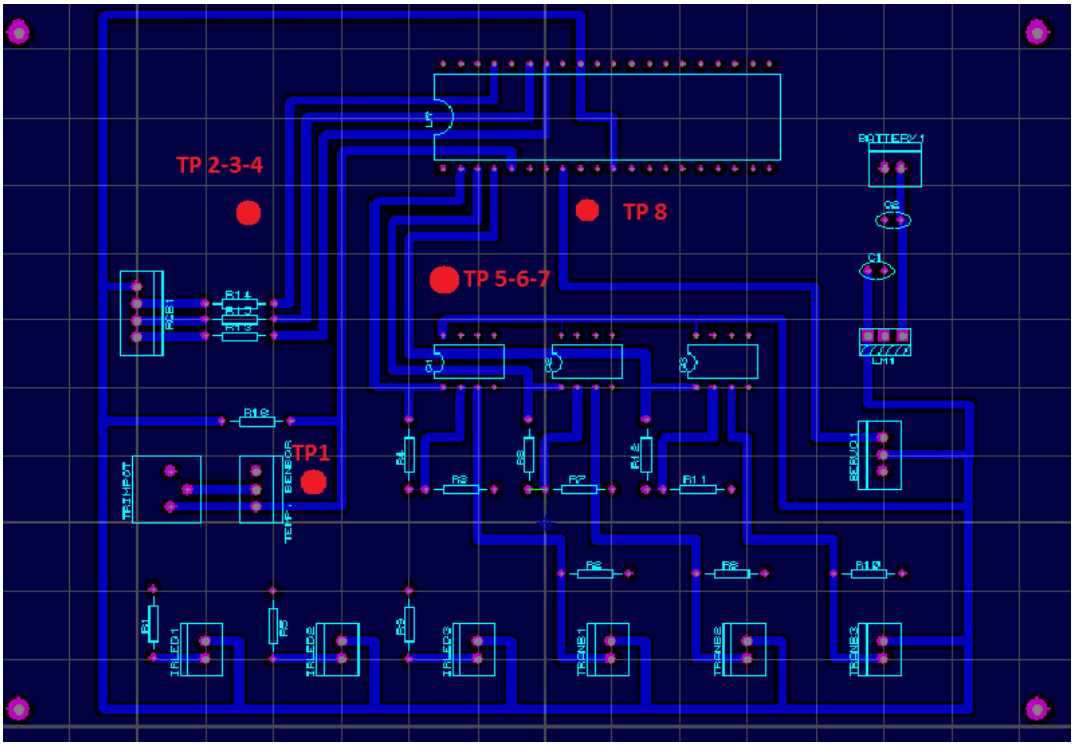


Figure 37: Test Points on PCB

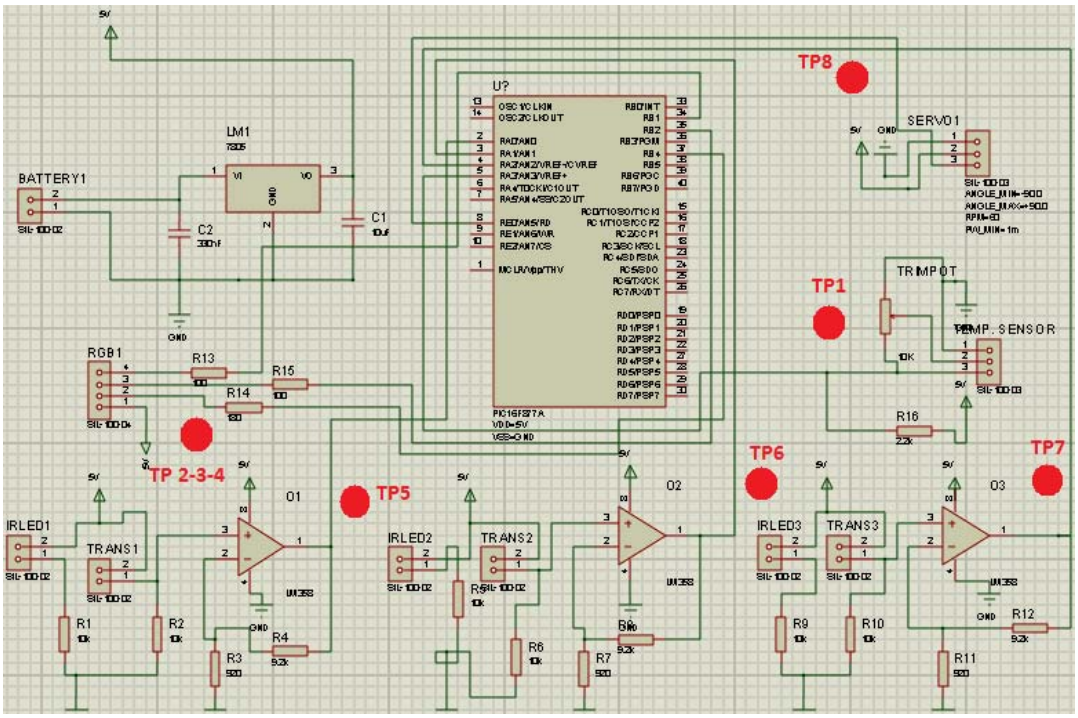


Figure 38: Test Points on Circuit Schematics

,

Test Point 1

It is the middle pin of the 10K Trimpot and also the second pin of temperature sensor. This has to be precisely 2.98Volts at 25°C, if not; it should be adjusted with a proper screw.

Test Point 2-3-4

These test points all correspond to the RGB LED's pins and 5Volt should be measured of the LED is off in all test points. When the LED is emitting red light, TP 2 should be 0Volts and the other two TPs should be 5 Volts. Similarly, TP 3 should be 0 Volts when LED is green, and TP 4 should be 0 Volts when the LED is blue. For the intermediate colors of yellow and purple, TPs 2&3 are 0 Volts and TPs 3&4 are 0 Volts respectively. According to the color of the LED, you can check the expected voltages according to this.

Test Point 5-6-7

These test points are the outputs of the movement sensors, which are the first pins of all three opamps. Since all of the sensors are identical, the measurements are approximately the same for all. When the system is powered and hand is not across the sensors, the voltage measurement for this point should be 0.450V to 0.500V. When the hand is about 7-8 cms away from the sensors, the measurement should go up to 0.800Volts to 1.00 Volts, hence the hand will be sensed properly.

Test Point 8

This test point is the control signal for the servo motor. The servo motor is directly powered by 5Volts and has a built-in motor drive, and can be easily controlled by the PIC microcontroller directly. The control signal should be a 50Hz Square Wave PWM signal with 5Vpp, and its width should be between 1ms to 2ms (%5-%10 Duty Cycle) according to the desired position of the motor.

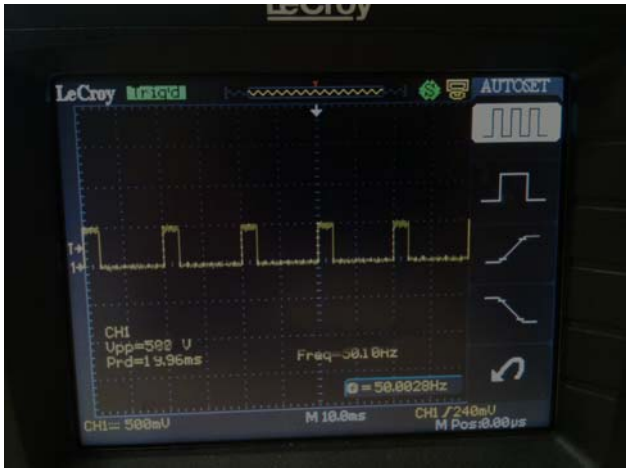


Figure 39: Control Signal for Servo Motor

,

Problems Report

At the first stage, we observed the problem which is about the sensitivity of the sensors. The sensors, which are corresponding to the detection of the hand movement, were not working as expected. The distance between the hand and the sensors were smaller than what we calculated. This problem was caused because of the different voltage values on the different sensors.

Secondly, we made mistake while drawing the PCB schematics.

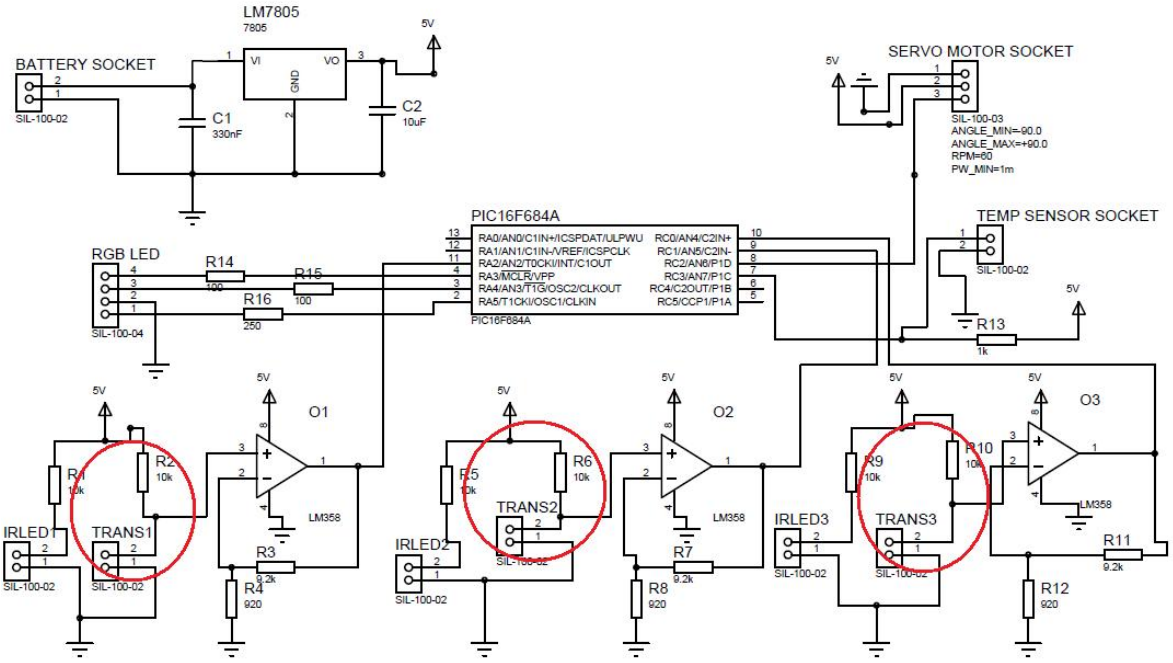


Figure 40: Wrong Schematic

As seen in the Figure 5, the red circled resistors were in the wrong place. They should be connected to the 1st pin of the transistors. In addition, the memory of the PIC that we use became not enough as we develop the code of the temperature feedback. Therefore, the possibility to use larger PIC is occurred so that the new PCB should be designed. You can see the corrected schematic on the appendix. Moreover, our PCB was too small so that it did not enable us to work on regularly. Therefore, new PCB has built.

,

Another problem was the mechanical connection between the motor and the water moderator which mixes the cold and hot water. We couldn't find an efficient way to connect them.

Finally, the last problem that we faced is the temperature feedback part of the project. First of all, the temperature sensor is covered with plastic enclosure and is filled with epoxy in order to achieve a water proof temperature sensor since it will be inside the water pipe all the time. Although hardware of the temperature sensor is working perfectly by doing this, there are problems of the software of the feedback system. The conversion of the analog signal from the temperature sensor could not be done as expected so that the feedback algorithm could not be developed as well.

,

Company Layout

The workshop is planned to be a room 10m x 10m, consisting of raw material storage shelves placed in the entry of the workshop, from which the sub-assembly parts such as sensors, LEDs, power supplies, microcontrollers and electric motors will be taken to the sub-assembly table. Here these parts will be assembled and be ready to be integrated to the faucet bodies. Next, these parts are sent to the assembly table, where all parts are assembled and after that they are stored in a space reserved for packaging and holding finished goods inventory, where the products wait ready for being sold.

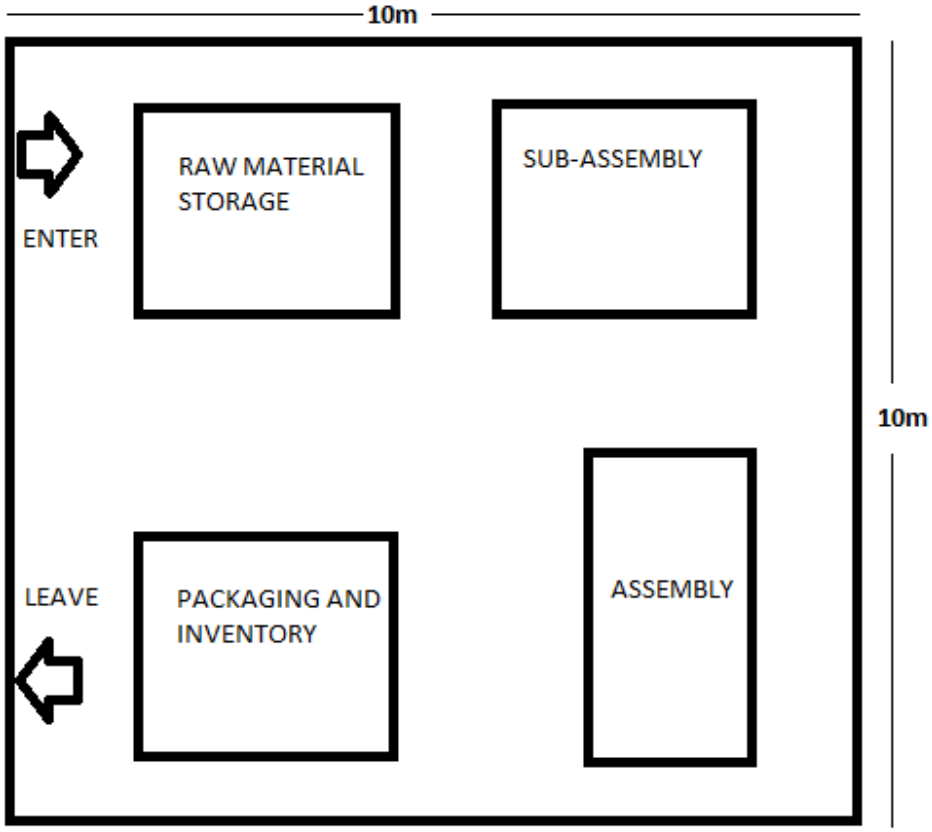


Figure 41: Layout of the workshop

,

The office room will be 6m x 8m, in which there will be four tables for the CEO, Financial Manager, Product Manager and Graphic Designer. Managing and designing processes are done in the office, and later all the designs, documents including information about sales forecasts and production quantities and quality requirements are sent to the workshop.

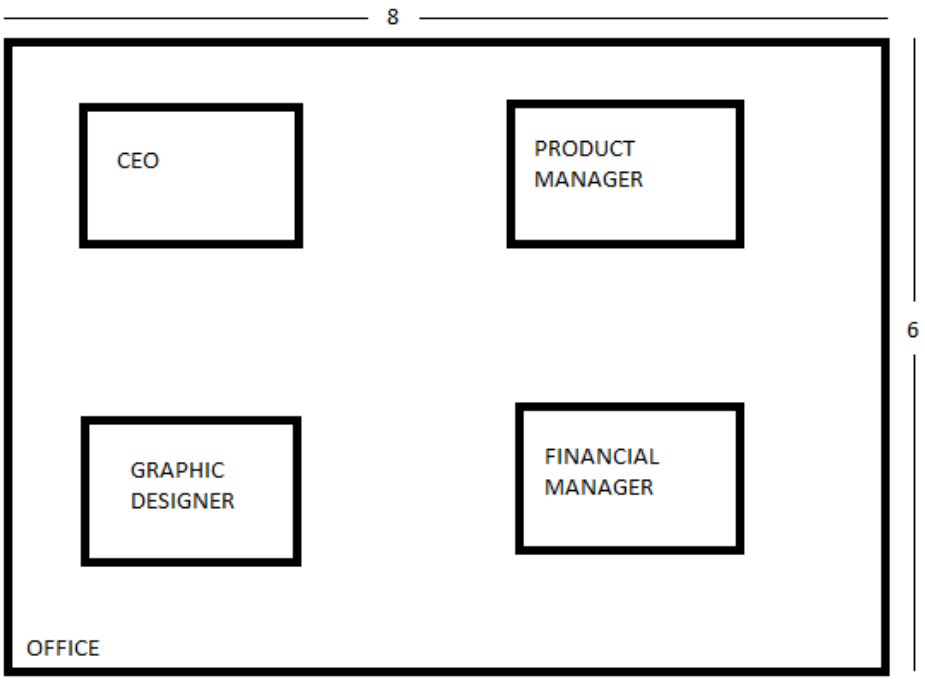


Figure 42: Layout of the office

Engineering Change Proposal (ECP) Forms

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	001
		Number of the Version to be changed:	001
		Tarih/ Date:	03.11.2010
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency Urgent x Routine	Change x Deviation Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Sensor Change
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	LS6511
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification
Reason For Change	Better Performance, Easier Implementation
Explanation of Reason for Change	Current sensor is a passive infrared sensor which is working with a simple principle, giving signals which determine there is a hand or not. This is not enough for optimal usage of the water temperature controlled faucet, hence we require a phototransistor – infrared LED couple in order to build our own sensor with the software. For maximum performance, and for faucet to work properly, this change is a must. Change from PIR Sensor –**LS6511** to Phototransistor & IR LED Couple – **BPW77NA**
Cost Effects	Material Cost

Total Labor Cost	-	
Total Material Cost	**2 TL**	
Schedule Effects	**None**	
Send Copies To	**Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler**	
Change Request Originator	**Cem Uran** **Cahit Taha İspir**	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	002
		Number of the Version to be changed:	001
		Tarih/ Date:	21.11.2010
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency Urgent x Routine	Change x Deviation Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Sensor Change
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	BPW77NA
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification
Reason For Change	Better Performance, Easier Software Coding
Explanation of Reason for Change	Current phototransistor is working with a wide range of wavelengths, which involves the visible wavelengths. This might cause unnecessary hand sensing + noise problems which will be hard to deal with using software, hence a new phototransistor with built-in daylight filter will solve all of the mentioned problems. SFH3011F is a phototransistor which works in only infrared wavelengths and ideal for our design. For maximum performance, and for faucet to work properly, this change is a must. Change from **BPW77NA** to **SFH3100F**
Cost Effects	-

,

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	**2 Weeks (Shipping Delay)**	
Send Copies To	**Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler**	
Change Request Originator	**Cem Uran** **Cahit Taha İspir**	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	003
		Number of the Version to be changed:	001
		Tarih/ Date:	08.12.2010
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency Urgent x Routine	Change x Deviation Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Microcontroller Change
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	PIC16F628A
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification
Reason For Change	Microcontroller Does Not Satisfy Our Requirements (No Built-In ADC)
Explanation of Reason for Change	Our current microcontroller is PIC 16F628A is not sufficient for some of our design requirements. We need an additional ADC in order to process the data coming from the sensor, hence using a microcontroller with a built-in ADC, we will not use any components in between for a safer design, and directly handle the data with the software. For maximum performance, and for faucet to work properly, this change is a must. Change from Microcontroller **PIC16F628A** to Microcontroller **PIC16F684**
Cost Effects	-

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	None	
Send Copies To	Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler	
Change Request Originator	Cem Uran Cahit Taha İspir	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	004
		Number of the Version to be changed:	001
		Tarih/ Date:	13.02.2011
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency Urgent Routine x	Change Deviation x Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Additional Temperature Sensor
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	None
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification
Reason For Change	Temperature Sensor Added to Implement a Closed-Loop Feedback System
Explanation of Reason for Change	This addition will allow us to implement a closed-loop feedback system which is necessary in order to have a stable and reliable system. The water temperature adjustment and important issue, and in order to make the adjustments precise, we will add this temperature sensor to guarantee the desired adjustments are done properly.
Cost Effects	-

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	**1 Month**	
Send Copies To	**Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler**	
Change Request Originator	**Cem Uran** **Cahit Taha İspir**	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	005
		Number of the Version to be changed:	001
		Tarih/ Date:	13.02.2011
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency Urgent Routine x	Change Deviation x Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	RGB Triple LED
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	Regular LEDs (5)
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification
Reason For Change	Better User – Interface and Use of Technology
Explanation of Reason for Change	This addition will allow us to have a much better looking user interface and being a new and more elegant technology, it will be charming to the consumers. This way we will improve the overall interface of the product.
Cost Effects	-

,

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	None	
Send Copies To	Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler	
Change Request Originator	Cem Uran Cahit Taha İspir	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	006
		Number of the Version to be changed:	002
		Tarih/ Date:	23.03.2011
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency x Urgent Routine	Change x Deviation Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Microcontroller Change
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	PIC 16F684
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification, Progress Report I
Reason For Change	Out of RAM, Require a better PIC.
Explanation of Reason for Change	Since the memory of the current microcontroller is not enough for us, this change is essential. This will also give us more Input / Output options with Analog-to-Digital Converters and will be easier to handle the hardware too. Change from Microcontroller **PIC16F684** to Microcontroller **PIC16F877A**
Cost Effects	-

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	None	
Send Copies To	Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler	
Change Request Originator	Cem Uran Cahit Taha İspir	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

	ENGINEERING CHANGE PROPOSAL (ECP) FORM SMART FAUCET	Engineering Change Proposal No:	007
		Number of the Version to be changed:	001
		Tarih/ Date:	02.04.2011
		Sayfa No/ Page No:	2

Priority	ECP Type	Reason for Change	Class for Deviation
Emergency x Urgent Routine	Change x Deviation Waiver	Deficiency x Slow Process of the Flows	Critical Major x Minor

Project Name- Project No	Smart Faucet – 001
Work Package No- Work Package Name	Design - 001
Change Description	Printed Circuit Board Change
Change Category	Plan Concept Requirement Design x Software-hardware Database-data file Test information Manual Other
Affected Item(s)	PCB
Status of Affected Item(s)	In stock product In production product x On order product
Affected Document(s)	Subassembly Specification, Progress Report I
Reason For Change	Wrong Circuit, Easier Handling of the Hardware
Explanation of Reason for Change	The first version of the printed circuit board has 3 mistakes in the circuit schematics. This hinders the product from working probably and should be fixed in the second version. While updating the PCB, we also have to make it larger, for easier mounting, soldering, etc…
Cost Effects	-

,

Total Labor Cost	-	
Total Material Cost	-	
Schedule Effects	**1 Week**	
Send Copies To	**Cem Uran, Fulya Çevikel, Cahit Taha Ispir, Ümit Eronat, Duygu Güler**	
Change Request Originator	**Cem Uran** **Cahit Taha İspir**	
Approval-Disapproval	**Work Package Manager- Sign- Date**	
	Configuration Manager- Sign- Date	
	Deputy Project Manager- Sign- Date	
Authorization To Proceed	**Project Manager- Sign- Date**	

Müşteri Onay Alanı **Customer Approval Area**	
Müşteri Adı **Customer Name**	
Müşteri Yetkilisi Adı- Soyadı **Authorised Customer Name- Surname**	
Sonuç **Result**	**Uygundur / Approved**
	Tarih/ Date
	İmza/ Signature
Görüşler **Comments**	

CM-FRM-ECP

,

Software Codes

```
#include <pic.h>

/*  PIC Configuration Bit:
**  INTIO    - Using Internal RC No Clock
**  WDTDIS   - Wacthdog Timer Disable
**  PWRTEN   - Power Up Timer Enable
**  MCLREN   - Master Clear Enable
**  UNPROTECT - Code Un-Protect
**  UNPROTECT - Data EEPROM Read Un-Protect
**  BORDIS   - Borwn Out Detect Disable
**  IESODIS  - Internal External Switch Over Mode Disable
**  FCMDIS   - Monitor Clock Fail Safe Disable
*/
__CONFIG(INTIO & WDTDIS & PWRTEN & MCLRDIS & UNPROTECT \
 & UNPROTECT & BORDIS & IESODIS & FCMDIS);

// Using Internal Clock of 8 Mhz
#define _XTAL_FREQ 8000000L
#define FOSC 8000000L

// Servo definition and variables
#define PERIOD 155 // 20ms.

void configure_leds( void );

unsigned char pulse_max = 0;
unsigned char pulse_top = 0;
unsigned char top_value = PERIOD;

unsigned int hand_delay_count = 0;

unsigned char motor_can_run = 0;
unsigned char current_pos = 8;
unsigned int motor_pulse = 0;

unsigned char target_temp = 25;
unsigned char calc_temp_pulse = 0;
unsigned char temp_calc_enabled = 1;

unsigned int input1;
unsigned int input2;
unsigned int input3;

void interrupt isr(void)
{
        if( T0IF )
        {           // TIMER0 Interrupt Flag
                pulse_max++;                            // Pulse Max Increment
                pulse_top++;                            // Pulse Top Increment

                /* (pulse_max = PERIOD) => turn off the pulse */
                if (pulse_max >= PERIOD) {
                        pulse_max=0;
                        pulse_top=0;
                        RC2 = 0;
                }

                if (pulse_top == top_value)
                {
                        if( motor_can_run )
```

,

```
                        {
                                RC2 = 1;
                        }
                }

                TMR0 = 156;                                     // Initial Value for 0.1ms Interrupt
                T0IF = 0;                                       // Clear TIMER0 interrupt flag
        }
}

void configure_leds(void)
{
        if( (target_temp >= 13) &&
                (target_temp <= 17) )
        {
                RA1 = 1;
                RC4 = 1;
                RC5 = 0;
        }
        else if( (target_temp >= 18) &&
                (target_temp <= 23) )
        {
                RA1 = 1;
                RC4 = 0;
                RC5 = 0;
        }
        else if( (target_temp >= 24) &&
                (target_temp <= 29) )
        {
                RA1 = 1;
                RC4 = 0;
                RC5 = 1;
        }
        else if( (target_temp >= 30) &&
                (target_temp <= 34) )
        {
                RA1 = 0;
                RC4 = 0;
                RC5 = 1;
        }
        else if( (target_temp >= 35) &&
                (target_temp <= 45) )
        {
                RA1 = 0;
                RC4 = 1;
                RC5 = 1;
        }
}

void get_IR_inputs( void )
{
        ADRESH = 0;
        ADRESL = 0;
        ADCON0 = 0b10010001;            // Get input from AN4.
        GODONE = 1;
        while( GODONE ) continue;
        input2 = (ADRESH * 256) + ADRESL;

        ADRESH = 0;
        ADRESL = 0;
        ADCON0 = 0b10010101; // Get input from AN5.
        GODONE = 1;
        while( GODONE ) continue;
        input1 = (ADRESH * 256) + ADRESL;
```

,

```
	ADRESH = 0;
	ADRESL = 0;
	ADCON0 = 0b10001001; // Get input from AN2.
	GODONE = 1;
	while( GODONE ) continue;
	input3 = (ADRESH * 256) + ADRESL;
}

void main(void)
{
	double adc_result;

	OSCCON=0x74; // Select 8 Mhz internal clock with stable internal oscillator.

	TRISA =0b00000101;		// RA0,2 is input
	PORTA =0x00;

	TRISC =0b00000011;		// RC0, RC1 are inputs
	PORTC =0x00;
	CMCON0=0x00; // Comparators off.

	OPTION = 0b00000000;		// 1:2 Prescaller
	ANSEL = 0b00110101;		// AN2,4,5,0 are inputs

	TMR0 = 156;					// Initial Value for 0.1ms Interrupt
	T0IE = 1;
	GIE = 1;

	// Make the motor go to the beginning.
	motor_can_run = 1;
	top_value = PERIOD - current_pos;
	__delay_ms( 500 );
	motor_can_run = 0;

	configure_leds();

	while( 1 )
	{
		get_IR_inputs();

		if( (input1 > 150) )
		{
			for( int i = 0; i < 1000; i++ )
			{
				get_IR_inputs();

				if( (input2 > 150) )
				{
					for( int k = 0; k < 1000; k++ )
					{
						get_IR_inputs();

						if( (input3 > 150) )
						{
							if( hand_delay_count != 0 )
							{
								if( hand_delay_count > 3 )
								{
									target_temp += 2;
								}
								else
								{
									target_temp += 4;
								}
```


,

```
                                                                        if( target_temp > 45 )
                                                                        {
                                                                                target_temp = 45;
                                                                        }

                                                                        current_pos += 5 / (hand_delay_count + 1);

                                                                        if( current_pos > 15 )
                                                                        {
                                                                                current_pos = 15;
                                                                        }

                                                                        motor_can_run = 1;
                                                                        top_value = PERIOD - current_pos;
                                                                        __delay_ms( 500 );
                                                                        motor_can_run = 0;

                                                                        hand_delay_count = 0;
                                                                        configure_leds();
                                                                        break;
                                                                }
                                                        }
                                                }
                                                hand_delay_count++;
                                        }
                                }

}
else if( (input3 > 150) )
{
                for( int i = 0; i < 1000; i++ )
                {
                        get_IR_inputs();

                        if( (input2 > 150) )
                        {
                                for( int k = 0; k < 1000; k++ )
                                {
                                        get_IR_inputs();

                                        if( (input1 > 150) )
                                        {
                                                if( hand_delay_count != 0 )
                                                {
                                                        if( hand_delay_count > 3 )
                                                        {
                                                                target_temp -= 2;
                                                        }
                                                        else
                                                        {
                                                                target_temp -= 4;
                                                        }

                                                        if( target_temp < 15 )
                                                        {
                                                                target_temp = 15;
                                                        }

                                                        current_pos -= 5 / (hand_delay_count + 1);

                                                        if( current_pos < 5 )
                                                        {
                                                                current_pos = 5;
                                                        }
```


,

```
                                                                        motor_can_run = 1;
                                                                        top_value = PERIOD - current_pos;
                                                                        __delay_ms( 500 );
                                                                        motor_can_run = 0;

                                                                        hand_delay_count = 0;
                                                                        configure_leds();
                                                                        break;
                                                                }
                                                        }
                                                }
                                                hand_delay_count++;
                                        }
                                }
                        }

                        //ADRESH = 0;
                        //ADRESL = 0;
                        //ADCON0 = 0b10000001; // Get input from AN0.
                        //GODONE = 1;

                        //while( GODONE ) continue;

                        //int adc_result = ADRESL;
                        //adc_result += (ADRESH << 8);
                        //adc_result = (adc_result / 2);
                        //adc_result = adc_result - 273; // Now we have the current temperature.

                        //int temp_difference = ((int) adc_result) - target_temp;

                        //if( temp_difference > 2 )
                        //{
                        //      current_pos += 5 / (hand_delay_count + 1);
                        //
                        //      if( current_pos > 15 )
                        //      {
                        //              current_pos = 15;
                        //      }

                        //      motor_can_run = 1;
                        //      top_value = PERIOD - current_pos;
                        //      __delay_ms( 500 );
                        //      motor_can_run = 0;
                        //}
                        //else if( temp_difference < -2 )
                        //{
                        //      current_pos -= 5 / (hand_delay_count + 1);

                        //      if( current_pos < 5 )
                        //      {
                        //              current_pos = 5;
                        //      }

                        //      motor_can_run = 1;
                        //      top_value = PERIOD - current_pos;
                        //      __delay_ms( 500 );
                        //      motor_can_run = 0;
                        //}
                }
        }
}
```

,

References

Faucet

http://www.tekzen.com.tr/newsite/prd-657815001-rainy_fotoselli_batarya.aspx

LEDs

http://i.ytimg.com/vi/LqnXRdc4KFs/0.jpg

http://www.melrose-nl.com/membrane_led_spec.pdf

Phototransistors

http://www.osram.com/search?sfh+3100f

PIC 16F684:

http://ww1.microchip.com/downloads/en/devicedoc/41202c.pdf

HD Mikro Servo - HD1900A

http://www.robotus.net/motorlar.asp

Battery:

http://photonlight-com-inc.amazonwebstore.com/Maha-PowerEx-MH96V230-Battery-rechargeable

,