Pvision Electronics

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January 23, 2012

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Capstone Project Proposal for a Parking Convenience System for use in commercial parking lots

Dear Dr. Rawicz,

We are writing with regards to our project proposal for a Parking Convenience System which we have attached for your ready reference. The objective of our project is to design a system which dynamically monitors the parking spots in a parking lot and informs drivers of the vacant and occupied spots in advance of them entering the site. The project functions on the principles of minimalistic design in order to develop an efficient and robust system which is user centered and financially attractive to our direct clients – owners and administrators of parking lots in malls, universities, hotels and other institutions.

The attached proposal provides an overview of our product while outlining the design, cost and implementation of the project. This is supplemented by our background research on similar technologies as it relates to the marketability of our solution. Further, it describes in detail, the composition of our company and its executive structure. Also included is the expected timeline of the project's progress.

Pvision is composed of five talented engineering students in the final year of their undergraduate degrees. The executive team consists of Mohammad Akhlaghi, Oshi Mathur, Milad Hajihassan, Noah Park and Yu-Jie Xu. We would be delighted to hear from you in case you would like to further discuss our proposal. We can be reached via email at "Pvision-ensc440@sfu.ca". Alternatively, our CEO, Mohammad Akhlaghi, can be reached via phone at (778) 997-1717.

On behalf of the executive team,
Sincerely,

M. Akhlaghi

Mohammad Akhlaghi
Chief Executive Officer (CEO)
Pvision Electronics Limited

Enclosed: Proposal for a Parking Convenience System

PVision Electronics

Project Team:	Contact Person:	Submitted to:	Issued date:
Mohammad Akhlaghi - CEO	Mohammad Akhlaghi	Andrew Rawicz (ENSC 440)	January 23, 2012
Oshi Mathur - COO	Pvision-ensc440@sfu.ca	Steve Whitmore (ENSC 305)	Revision 1.7
Milad Hajihassan - CTO	778-997-1717	School of Engineering Science	
Noah Park - CFO		Simon Fraser University	
YuJie Xu - CMO			

Executive Summary

Alex has been cramming all night and has trouble waking up on time on the day of his final exam. In a rush, he throws on some clothes and runs out the door; he only has 20 minutes to get to school! By the time he reaches the campus, 15 minutes have passed by already, leaving him 5 minutes to find a parking space in the busy parking lot which he has a pass for. Alas, all the spots in that lot are taken and it takes him another 10 minutes of wandering around the neighbouring lots before he is able to find a spot. He is certain he will have to pay a hefty parking ticket, as walks into the exam 15 minutes late…

Replace the exam with a meeting or an appointment, the campus parking lot with that of a mall or an office building in the city's downtown area; whatever the change, Alex's story is all too common. The amount of time and fuel wasted my many while searching for parking is growing steadily in cities around the world as parking space refuses to grow at the same rate as human population and the related increase in vehicles on the roads.

An exploration into this issue conducted by the Department of Urban planning at the University of California suggests that people in the major cities in North America spend about 8.1 minutes finding a parking spot in the city's core during work-hours. As per the report, such vehicles constitute over 30% of the traffic cruising in any given area.

To add to the gravity of the issue, one is forced to consider the carbon emissions associated with idling cars in a situation like Alex's – waiting for a car to vacate a parking spot, circling around the block for free spots and so on. A survey conducted by ParkingAuction.com, a website dedicated to solving parking congestion, states that "…on a 15-block section of Manhattan's Upper West Side, the non-profit Transportation Alternatives discovered that drivers burned an extra 366,000 miles hunting for parking in a year. Statistics are even worse in Los Angeles, where 950,000 excess miles were driven per year by parking spot seekers. It goes without saying that those miles add to drivers' carbon footprints. That extra 950,000 miles wasted 47,000 gallons of gas and spewed out an additional 730 tons of carbon dioxide. If all this is happening in small pockets of our major cities, imagine the cumulative effect of all cruising in the United States."

Needless to say, other alternatives have been explored to solve this problem. They all invariably include the use of individual sensors installed in at each parking spot feeding into expensive sytems that monitor the traffic in these spots. Our alternative solution at Pvision Electronics is exceedingly low-cost, more robust and allows for a more visual and user centered experience while parking.

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Introduction

Nowadays, car has been one of the most useful transportations for the people. In the most major cities, almost every driver has experienced of busy cruising for a vacant parking spot in a very crowded parking lot, above ground parking lot, below ground parking lot. Since a driver cannot visually assess whether or not there is a vacant parking spot in the parking lot he or she wants to enter, and the parking lot operator has no responsibility to tell you whether or not there is a vacant parking space, or even some parking lots don't have the parking lot operator. Therefore, the only way for a driver to looking for a vacant spot to park is that he or she needs to drive through the entire parking lot to cruise an available parking spot for himself or herself. If the space of parking lot is huge and multi-leveled, it will be very time-consuming. Thus, if the driver is running out of time and looking for a vacant parking spot in a huge parking lot is very frustrating. For example, if a student is driving to school to have an important exam and looked for a vacant spot to park while the minutes are ticking away towards the starting of the exam.

According to various researches on the time spent cruising for a parking space, the average time varies from 3.0 to 13.5 minutes, with distance drove varies from a half kilometer to more than a kilometer. If the driver is informed about how many parking spots are available and also the locations of the vacant spots in parking lot before entering the lot, he or she will not have to waste time and gas to cruise for a vacant parking spot in a crowded parking lot.

The main goal of our project is to design a system which dynamically monitors the availability of parking spots in a parking lot and notifies drivers of the vacant and occupied spots before they enter the parking lot. The system uses 2 cameras which are installed in a high view of a parking lot, to capture pictures of the entire lot every several seconds and then analyzes the pictures captured using the image processing algorithm we are going to develop. After that, the analyzed result is sent to the display unit located at the entrance of the parking lot in order to represent a real time map of the parking lot. Thus, before the driver enters into the parking lot, he or she can make an accurate decision on where to park.

This proposal is going to provide an overview design of our smart parking system. We will talk about the system overview, possible design solutions, proposed design solution, sources of information, budget and funding, project scheduling, and also the team organization in the following document. The entire design of the smart parking system will be done at the beginning of April 2012.

System Overview

Figures number 1 and 2 show the basic function of the parking system. Figure number 1 shows how the system functions from the user point of view where the user looks at the LCD display screen and enters the parking lot if there is a free space. Figure number 2 shows the functionality of the system. The system takes images in a very timely fashion and analyzes the images until it detects cars. At that point, the system compares the location of cars with the layout of the entire parking lot including the location of parking spaces and a map a generated. The generated map is then outputted on the display screen.

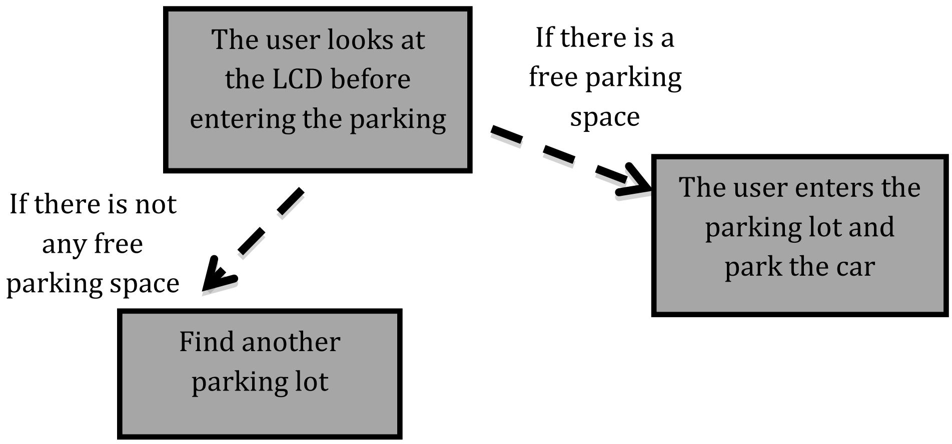

Figure 1: Conceptual User Overview

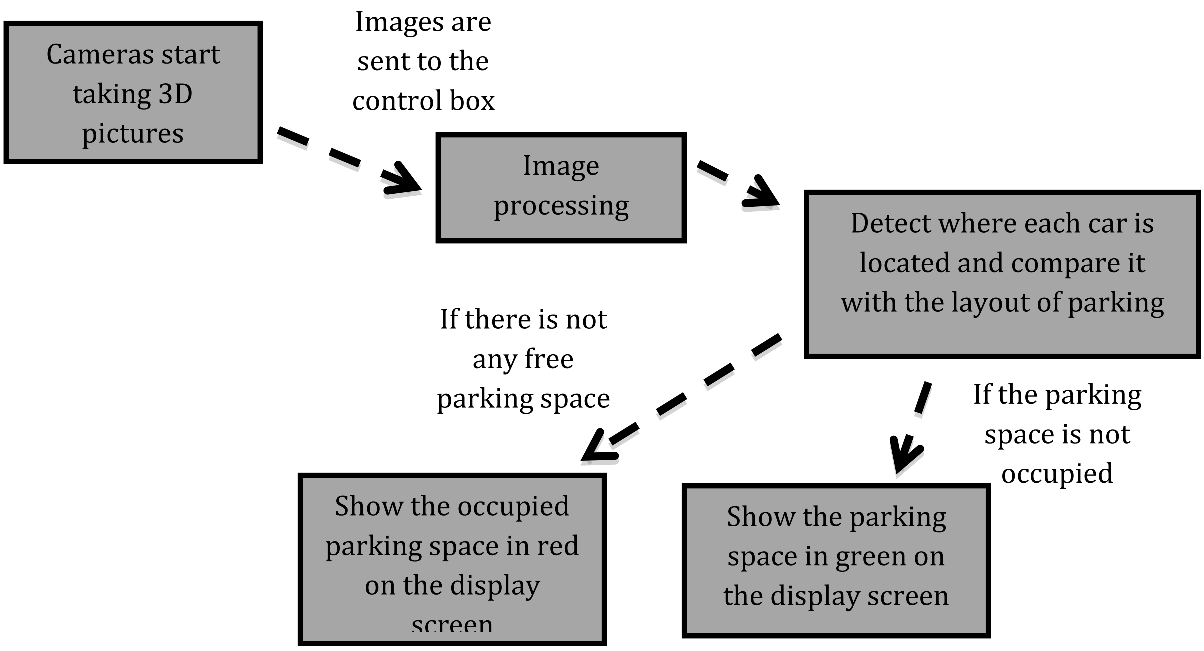

Figure 2: Conceptual System Overview

Possible Design Solutions

Parking management system has three main components: occupancy detection unit, main management unit, and availability indicator unit. There exist a number of solutions to occupancy detection unit and availability indicator unit of the system. Please note that following possible design solutions already exist in the current market.

Ultra Sonic Sensor

Ultra Sonic Sensors located on top of each parking space detect presence of vehicle in the designated parking space. Ultra sonic sensor generates high frequency sound waves to its objects and interprets the echoes to determine the distance to the object. The main advantage of ultra- sonic sensor is its accuracy to detect the presence of vehicle. Current ultra-sonic sensors, being installed for vehicle detection purpose, have detecting distance of 30cm to 4m with detection angle of 45 degree. Unless the sensors malfunction, they detect vehicles in various sizes with great accuracy. However, installing sensors on top of every single spot of parking lot require considerable installation costs. Also the wiring to main management system and maintenance costs is a significant disadvantage of ultra-sonic sensor. [1]

Induction Loop Sensor

Induction loop is commonly used for vehicle detection around intersections for effective management of traffic signals. These sensors can also be installed under parking spaces to detect presence of vehicles above them. Induction loop is electromagnetic detection system where conducting loop is installed under the ground. When vehicle is on top of conducting loop, it induces current in the wire loop, thus decreases inductance. Decrease in inductance then triggers the output electronics unit which send signal to the main control unit. The advantage of installing induction loop sensor is the easiness of maintenance. As the sensors are buried under the ground, it can tolerate harsh weather conditions. Outside temperature or humidity will not affect the functionality of the sensor, and it does not require regular cleanup to perform properly. However, induction loop sensors need significant amount of money for initial installation and replacement in case of failure. [2]

Pressure Sensor

Pressure Sensors are similar to inductive loops in terms of installation process. To detect the pressure difference caused by weight of vehicle, pressurized tubes filled with liquids are buried under ground. When vehicle is parked above the sensor, the weight of vehicle exerts pressure on the tubes. This causes the pressure monitor to detect the pressure changes on tubes, which then transmits signal to the main control unit. Pressure sensors are not commonly used for vehicle detection as they are sensitive to temperature changes and have low accuracy. When vehicles are parked, it is not guaranteed that the wheels step on the pressure tubes. Moreover, initial installation and maintenance costs are disadvantages of pressure sensors. [3]

Counting Signboard Display

Counting signboard display updates the occupancy of current parking lots in real time. LED display, visible at the entrance of parking lot, shows the number of available spaces in each floor of parking lot. As drivers enter the parking lot in their vehicle, they can briefly scan through the numbers on the signboard for availability. Then they make a decision to drive into the least busy parking lot. Inside the parking lot, LED signboards are strategically deployed at every decision-making point. Drivers drive into the road that has the most availability again. Finally, drivers find themselves near the parking space where they are encountered with LED lighting on top of each parking spot. Red indicates occupied parking space and Green indicates available parking space. Series of LED displays on the way to the parking space effectively guide the drivers into empty space with minimum effort. Yet, the installation and maintenance costs often outweigh its effectiveness since large number LED displays are required to be installed. [4]

Proposed Design Solution

The proposed design solution consists of a system that can detect whether a car is parked in a parking spot or not. The system can be installed and removed in any parking without any damage to the parking. The design process consists of development of both small size prototype and full size prototype which use the same program for image processing. The only difference between the small size prototype and full size prototype is the components used. These components include the cameras, control box, and the LCD display screen.

The system uses 2 cameras to capture 3D pictures of the entire parking in a very timely fashion and analyzes the pictures using image processing; the result is then sent to the LCD display screen in order to represent a real time map of parking. The small size prototype uses VGA cameras while the full size prototype requires 720p cameras which have higher quality.

The control box is the main body of this system where it communicates with cameras and does all image processing. The control box in the small prototype is a Microcontroller (MicroChip PIC32) which runs a program to do both image processing and storing data. A small industrial computer is used instead of the Microcontroller in the control box. The control box is installed at a place where it can't be accessed by regular people for security purposes.

A 3D layout of the parking lot with location of parking spaces is generated by the system at the time of installation. This layout is customizable and is different for all parking lots. Figure number 3 shows a sample picture of a parking lot which is captured using cameras and used in the system. The captured image of parking at any instant of time is sent to the control box to be analyzed and compared with the captured image at the previous instant of time using image processing. The program compiled in microcontroller then starts detecting cars based on the edges of cars and finding where each car is located at each moment. Figure number 4 shows basically where the cars are located which is the key for defending whether a car is parked in a parking spot or not. The system then compares locations of cars with the layout of the entire parking and represents the result as a map on the LCD display screen. The number of free parking spaces is also represented on the screen. The small size prototype uses LCD Microcontroller module as the LCD display screen while the full size prototype requires a large LCD display screen.

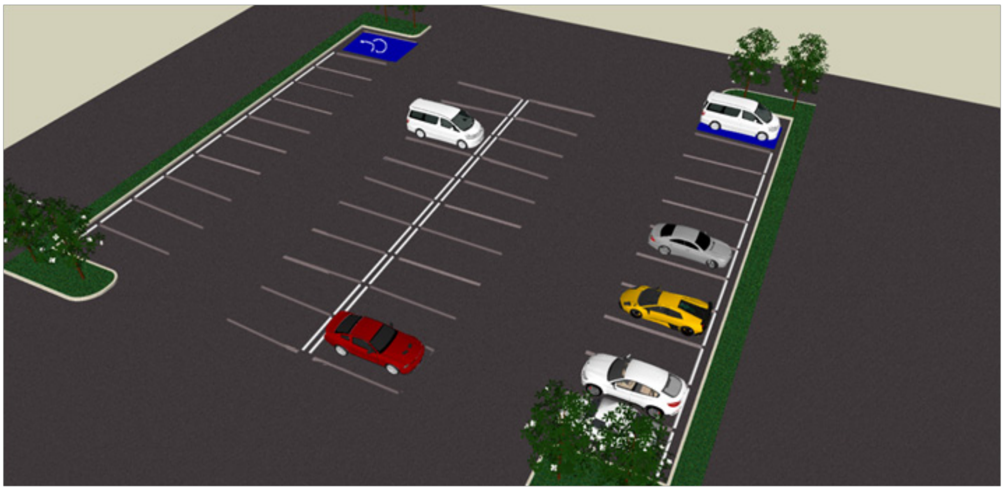

Figure 3: Sample parking lot

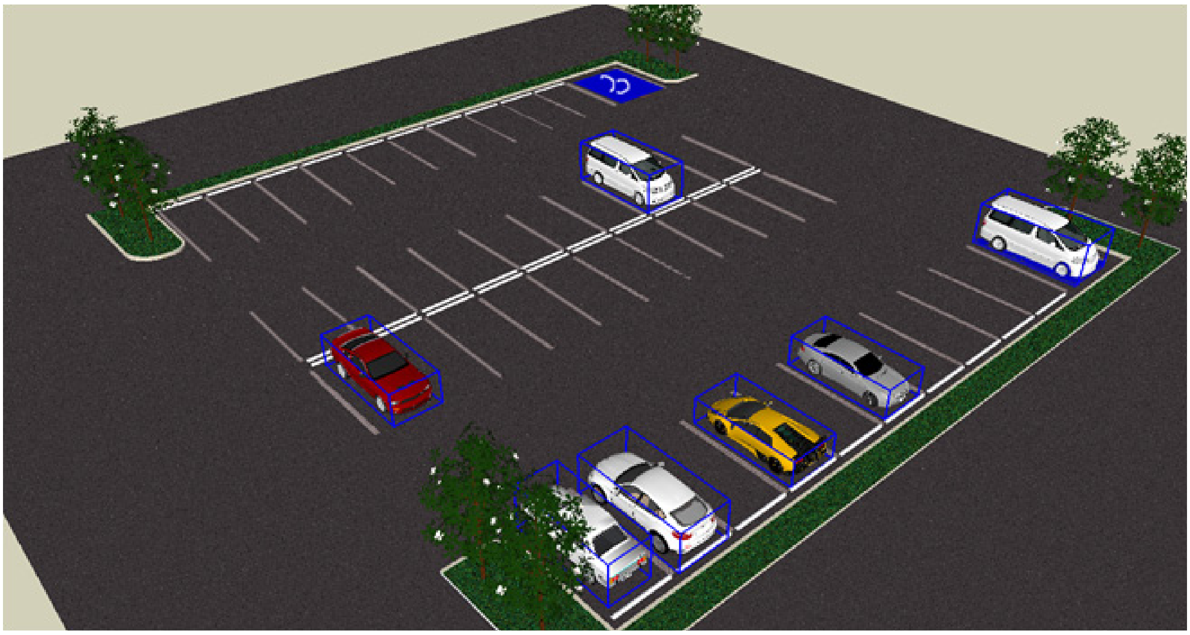

Figure 4: Car recognition software

The system covers out-doors parking's to a range of distance and additional cameras may be required as the distance exceeds the range. The in-door parking's also require additional cameras in order to cover the entire parking. Figure number 5 shows the visual representation of entire system and the outputs on the display screen. Figure number 6 shows the installed system in an out-door parking lot.

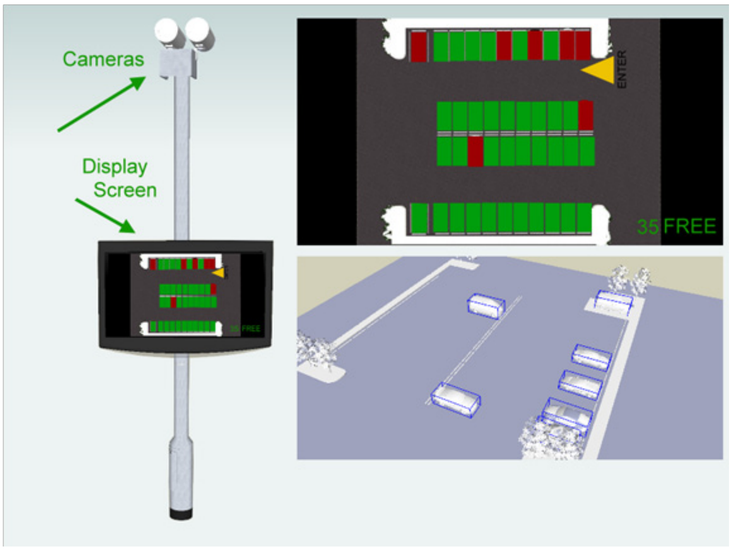

Figure 5: Display screen

Figure 6: Installed system

Additional user friendly features can be added to the system such as a wireless module in order to make the system useable by computers and smart phones in order to inform the user when the parking time expires and the parking time needs to be extended. The control box can send the data to an external storage when it's connected to a network via the wireless module which can be used by parking lot security in order to make it easier for monitoring.

Sources of Information

To implement our project, we need to access a variety of sources of information on real time 3D image processing and microcontrollers. This project involves programming on microcontroller so that it is very import to get ourselves familiarized with PIC32 at early stage of development. Microchip website (http://www.microchip.com) has a large information database as well as a technical knowledge on microcontrollers.

Fortunately, ENSC 424 has touched the basics of multimedia signal acquisition, compression, processing, and transmission. Our team will constantly access the course notes and textbook for information. However, majority of information will be on World Wide Web. There are number of cooperation and individuals who post their research materials on subject of image processing on their website.   Number of books on image processing is also available at SFU library.

We are currently in the progress of arranging a meeting with David Agosti, SFU manager of parking services to obtain suggestions on parking system and to ask for further cooperation with field testing in the future.

Budget

The budget for our system is divided into two major parts; first is the small scale prototype, table 1, which will allow us to perform thorough testing on our system before going full scale. Second is full sized prototype, table 2, which consist of the major portion of our budget.
Possible modification to the design at various development stages could increase/decrease the budget by 10%. Also the budget is constructed for our first and final prototype only and we need to point out that mass production of the system will significantly decrease our costs, due to the fact that manufacturing costs decrease with mass volume purchasing.

Components	*Estimated Cost (CND)*
720p webcam * 2	180
Microcontroller board (MicroChip PIC32)	150
LCD display Module	300
Other expenses	70
Total Cost	700

Table 1: Tentative development budget breakdown for our prototype

Components	*Estimated Cost (CND)*
720p HD Camera with night vision * 2	500
Microcontroller board (MicroChip PIC32)	150
LCD display board	2,000
Other expenses	350
Total Cost	3,000

Table 2: Tentative development budget breakdown for full sized prototype

The project consists of three main parts which work together to perform the required task. These three parts include camera, Microcontroller, and display screen. The camera needs to be able to perform under different types of weather conditions and hours in a day. We selected a Camera with Infrared night vision in order to fulfill this requirement.

The Microcontroller is a PIC32 MicroChip that is going to be used to run our program and store information. The cost of LED display screen makes the biggest portion of the total cost as it has to be able to perform out-doors and can be visible from reasonable distances.

We estimated a total cost which covers the cost of all essential parts required for the completion of project. Various factors can affect the pricing of certain parts such as expedited shipping and retail availability. There are also other expenses which include costs such as PCB fabrication and Integration, Conducting wires.

Funding

The design and manufacturing of our system requires considerable costs which will be provided to us through two main sources. First is through various funds from the Simon Fraser University engineering department, and second which is the major part will be through new ventures BC.

Pvision Electronics has obtained funding from the Engineering Science Student Endowment Fund (ESSEF) in the amount of $700 CAD. The tools we buy through this funding source is the property of the engineering science student society and has to be returned to them upon completion of the course. Fortunately this will cover all the potential costs for our first prototype.

Pvision Electronics will look for potential investors through new ventures BC in order to be able to fund the big portion of the project which would be the full sized prototype. Having a small scale prototype will give us an advantage in looking for other sources of funding. Also we will be working on our business model to estimate our profit margin since this will be required in order for us to apply for any funding through new venture BC.

Business Model

Thanks to the business potential of our system, we have already consulted SFU Venture Connections and they have helped us greatly with our business planning. Further, we have a business mentor who will guide us throughout the course of this project. Below, we have a brief description of our initial business plan. There are two main revenue solutions which will be decided based on our negotiations with the owners / administrators of the parking lot(s).

Profit Sharing: The idea is to share the profit with the owners of the site. Since our system can easily monitor the frequency and volume of vehicle-traffic making use of the parking lot(s), we can determine how much profit is the parking owner making and set a percentage of that as our revenue. Besides, parking lots will incur a periodical charge for maintenance besides the initial installation costs.

3rd Party Revenue Stream: The costumers of the parking lot (i.e. the car owners) will get charged extra for convenience fees which can directly reach our bank account. This way the parking-lot owner will only pay us for monthly maintenance and one-time installation costs.

Schedule

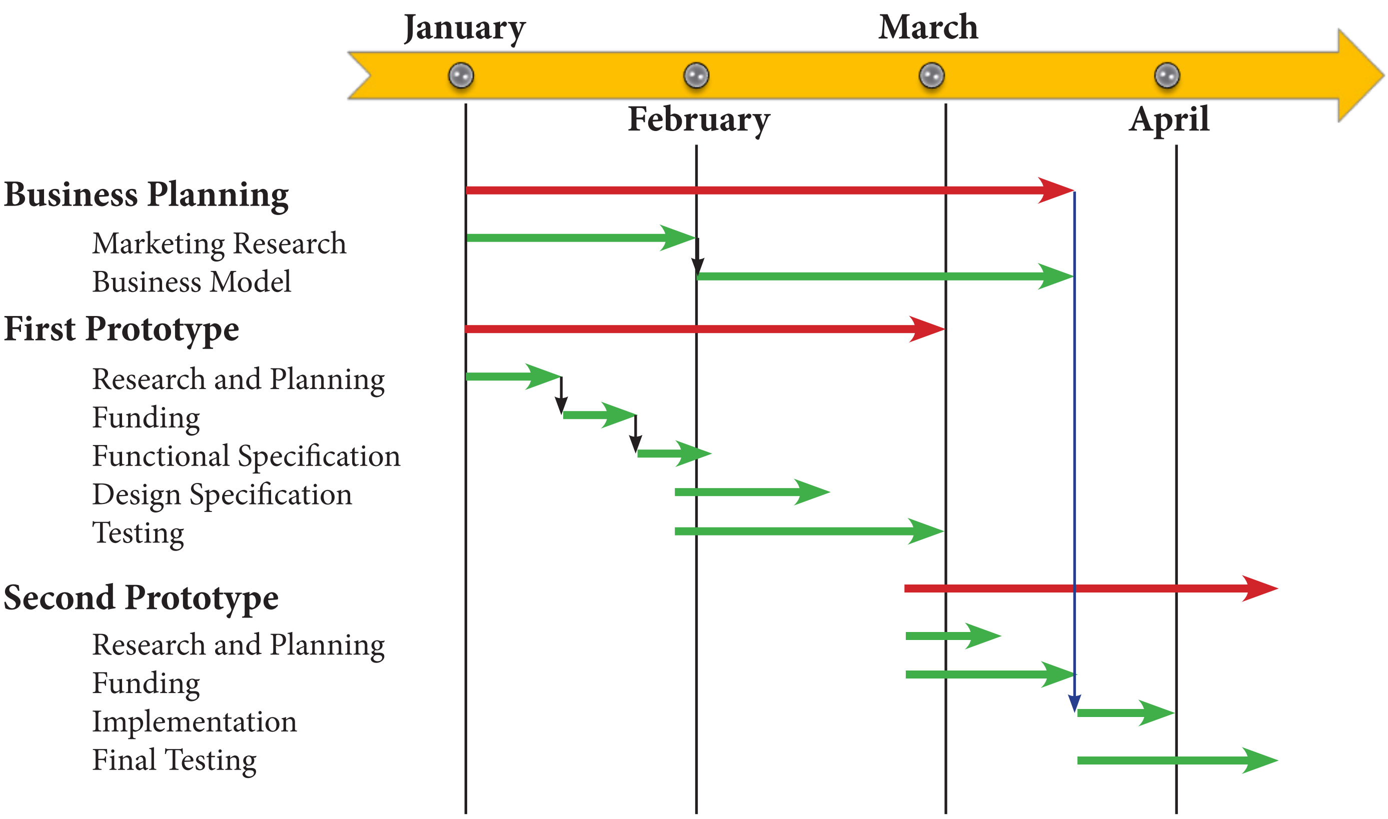

Figure 7: Gantt Chart

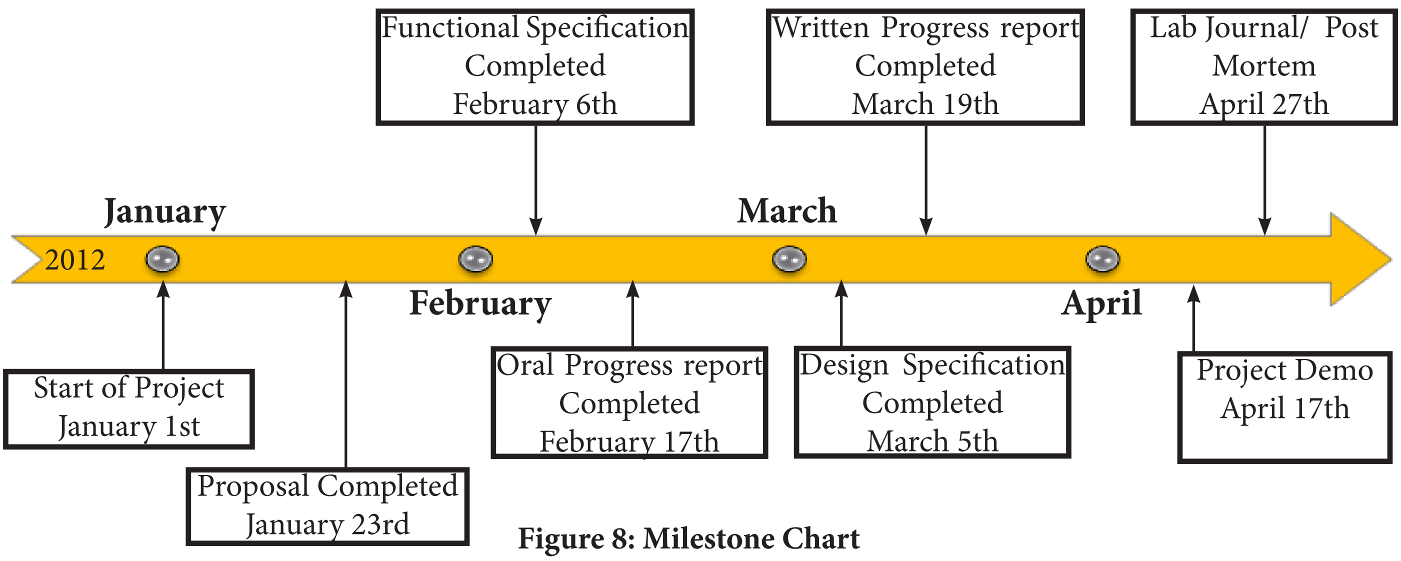

Figure 8: Milestone Chart

Team Organization

Pvision Electronics Ltd. Has been formed by four engineering students – Mohammad Akhlaghi, Noah Park, Milad Hajihassan and Oshi Mathur. All members are in the 4th year of their undergraduate career. They are nearing the end of their degree at SFU and are motivated to extend the progress they make in the Capstone project, to big-picture marketing ideas in the near future.

Pvision's corporate structure allows for flexibility within the organization maximally utilizing the members' talents while enabling efficient operations via division of labour. Mohammad Akhlaghi is serving as the Chief Executive Officer (CEO) of the company and is responsible for the implementation of the over-arching direction the company intends to take. Additionally, Mohammad is also responsible for conflict resolution. Oshi Mathur, the Chief Operating Officer (COO), manages the smooth functioning of the company by scheduling tasks and monitoring progress while serving as the first point of contact for the company. Milad Hajihassan, who will be overseeing the hardware and software design for the products along with documentation, assumes the role of the Chief Technical Officer (CTO). Noah Park, the Chief Financial Officer (CFO), is in charge of the budget and generating funds for the company.

The executive team holds weekly meetings to discuss the tasks at hand and review project-progress. An open source project management software, Zoho Projects, is used for all virtual communication including - scheduling meetings and tasks, sharing documents, participating in discussions forums, etc. Each meeting will see a team-building activity run by the members along with monthly socials.

Mohammad Akhlaghi
Chief Executive Officer (CEO)

Mohammad Akhlaghi is a fourth year electronics engineering student at Simon Fraser University and he is also working towards his minor in Business. A team-focused, task-oriented, and results-driven engineering student with a strong business background. He has gained a lot of technical knowledge through two coop work terms in the industry and research. Experienced in project management, technical support, and working in multi-disciplinary teams. Puts a strong emphasis on effective communication, organizational sustainability, and meeting client and market needs.

Noah Park
Chief Financial Officer (CFO)

Noah Park is a fifth year computer engineering student at Simon Fraser University. He has gained significant practical experience through co-op work terms at Siemens and DongWon where he worked as a software engineer for designing and developing software for analyzing test data. These coop experiences exposed him to the business side and organizations of a large corporation as well. As a student, he has gained wide-range of knowledge in programming languages such as C/C++ and Java. He is also familiar with using VHDL to design custom circuits. With his extensive experience in programming, his contribution to the team will be focused in the area of software engineering.

Milad Hajihassan
Chief Technology Officer (CTO)

Milad is a fourth year systems engineering student at Simon Fraser University. His areas of interest include software development and graphic designing. He has taken courses in microelectronics, robotics, and real-time and embedded systems during past few years of his studies. He has experience working with microcontrollers as well as implementing games using C and Linux which he gained from the previous engineering projects.

Oshi Mathur
Chief Operating Officer (COO)

Oshi is in his fourth year of my engineering degree with a concentration in Biomedical Engineering. Thanks to the engineering courses offered at SFU, he finds himself adept at the basics of circuit design, programming, and problem solving. A two-semester Co-op work term at Active Network Ltd. gave him great background in working as part of a big team while focusing on the technical back-end of software solutions that run the city halls, recreation centers and universities of all major North American Cities. Liaising with clients and different departments both within and outside a company are things that his position taught him best. Through plethora of extra-curricular employment in SFU's university Life, he has had the chance of working with a diverse population of people wile gaining leadership skills.

YuJie Xu
Chief Marketing Officer (CMO)

YuJie Xu is a fourth year electronics engineering student at Simon Fraser University. Through one year co-op work term at the Montior King Ltd, he obtained plenty of practical experiences on hardware assembling. He has finished the programming languages, like C or C++ and real-time and embedded systems in his third year studies. With his co-op work experience and course studies, he will be responsible for both hardware and software design in our company.

Conclusion

At Pvision Electronics, we are confident that our product will help save time, money and unnecessary carbon emissions while delivering a luxury service to the masses. The simplistic design, cheap and straightforward installation process, and benefit to customers will make the product highly marketable.

In the presence of an enthused, talented team, we are confident that we shall be able to successfully develop and market the said product by April 2012. Our project plan and timeline have been set with realistic goals in mind. Our focus is to come up with a fully functional prototype, which will withstand the test of limited funding available in an academic setting. This will allow us to come up with the most cost-efficient model which can then be custom made to suit the needs of our diverse clients.

In the process of design, we will ceaselessly be looking for ways to simplify the technology and evolving the project in our quest for the best, most efficient Pvision system. We thank you greatly for your consideration.

References

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