Team Chase Technologies

September 20, 2014

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A1S6

Re: ENSC 305W/440W Project Proposal for Smart Irrigation System

Dear Dr. Rawicz:

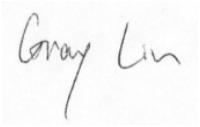
Please find the enclosed paper, “Project Proposal for Smart Irrigation System”, which is about the smart control box for automated garden irrigation system designed specifically for the Internet of Things (IOT).

Nowadays more and more home appliances are embedded with Internet capability. We predict the connected technologies will become essential as the price of smartphone and mobile network are generally affordable and accessible to consumers.

Therefore we propose to design a smart irrigation system which the device is able to act independently without complex setup and inputs, and users have options to control the sprinklers remotely and check the analyzed data and records through the Internet either on the website or mobile app. Details of the current market, source of funding, cost and ideas of design solution will be presented in this proposal.

There are five experienced engineering students in our team: Team Chase Technologies (TCT) .If you have any question or concern, please contact me by phone at (778)881-5322 or by email at yuhengl@sfu.ca . I will serve as the contact person for our team. We look forward to your comments and suggestions.

Sincerely,



Gray (Yu Heng) Lin
Chief Executive Officer
Team Chase Technologies

Enclosure: Project Proposal for Smart Home Garden Irrigation System

Team Chase Technologies

Project Proposal:

Smart Irrigation System

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Submitted to: Dr. Andrew Rawicz – ENSC440
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School of Engineering Science
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Issued date: Sep 22, 2014

Executive Summary

In the modern society, the Internet has been widely used and made a huge impact on our daily life. Once connected to the Internet, information can be shared and exchanged instantly. Thanks to the rapidly improved mobile technologies, it becomes easier and faster to access the Internet and connected to the world. It is now possible for us to finish our daily routines remotely. There are some manufacturers provide such function to their high-end home appliances. For example, with some expensive smart TV, people can control their TV, schedule recording of PVR or replay video via Wi-Fi on smartphones. So we decide to focus something that people hate to do but have to do on the daily basis, and it should not be very costly after production.

After research, we propose our project, “C-Sprinkler”. It is a smart irrigation system with a control box connected to the sprinkler and allows you to remotely control the sprinkler on your phone no matter where you go. It has the same function as the traditional sprinkler, and we implemented the “smart” function into it. What does “smart” mean? Being smart, our product can make the most appropriate decision for their owners to free their hands. You don’t have to worry about if you forget to irrigate your garden, the C-Sprinkler will take care of it. Our product has built in sensor in the soil which can send the outdoor information back to the control box, such as temperature and humidity. Meanwhile the C-sprinkler is also getting the information from Internet, it will use all these data to calculate and select the best solution to their owners. For example, it can automatically adjust the watering amount if there is an upcoming rain. It will use the estimate rainfall amount combine with current humidity, to decide when and how to irrigate the garden, to maximize the water saving. Also C-Sprinkler can give the new home owners suggestion what is the best watering setting if they are no familiar with irrigation yet. They just simply need to input what they have in the garden and our product will choose the solution based on the plants characteristics.

In our team, Team Chase Technologies, we have 5 experienced and brilliant young engineering students to provide solutions to real life problems and to facilitate people’s daily life. Currently our budget is $200 since most of the developing kits are owned by ourselves, and estimated cost for first prototype is around $150. We are looking to lower down the cost below $100 after production which the selling price range would be around $200 to $250. This should be an affordable price for most of the house owners and competitive to other products. Our project has started since September 2014 and we are aiming to finish our first prototype in the late November.

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1. Introduction

Fresh Water is a limited resource, there is only 2.5% of all the water on earth is fresh water and 1% of all the fresh water (~0.007% of all water) can be directly used by the animals and human beings [1]. It is remarkable how this small amount of fresh water can support 7 billion people on our blue planet. Based on the research, human are approaching the limit of available fresh water supply [1]. This becomes a very important issue worldwide. From U.S. Environmental Protection Agency's data, "as much as 50 percent of the water we use outdoor is wasted from inefficient watering method and systems" [2]. If we can change the design of current irrigation system with modern technology, at least we can improve the efficiency of water use.

There are a lot of great inventions since 20th century, such as the Internet and smartphone. Internet has very huge impact to our life, it changes the way how we exchange information, which improves people's lifestyle and living quality. Nowadays some manufactures have begun to provide Internet function on their high end home appliances, which use the concept of Internet of Things (IOT). IOT is a scenario that objects are capable transferring data to other objects over a network without human interaction [3], for example, pacemaker can be monitored and regulated long distance by hospital [4]. On the other hand, smartphones has become necessity for everyone's life as the phones and mobile plans are more affordable than before. According to the research, smartphones has accounted 56% of US phone market in 2013, this number was less than 40% in 2011 [5].

As the beneficiary of technology developing, we decide to combine these ideas together, and propose our project, "C-sprinkler". It is a smart irrigation system which has independent AI, remote control ability and cloud service. Our goal is to help users to free their hands and still maintain the garden well even they are away from their home. With our product, users will keep having the original functions of tradition irrigation system, such as timers and changing directions of sprinkler. The difference between C-sprinkler and other products is, we are "smarter". Our system allows users to check the humidity, temperature and all other information in real time and for past history, and the system will adjust the settings for their need and to save the water. Moreover, C-sprinkler will notify the users when there is an unusual change in the garden, for example, a sudden rain. With the cloud service, we can now send the weather forecast information to the C-sprinkler. When the system knows there is an upcoming rain, it will adjust irrigating time and amount of water to maximize the water saving. In the current plan, C-sprinkler will provide 2 platforms for users to access the setting and real-time information, one is on web based interface, the other one is mobile app.

This proposal will present the overview of our project, information of current market and the benefits comparing to other existing products. Moreover, the budget, source of funding and cost will be further discussed.

2. Scope

To make plant maintenance convenient and intelligent, our proposed solution is to design a smart thinking sprinkler controller which provides independent AI, cloud service and remote control ability. The scope for the project includes:

- The controller can self-determine irrigation timing based upon current plant environment
- Irrigation criteria and duration will be auto-adjusted based on forecast, plant species with Internet connection
- Users can control the sprinkler remotely on mobile devices
- Users can view irrigation history and plant environment status on mobile devices
- Traditional operation ability will be remained on the device

2.1 System overview

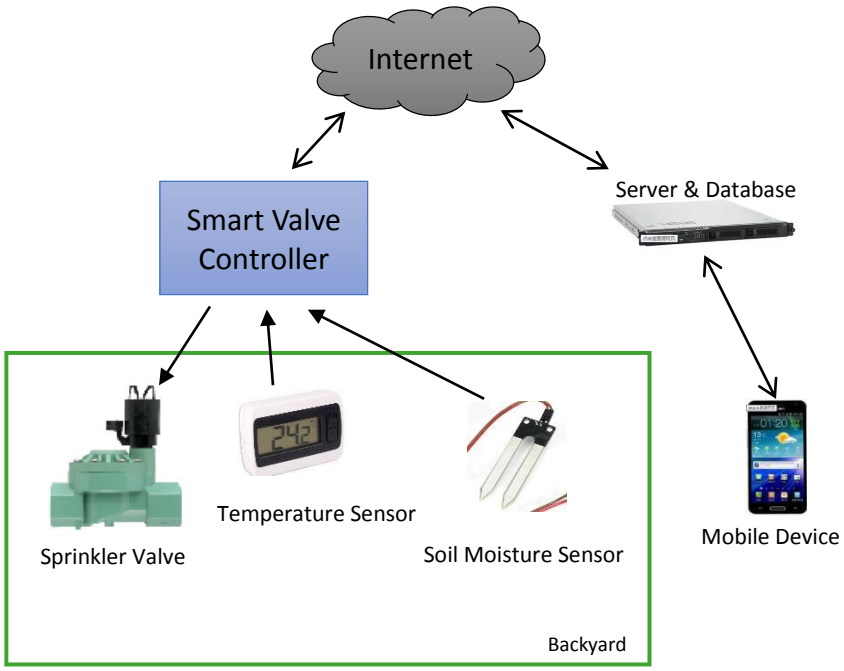

Figure 1: System Overview

Figure 1 demonstrates the system overview of the design. The system consists of mainly three parts: valve controller, server/database and client mobile. Controller possesses ability to collect and process data from external sensors. From these sensors we can have information of soil moisture to determine when more water is needed, and the temperature to determine if it is safe for the plant to irrigate. The device also connects to the Internet and have access to the cloud services on the server. Server database will provide irrigation criteria corresponding to the

user selected plant species. Other services of our system include forecast download, growing environment monitoring and irrigation history record, will eventually help controller to make decisions based on all factors above.

The task of the server is to create a connection between client mobile and controller when requested. Meanwhile, useful data such as irrigation schedule, environment variation and plant species will be stored in server database. Data collection and analysis not only improves user experience, but also provides the controller more information for a better performance.

Finally, with a mobile application, a recommended maintenance plan (e.g. activate criteria) will be presented to users after selecting plant species. The irrigation history can be viewed and irrigation schedule can be edited by users in real time. Any modification will be synchronized to the server. Besides the ability to control the sprinkler valve, the mobile application is also able to show the environment variation if a high quality plant maintenance is required.

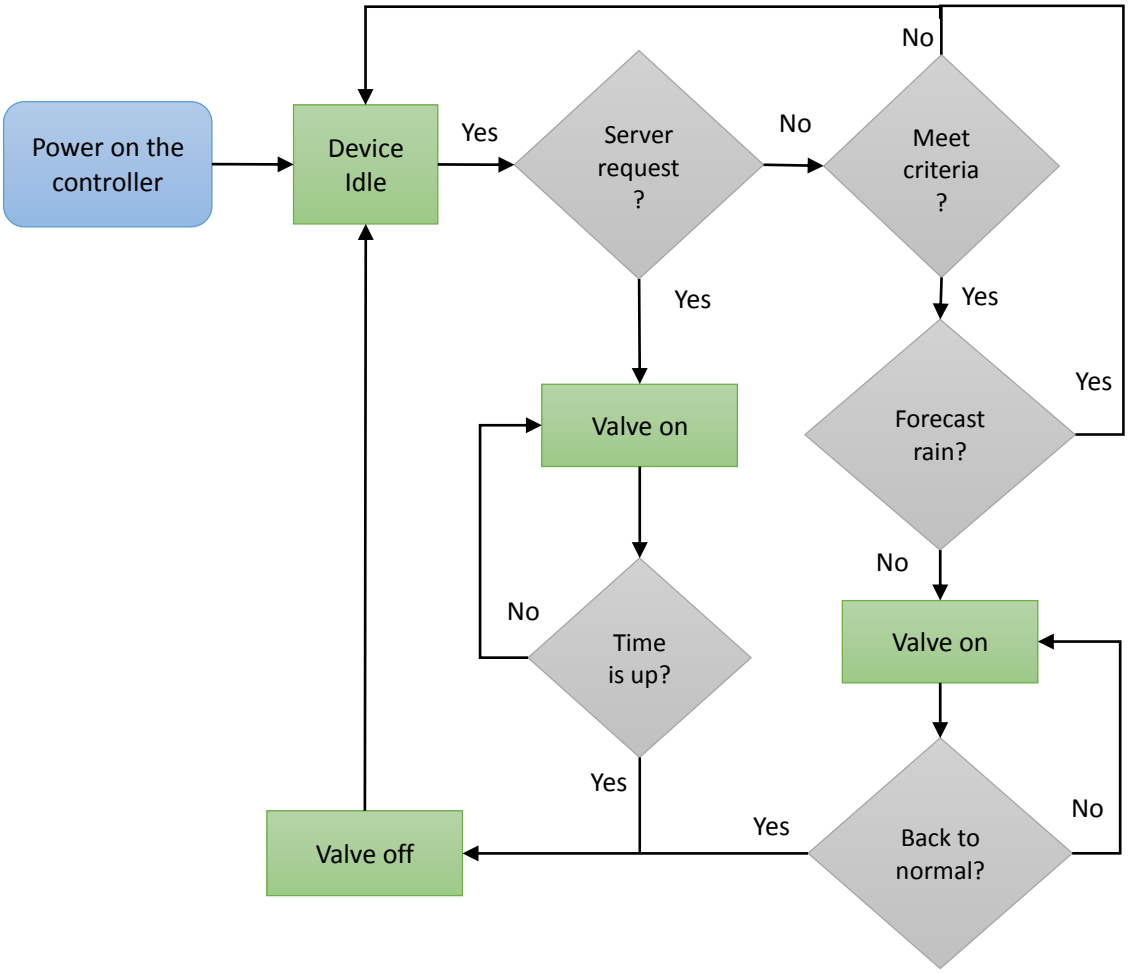

Figure 2: Controller Flowchart

Figure 2 in the last page summarizes the behavior of the system. Valves will be activated by either meeting the criteria such as low soil moisture level, or receiving a command from the server (the command may be originally created by user app).

2.2 Benefit

The first benefit of the proposed system is that users no longer need to worry about the irrigation of their backyard plants. Our system will handle the daily routine for users with a better management. Plenty of time can be saved.

The second benefit is the advantage of IOT (Internet of Things). With Internet connectivity, the controller is no longer a single device but a part of intelligent system that can think, adjust, perceive and communicate. Weather forecast will be downloaded and affect the coming irrigation plan. Environment will be monitored and recorded so people will get notified whenever something is going wrong. Irrigation history can be viewed and valve status can be modified on mobile devices. All these features enable household to get everything in backyard under control, even though they are not necessary to go out and check in person

Besides the benefits to owners, the system is also environment friendly. Water is one of the most precious resources on the earth and a better irrigation plan with a feedback control can prevent water waste. The amount of water it can save is considerable in long run.

2.3 Risk

Although the controller can work independently without Internet connection, for a better performance and user experience, Internet is necessary. Therefore, the Internet and server reliability become crucial. How to deal with delay, data loss and disconnection will be an important task in the future.

With Internet connectivity, the risk of security problem increases. Private information in the database should be well protected. Connection between client and server should be encrypted and unauthorized access should be prevented.

3. Market

House owners are the target audience for our product, which *yard maintenance is required as their daily work*. The potential demand for our product is huge based on an increasing population of house owners in recent years. According to Canadian Census, as of 2011 there are about twenty million people (out of thirty-two million) living in Single-detached house as one family or families sharing one home, which is a higher amount than the people living in all other structural type added together. This is a result of an increase trend of over a decade where there has been a two percent increase for every five years in the period from year 1996 till year 2006 [6]. By 2006, 68.4% of Canadian households owned their home and almost seven million households owns a single-detached house. The number of house owning households has further increased to 7.3 million by the year of 2011 [7]. These information is suggesting a substantial yet increasing market for our product.

As our product combines both automation and IOT technology, there is a huge potential market behind it. In terms of automation, the competing product on current market can only satisfy the basis requirement of the customer, to irrigate lawn at fixed time. Routine jobs such as plant inspection is still required, because improper irrigation amount and timing can cause the plant damage. As microcontroller have become cheaper and prevalent, making current irrigation automatic control intelligent is desired.

Besides the market potential on automation, implementing IOT technology on device is turning into a huge trend in various areas including home facilities, industries, public safety and environmental protection [8]. Technology companies such as Google (Smart Camera), Apple (Homekit) and Microsoft are all developing their own IOT device and preparing for the coming IOT revolution. The economic impact is evaluated to be $2.7 trillion to $6.2 trillion annually by 2025 [9]. Hence, IOT irrigation system will possess plenty of market opportunities, not only because the convenience the system can provide, but also the compatibility to future IOT platform lets further upgrades become possible. .

4. Company Details

Figure 3: Team Chase Technologies Logo

Team Chase Technologies (TCT) were founded by five brilliant experienced engineering students. We aimed to apply our sparkles of ideas and modern technologies to provide solutions to real life problems and to convenient people's daily life. We used water blue on our company logo to represent their design principles of water-saving, low waste, energy savings and environmental friendly. Our first product: C-Sprinkler, is a good example to maximize the efficiency of watering plants and to help gardeners increase the wellness of plants growing. C-Sprinkler with the meaning of "Connected-Sprinkler" and "Cloud-Sprinkler", it describes the main features: smartphone network connected control and cloud calculations.

Yu Heng Lin —Chief Executive Officer (CEO)

I am a fourth year undergraduate student major in Electronics Engineering at Simon Fraser University. I have been working at Glentel as a System administer to maintain the hardware and software for the head office and over 800 retail stores. I have special interest in electronics circuit schematics design. I have multiple electronics circuit design experience. For example, I designed a NTSC video signal decoder circuit and implemented the design on the breadboard. I have four years' soldering and wiring experience and knowledge of IC and PCB board. My detail orientated personality and extremely patient makes me a perfect hardware engineer in the team.

Able Lin —Chief Technology Officer (CTO)

I am a fourth year undergraduate student major in Computer Engineering at Simon Fraser University. I did my 16 months co-op as an embedding software developer in OS Platform Power Team at BlackBerry. My primary tasks were device power analysis, debugging, and development in BlackBerry OS10. During my work term, I developed strong knowledge in power, thermal, performance and stability. I am also familiar with radio technologies, radio power and networking. I believe that I am a perfect team player and some business courses I have done regarding handling disruptive behavior in the team work will help improving team performance. .

Chase (Youdao) Wen — President & Chief Financial Officer (CFO)

I am a fourth year undergraduate student major in Electronics Engineering at Simon Fraser University. I have two previous Co-op placement at Broadcom as a software developer. My specialty is at Digital/Analog circuitry which includes FPGA and VHDL. Through courses and work experiences, I obtained skills set in both software and hardware, especially in embedded system programming. I programmed timer driver and bush button driver with Xilinx Atlas board in C. My enthusiasm in product development process and friendly personalities ensures make me a perfect team player.

Yolanda Wu — Chief Operation Officer (COO)

I am a fourth year undergraduate student major in Computer Engineering at Simon Fraser University. I have completed two Co-op terms at Ericsson as a software designer and one Coop placement at DenScope as an Android app developer. During the first two Co-op placement, designed the testing software for the Smart Service Router with Tcl/Tk and PHP. I have strong software programming skill and obtained Android app development experience when working on the apps for CJSF Radio and DenScope. Furthermore, I am always able to perform professionally as an engineer.

Yuchen Wang —Chief Information Officer (CIO)

I am a fourth year undergraduate student major in Electronics Engineering at Simon Fraser University. I have strong math skill and proficiency in MatLab. In addition, I am particularly interested in multiple electronics sensors and semiconductors. I have successfully figured out a reliable algorithm to define object positions and motions with MatLab and the combination of the accelerometer, magnetometer and gyroscope in Texas Instruments SensorTag. Furthermore, my prudent working attitude and my enthusiasm in research will make a great contribution in the project.

5. Project Timeline

Table 1 lists the expected task completion date for the project and Table 2 shows the Gantt chart of the entire project timeline.

Important Dates	Documentation Preparation	Due Date
Project Proposal documentation	Sept 11 – Sept 19 (duration 7days)	September 22, 2014
Functional Specification	Sept 22 – Oct 7 (duration 12 days)	October 14, 2014
Oral Progress Report	October TBD (duration 1 day)	Late October, 2014
Design Specification	Oct 8 – Oct 28 (duration 15days)	November 3, 2014
Written Progress Report	Oct 29 -Nov 14 (duration 13 days)	November 17, 2014
Project Demo	December 5, exact date TBD	Early December, exact date TBD

Table 1: Milestone Chart

Task Name	Duration
Software Development	**64 days**
Scope	**10 days**
Topic decision and project scope	3 days
Project Proposal documentation	7 days
Analysis and Requirements	**20 days**
project requirements and specification	1 day
initial system design	2 days
resource allocation, cost and risk analysis	1 day
Functional Specification documentation	12 days
Design	**31 days**
Overall system design	3 days
general software	3 days
general networking	3 days
general hardware	6 days
Design specification report	15 days
finished design	0 days
Development	**40 days**
Networking development	10 days
Android development	20 days
Software application and driver development	20 days
Hardware circuitries development	15 days
Oral Progress Report	1 day
Hardware logic development (VHDL)	15 days
Networking integration	20 days
Written Progress Report	13 days
System integration	10 days
finished development	0 days
Testing and Demo	**7 days**
performance test and modification	3 days
stability test and modification	3 days
final test	1 day
project demo	0 days

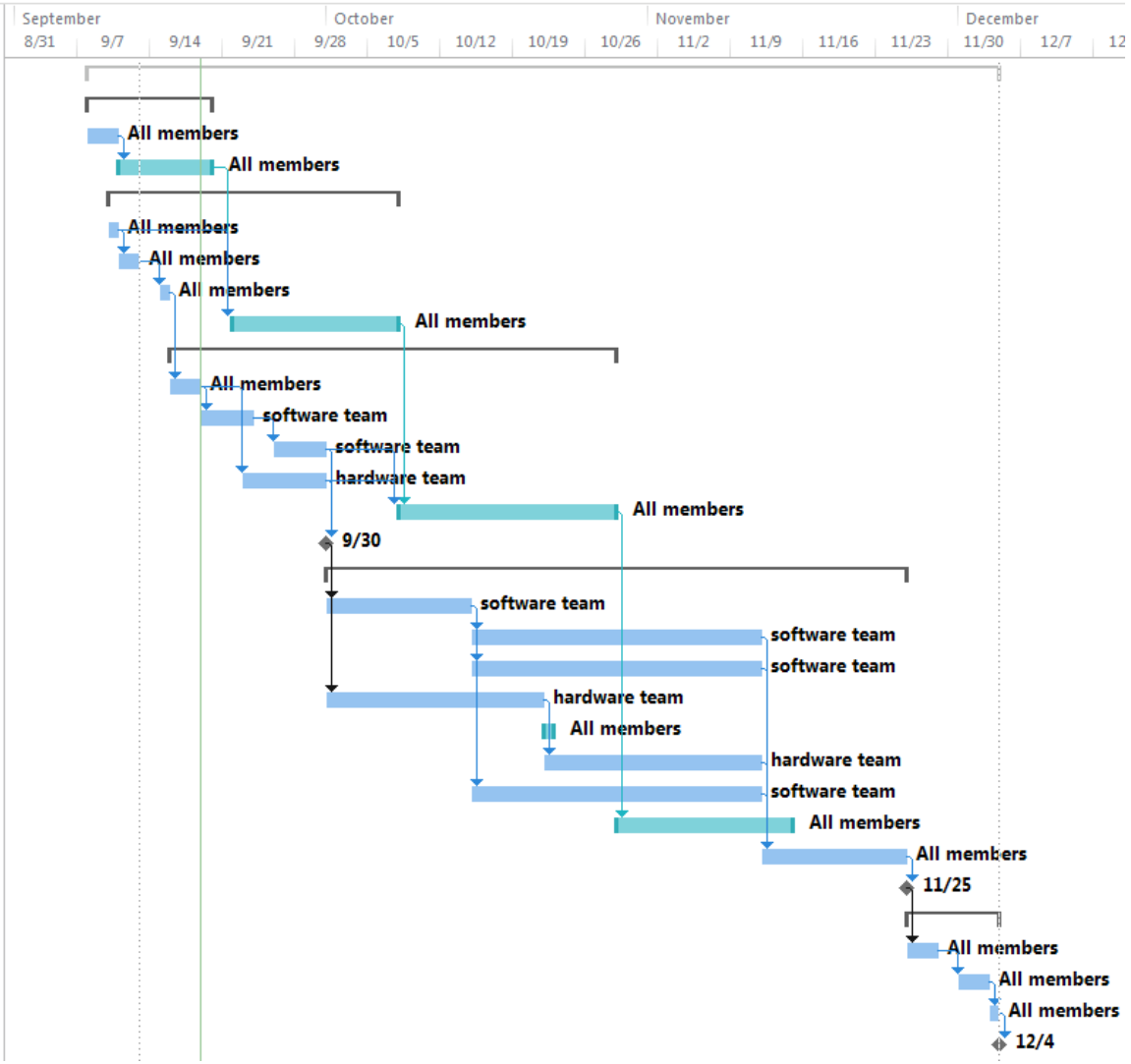

Table 2: Gantt Chart

6. Budget, Cost and Funding

Table 3 below shows an approximated cost for developing our first prototype. Altera DE2i-150 FPGA board is borrowed from friends thus cost on developing board will be zero. Other loaned properties include a server and a mobile phone for test purposes. Additionally, most electronic components were purchased in China which dramatically decreases our expenditure.

Our first prototype will mainly focus on product functionality and its efficiency. Most of features will be achieved by software applications and digital circuitry on the developing board, thus cost effective. However, future improvements such as making sensors wireless, waterproof, anticorrosion and PCB, will result in additional cost which is included in section **"Others"** in the table.

Item	Quantity	Cost (CAD)
DE2i-150 FPGA Development Kit	1	Borrowed
Electronic Components		41
Soil Moisture Sensor	2	5
Wire and Jumpers	1 (Pack)	15
Motion Sensor	2	5
DHT22 Sensor	2	10
10 Bit ADC	2	3
5V Relay	2	3
Irrigation Auto Inline Valve	1	17
Plug in Transformer 24V	1	20
Others	1	80
TOTAL		158

Table 3: Cost Approximation of First Prototype

A final product is aimed to replace the traditional valve controller normally installed in the backyard. To manufacture such devices, ASIC chip and other components will be soldered on PCB board with well-protection shell.

Due to economy of scale, unit cost of final production will vary with sales. For instance, a mass production will result in a less unit cost. Additionally, capital cost such as server infrastructure will be also allocated to each single product. In order to get a more precise approximation, we assume the volume of sales per year is 500 units. **Table 4** below summarizes an estimated hardware cost of a final product under such assumption.

	Intel Solution	Arm Solution
Computer	Atom Z510 Controller HUB US15W 512MB DDR2 -533MHZ Ethernet Controller Flash memory 8GB	Freescale iMX6S 4GB eMMC 256MB DDR3 Ethernet Controller 10/100
	$80	$50
Design hardware IC	Altera Cyclone 2 $20	
LCD display/ push buttons/ LED lights	$5	
Sensors	$10	
Assembly Cost	$20	
Server maintenance cost/unit	$10	
PCB Fabrication	$10	
Total	$155	$125

Table 4: Cost Approximation of a Final Product

We have raised CAD $200 for our project so far. Due to a low financial requirement in the development phase, majority of our project funding is sponsored by our own team members. So far we have only spent approximately $40 towards purchasing electronics components. The advantage of being self-financial support is that we have entire control over the project.

7. Conclusion

Team Chase Technologies is currently building the first prototype of C-Sprinkler. It is an automated intelligent irrigation system connected to the cloud server and can be remote controlled by end user easily. Therefore users have more flexibility to manage their garden and reduce water usage for the better environment. During the progress, we will test the product in different conditions to ensure the reliability, and try to lower the cost to meet the customer's expectation. Also we will keep in touch with our testers to get the feedback in order to improve our product. In this way, we are expecting to expand our customer base and profits.

In our team we have 5 experienced engineering students, we believe we can conquer the problems and present our first prototype in the demo as scheduled in the Gantt and milestone charts. We are fully prepared for this project, to make people's life easier.

8. Reference

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