



January 23, 2015

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

Re: ENSC 305/440 Project Proposal for Smart Windows

Dear Dr. Rawicz,

Smart Windows is a device that will provide its user a more convenient and efficient way of life. Our objective is to create a device to control the windows and curtains of a residential house, apartment, or office building. The device will help maintain a comfortable indoors environment by automatically closing and opening the windows and curtains based on weather, room temperature, lighting, and humidity.

More and more devices nowadays are becoming automatic so we believe that our device will definitely have its place in future markets.

Attached below is our Proposal for Smart Windows which outlines our project for ENSC 305/440. It consists of information on our project, company, time line, budget, funding, and competition.

Our team consists of five dedicated and outgoing engineering students. For further information on our project you can contact us at dzhuo@sfu.ca.

Sincerely,

A handwritten signature in black ink, appearing to read "Dong Hao Vincent Zhuo".

Dong Hao Vincent Zhuo

CEO

Smart Window



Proposal for Automatic Window Controller

Smart Windows Proposal

Project Team: Dong Hao Vincent Zhuo

Steven Ho Chong Zeng

James (Chia hung) Lee

Jie Wen Mai

Jing Xiang Hou

Contact Person: Dong Hao Vincent Zhuo

dzhuo@sfu.ca

Submitted to: Dr. Andrew Rawicz

Steve Whitmore

Date: January 23, 2015

Background & Summary

Windows are a daily thing we can see and use to get some fresh air and balance temperature for buildings and rooms. A lot of people are not able to adjust the window to be opened or closed when they are not around the window. Many things are being automated these days because people don't want to worry about the little things in life such as closing a window during rain storms.

The main purpose of our product is to control the windows and curtains of homes and office buildings. In order to determine the movement of the windows and curtains we use rain sensors, temperature sensors, light sensors, and humidity sensors to evaluate the indoor and outdoor environment. It will cost us approximately 300 to 600 dollars depending on the functions that will be implemented.

Our main customers are office, home, and apartment owners. Currently, there are some similar products out in the market but they are expensive and not mass produced. For the auto window controller, we provide an affordable control system which is small and compacted for most of the rooms. In this document, we will discuss the problems, solutions, cost, and planning details.

Our company, Smart Windows, is consisted of five electronics engineering students; we work together every week and share our ideas for this project. For the final prototype, we plan to build the window frame out of aluminum and the wall which the window is mounted on out of ply wood. Also, we use motors to drive the gears and treads so that the window can move smoothly.



Figure 1: Property Damage from Rain



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1. Introduction

Imagine a daily life that you wake up with slow music, and the French window opens automatically letting sunshine come through onto everything in the room. Suddenly and slowly, sensing the existence of the sunshine as a signal of another fresh new day, everything around you wakes up. Instead of music, the television is playing the morning news. Time, schedule, tasks and messages are shown on the windows or mirrors, moving between glasses as you change your view. Bread is just toasted and coffee is just cooked after you just finished the wash. Belongings that accord to today's tasks and needs are prepared on the door desk. Then you carry them with you, and the moment you step out the door seeing your car slowly drives out from the garage and stops in front of you, you think what a wonderful day!

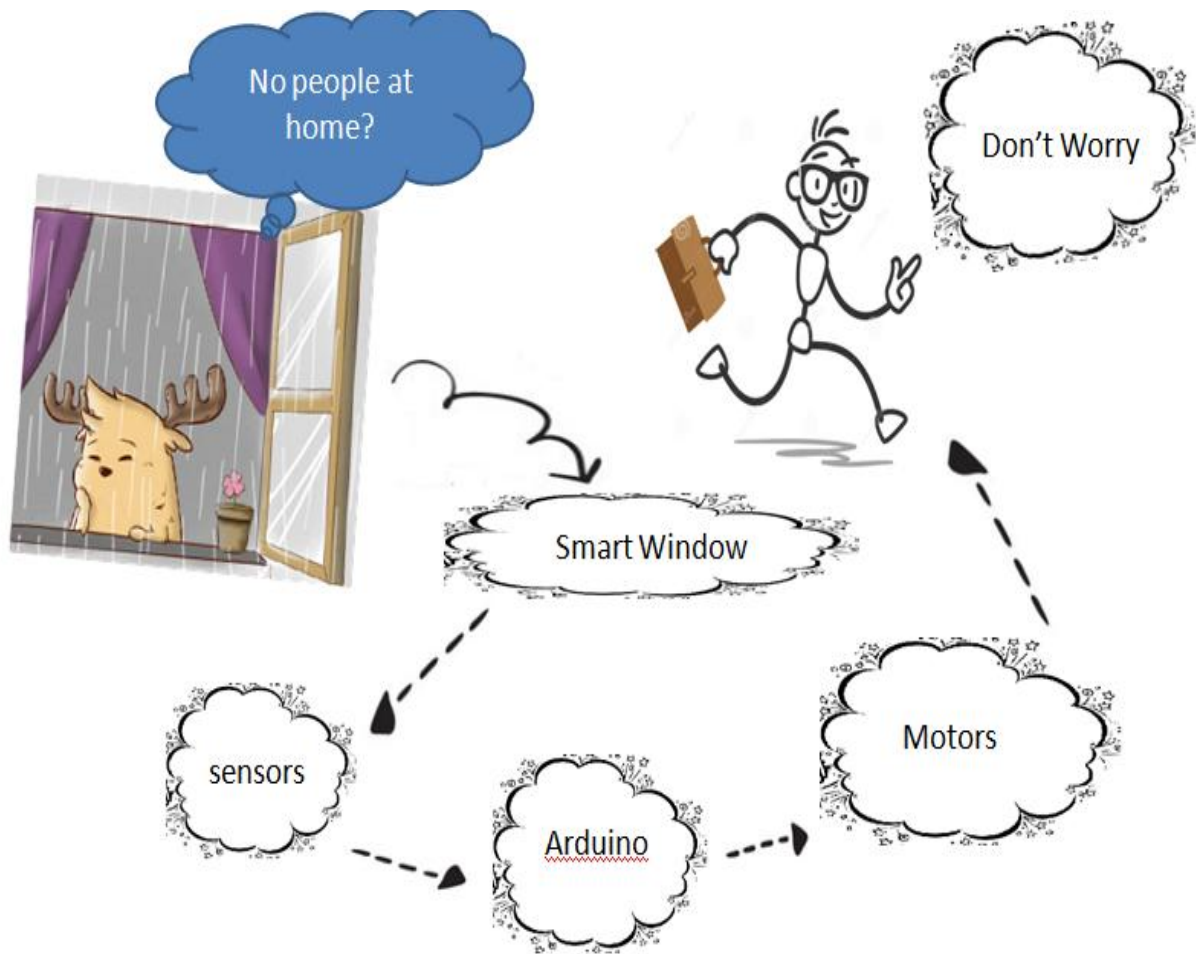
“Any sufficiently advanced technology is equivalent to magic.” Sir Arthur C. Clark can be agreed no more. The modern life described above could be accomplished with AI or programmed technology.

Our project intends to develop a stand-alone & plug-in module that serves on the functions of the window control in this in-door automatic system. The entire device senses the environments on both sides of the windows. Then the program will analyze the data to process to several phases that help to adjust the conditions in the house. In different phases, the device will give instructions to launch corresponding mechanical parts with information of angle, displacement and speed, in order to adjust ventilation, moisture and temperature creating relatively comfortable indoor environment.

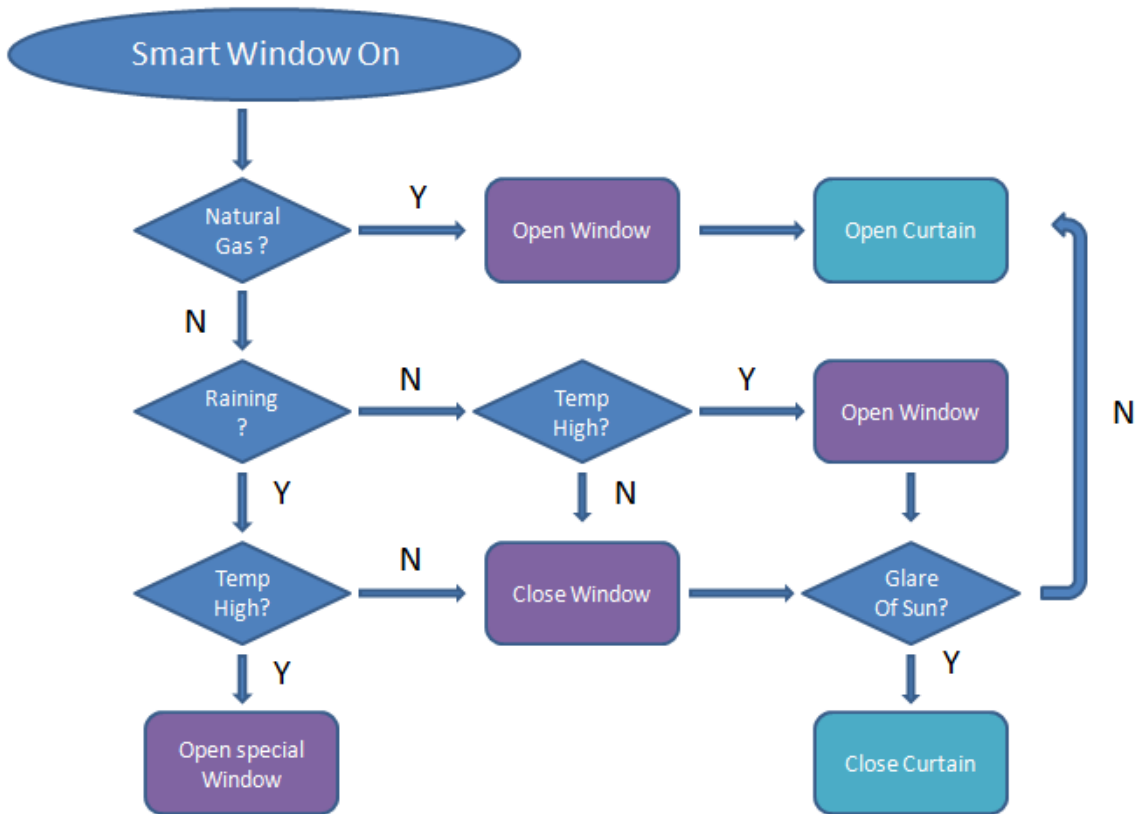
This Smart Window is designed to handle several specific situations and also serve on long-time monitoring to the room conditions. It detects environmental factors like light, air, rain, and transforms those into brightness, moisture, temperature, etc. These data will be fetched to affect the motion of the windows. With this design, there will be no more wind-blown documents everywhere, rain-drenched stuffs, dry air and so on.

2. System Overview

Our smart window is using sensors like rain sensors, temperature sensors and natural gas sensors for detecting different situation. The data observed from sensors will be as input for Arduino, and then the output from Arduino which can control the actions of the motor.



State Chart for the system:



3. Project Overview

Nowadays, people have to worry about when to close and open windows. Especially, in areas that frequently have heavy rain fall; users have the trouble of forgetting to close the windows. Therefore, it causes lots of rain damage to the stuffs inside the rooms. Also, it is more convenient to control windows automatically so that the temperature can be stable. For the security, it can detect the leakage of gas and smoke and will open the window for better ventilation.

3.1. Temperature & Humidity Sensors

The most common function of our project is to adjust the windows based on room temperature and humidity to maintain a comfortable environment. The temperature and

humidity sensor is connected to the Arduino so that the window can be opened when a certain temperature or humidity limit is reached.

3.2. Rain Sensors

The temperature is actually not the most serious problem. If it is rain outside and the users do not aware of that. The rain sensors can detect the presence of liquid. When there is certain amount of water occupies the area, windows will be closed.

3.3. Light Sensors

Another function is using light sensor to control the curtains. Whenever the sun light is too bright, window curtains will adjust themselves to compensate for sunlight glare.

4. Project Benefits

The goal of our project is to provide its user a more convenient and efficient way of life by eliminating the small but repetitive task of opening and closing a window and curtains. Office workers will not need to get up from their desk and walk across the room to adjust a window or curtain, thus increasing their productivity. Home owner will not need to worry about property damage from rain or wind getting into a window that is left open. The elderly and physically disabled will not need to ask for assistance to adjust a window or curtain.



Figure 2: No More Destroyed Documents

5. Project Risks

A risk of our project is that the window may close on a person or an animal that is reaching out the window causing tissue damage in a mild case or bone fractures an extreme case. Other risk includes water getting into the electrical compartments of the device causing electrical issues and possibly a fire.

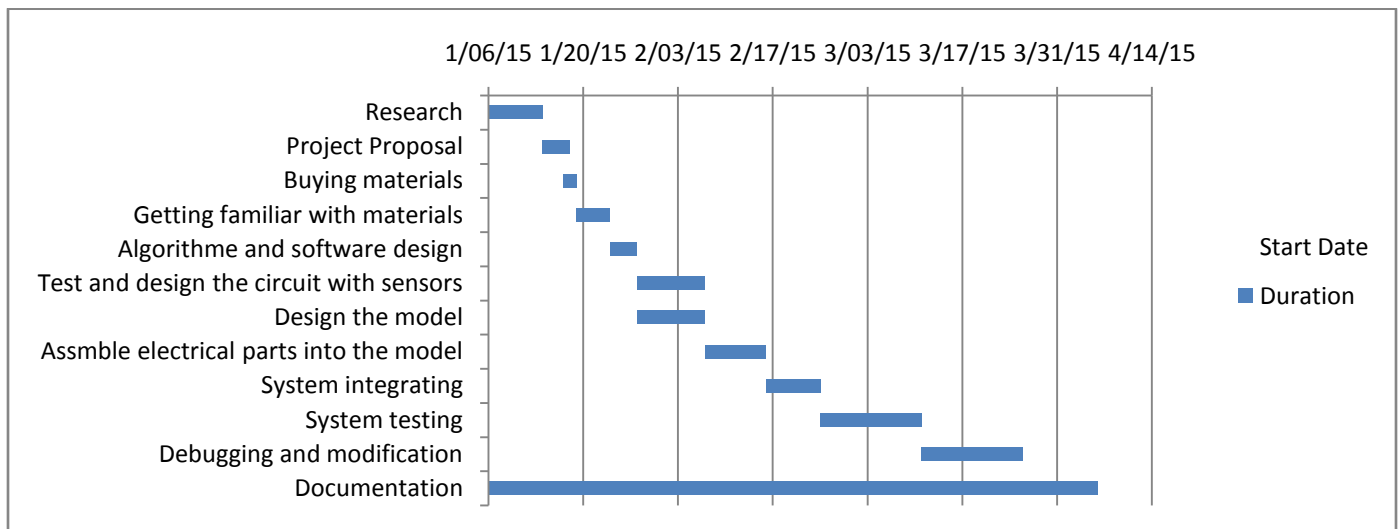
6. Market and competition

There are many companies out there that have automated windows, but they are mostly for awning (swings open from the bottom) or casement (swings open from the side) window types which are popular for garages, greenhouses, or attics but not in office buildings or residentialhouses. These companies include Rocburn limited and SEcontrols which both focuses on push to open windows such as awning and casement types. Both these companies use chain actuators to open or close their windows. Their solution works great but cannot be used for sliding or gliding windows found is most houses and office buildings.

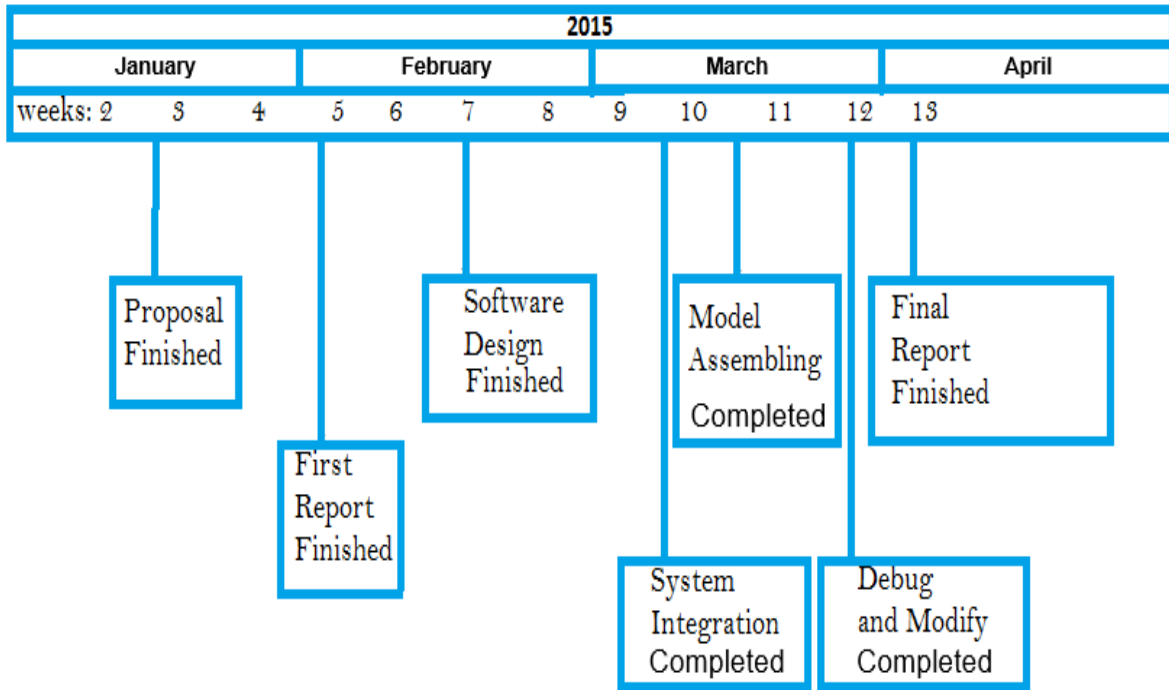
7. Schedule

A Gantt chart which indicates our planned schedule for the project procedure is shown in the figure below,

Table 1: Gantt Chart



Milestone chart:



8. Funding

Our main source of funding is from Engineering Science Student Endowment Fund and money coming out of our own pockets. We will try to minimize the cost by doing adequate research before ordering parts to prevent buying any unnecessary parts and also by using as much scrap material as possible. However like any project funding will need to be spent on trial and error by creating multiple prototypes and revising them as needed.

9. Budget

The table below estimated the budget for this project:

Table 1: Budget

Item	Price
Ply wood for framing	130
Rain sensor	50
Smoke detector	50
Carbon Monoxide Sensor	50
Hydraulics	40
Windows	160
Arduino Uno	70
Stepper Motors	45
Gears and connection components	50
PCB	45
Total Cost	690

10. Conclusion

Smart Windows is a company dedicated to improving the lives of many people. Our project will make it more convenient for office workers, home owners, and especially the elderly, and the physically disabled. Along with convenience, Smart Windows also offers a peace of mind to families that are away on vacation or a long trip from home; when they return, their home environment will be comfortable and safe.

Our device is unique and has very little competition in the market to date. Our approach is simple but effective and cost efficient. Smart Windows is superior to other companies because we are redesigning our own version of a window instead of building an external component for already existing windows.

Our group has a strict schedule and timeline to follow and will complete this project in the time frame represented by the Gantt chart. We have stated the usefulness of our project, outlined our budget and funding, and demonstrated our approach in the system overview.

11. Team Organization

Smart Window was founded by five talented members: Vincent Zhuo, Steven Zeng, James Lee, Jiewen Mai and Aromis Hou. All members are fourth-year engineering undergraduate students with different specialization interests in many engineering related fields. If it is said that our passion in any challenge is noted to drive us to the final goal for this project, then our creative imagination and tacit cooperation are everything to accomplish it.

In Smart Window, a horizontal structure is chosen to the team. Every member shares the same place and equally discuss to each other. This structure ensures group dynamic communication which allows each member to state his/her ideas and opinions. The team holds a group meeting twice a week and we keep touch in a group chat to ensure the progress stick with the schedule. The project is separated into several tasks. For each individual task, members are free to express.

The completion of each task are contributed by members' strengths and also limited by our weaknesses. Instead of holding back, we choose to take full advantage of this horizontal forum meeting structure and above all, respect the others' opinions. In this case, strengths of a member are expanded by the other members, and limits brought by members' weaknesses are minimized.

Smart Windows that is in charge of this large project cansucceed, only if members share and delegate the work. Vincent Zhuo, Chief Executive Officer, is in charge of the overall progress and is also responsible for hardware support. Steven Zeng, Vice President of Operation, is in charge of the technical operation of this project and responsible for maintain the cooperation between members. Jiewen Mai, Vice President of Marketing, is in charge of generating capital any possible resources and defines the prospect of the project. James Lee, Chief Financial Officer, is responsible for managing the budget and

seeking for financial support. Aromis Hou, Vice President of Programming, is responsible for programming design and solving software issues.

Members in Smart Windows are also friends in real life. We even make contribution in thoughts-level by chatting during meals. We believe open minds, friendly commutation and good relationship is the key for a 5-people size group like us to complete a project like this large.

12. Company Profile

Dong Hao Vincent Zhuo- Chief Executive Officer (CEO)

Vincent is a fourth year electronics engineering student at SFU. He improved his software skills during his years of academic studies in SFU. He utilized multi-threaded programming to simulate the XMODEM file transfer protocol in C++ using QNX Momentics IDE. He also designed a video game with VHDL language by Quartus II. Moreover, he has electrical knowledge and hardware skills as well. For example, he designed and built an active low-pass filter using electrical devices such as SPA, DMM, function generator and oscillator. He also analyzed the architecture and the performance of the AD-8657 op-amp with LT-Spice and HSpice. From the time-consuming and difficult projects, he became more self-motivated to work hard to reach solutions, and more cooperating with others when discussions were required to finish the projects. Aside from these, he has also improved my technical skills and the skill of working as a team leader.

Steven (Ho Chong)Zeng- Vice President of Operation (VP Operation)

Steven is a third year electronics engineering student at SFU. His strengths lie in electrical circuits, real time embedded systems, assembly language, and systems analysis. Some projects he has participated in includes building a radio using a bread board and other electrical components, coding for a VGA display monitor using c/c++ language, and coding for a LCD controller using assembly language. Steven has excellent communication skills and works well with people that have different personalities.

JieWen Mai – Chief Marketing Officer (CMO)

JieWen is a fourth year electronics engineering student at SFU. His interest lies in using mechanical equipment to build or fix circuits. When he was in high school, he started to learn the structural of circuit and renovation of short circuit. He is also improving his electrical knowledge through the courses of Electric Circuit and Microelectronics Circuit. These two courses familiarized him with many kinds of electrical devices such as SPA, DMM and oscillators. The laboratory classes allow him to work with LT- Spice and HSpice which are useful in designing circuit configuration. It has given him the skillset to build a complex circuit using Hspice in only a few minutes. Moreover, it has taught him to be more responsible and has been motivated him to work hard and cooperate with others during lab times. He has ability to write programs by assembly language, VHDL language or C++ language. He has a huge social communication circle which can promote our smart window.

Aromis (JingxiangHou) –Vise President of Programming (VPP)

Aromis is a fourth year Electronics Engineering undergraduate student at Simon Fraser University with previous co-op term experiences in a variety of fields. In the past four years, he has been developing his knowledge and skills widely on many fields related to software & hardware design and construction. He has engaged himself in many projects with his particular strengths playing an important role. Even though his fields are more about hardware, he has fast self-teaching ability to manage basic programming needs for many cases. Above all, he has programming experience in C++, VHDL and assembly language.

James (Chia Hung) Lee - Chief Financial Officer (CFO)

James is currently in the fourth year and his major is electronics engineering. He is a patient and hard working students. Especially, he is very good at microcontrollers, electronic devices, advanced of C++ language, and experienced with VHDL. He has done lots of remarkable projects such as using SolidWorks to print 3D model, designing a VGA game with Quartus, and design filters with simulators and lab equipments. James has much passion for engineering's scenario.



Sources:

Lee's Electronics store

Main's Electronics store

Rona

Home-depot

Canadian Tire