September 28, 2015

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

Re: ENSC 440 – Project Proposal for an Automated Cooking System

Dear Dr. Rawicz,

The attached document, *Proposal for an Automated Cooking System*, outlines our project for ENSC 440 (Capstone Engineering Science Project). With the intention of improving the quality of life for those who are physically disabled, our goal is to design and implement a cooking unit that will prepare a meal for individuals who may not do so without assistance.

The purpose of this proposal is to provide an overview of our proposed product, an outline of the design considerations, our sources of information and funding, a tentative projected budget, and information on project scheduling and organization. This document also explores alternative forms of automated cooking and this system’s market potential.

SmartChef consists of four innovative and ambitious engineering students: Christine Huang, Wesley Kendall, Pasang Sherpa, and Amandeep Singh. If you have any questions or concerns regarding our project, please do not hesitate to contact me by phone at (778) 688 6157 or by email at cyh12@sfu.ca.

Sincerely,

Christine Huang  
CEO, SmartChef

Enclosure: *Proposal for an Automated Cooking System*
Project proposal for an
Automated Cooking System

Project Team: Christine Huang
Wesley Kendall
Pasang Sherpa
Amandeep Singh

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Submitted to: Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 305
School of Engineering Science
Simon Fraser University

Issue date: September 28, 2015

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Executive Summary

Around 15% of the world’s population, or more than 1 billion people, live with a disability. They are the world’s largest minority, and the only minority group any of us can become a member of at any time. –Rick Hansen Foundation [1]

Physical impairment is a prevalent issue that affects individuals worldwide. Everyday tasks that are seemingly easy for the able-bodied population present unremitting obstacles for those who are physically disabled. While many home automation solutions already exist, we want to push these limits and further improve the quality of life for the disabled. We want to provide them with an additional degree of independence, regardless of their impairment.

In an aging population such as Canada, it is important to implement solutions for assisted living that eliminate the burden of home care services. Presently, a vast amount of home automation technologies exist. They encompass simple devices such as wireless remotes that control home appliances or lights, and can range to more complex solutions such as emergency assistance systems. Despite such a diverse scope of technologies, one area that is notably overlooked is kitchen automation. While a number of automated kitchen devices currently exist, they are costly, and are generally tailored towards industrial food applications.

This document proposes the development of a home automated cooking system that can prepare meals with fresh ingredients with the simple push of a button. Located anywhere at home, a physically impaired individual will have access to a remote that can activate the cooking system just by pushing a button. Correspondingly, the system will dispense the ingredients onto a heated element, stir and cook the ingredients, and serve the meal onto a plate. Using this automated cooking system, a daily task that may be difficult for the disabled has now been facilitated, thereby permitting a more independent lifestyle.

SmartChef consists of four engineering students who are enthusiastic to work on this project. We propose the engineering cycle for this project will encompass research, design, and construction. The timeline spans a 13-week period, with a completion date set at December 1, 2015. Tentatively, the project is budgeted at $900.00, which we expect to obtain from various funding sources.
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Glossary

ESSEF: Engineering Science Student Society Endowment Fund
1. Introduction

Physically disabled beings face a number of avoidable problems in their daily lives, out of which many have been solved by microelectronics, networks and other related technologies. Despite such a variety of assisted living solutions, cooking still represents a great challenge for the physically impaired. Although there has been some development of different technologies with regards to automated cooking, there has been no relevant strides. The market has yet to present cost effective and user-friendly kitchen solutions, enabling the disabled to self-prepare meals using fresh ingredients.

This project revolves around helping the disabled by automating cooking. The system will include a remote control with different input buttons that can select various food items that the individual desires to prepare. These buttons will send a signal to a microcontroller, after which the microcontroller will control relays throughout the cooking process. These relays will be connected to a heating element and different motors. By activating these motors, the system will dispense ingredients such as oil, meat, and vegetables into a cooking pot. This cooking pot will include a mechanism that stirs the food, which similarly is activated by a motor. Once the food is fully cooked, the system will automatically take the pot off the heat and serve the meal onto a plate.

The home automated cooking system will not only help the physically disabled, it can also extend to the able-bodied population and help with busy lifestyles. For the purposes of simplicity, this automated cooking system will not require any integration into a pre-existing kitchen. It will simply be a portable device with a size that’s suitable to sit on any kitchen countertop. The system will be accessible through a remote that will allow users to activate the cooking device from any room or location in the house. Safety features will be implemented in case of malfunction during runtime. Using this home automated cooking system, lifestyles will become easier and more independent, especially for the physically disabled.

This proposal provides an overview of our product, outlining design considerations, sources of information and funding, and project scheduling. The proposal also includes financial requirements, as well as Gantt and milestone charts that show different tasks and deadlines throughout the 13-week period span.
2. Project Overview

2.1 Project Scope
The main goal of the SmartChef is to make a rudimentary meal without supervision. The overall cooking system consists of four distinct processes: dispensing ingredients, heating ingredients, mixing, and serving. Additionally, we need a controller capable of issuing commands to the subcomponents in an appropriate sequence, and a static structure or frame which holds the subcomponents. Figure 1 below summarizes the aforementioned processes of the automatic cooking system.

![Figure 1: Conceptual Overview of the SmartChef](image)

The scope of our prototype is to demonstrate the sanity of our design and better understand the mechanical requirements of each subsystem. The dispensing system will consist of motors, valves, and supporting circuitry, which will enable the selection of an ingredient, as well as the amount of that ingredient to dispense. This dispensing system would ideally store refrigerated pre-processed ingredients, however the refrigeration mechanism will not be included in our prototype due to time constraints.

The heating system will be a cooking surface, such as a skillet, and a heat source which can be activated once the ingredients are in place. The mixing system will be a motorized arm and shaft. The mixing system must be retractable or integrated in a non-obstructive way. The serving system will allow the transfer of ingredients from the cooking surface to a serving dish.

Finally, a microcontroller interface will allow manual control or an automatic sequence of commands which results in a completed meal service. This is demonstrated with a block diagram shown in figure 2. Each subsystem will be individually testable, to better resolve
mechanical or timing issues. Wireless connectivity to control our device was considered, but will not be feasible with our limited time.

![System Block Diagram](image)

**Figure 2: System Block Diagram**

### 2.2 Project Risks

We strive to create an effective and safe product, such that it is appropriate for domestic use with little supervision or risk to the customer. Like all cooking appliances, we will face three major safety risks in our design: electrical hazards, heat hazards, and moving parts. Our design will ensure proper shielding and grounding of electronic components, and isolating the electrical components from the user, and also the moving parts in the design. During runtime, heating will be strictly monitored via a microcontroller and, should the microcontroller fail, a relay will cause the heating element to fail safely and turn off. Moving parts will be situated away from the user and the motors will deliver only the minimum force required to accomplish the aforementioned tasks. Powerful motors that could injure users will be eliminated from the design if possible. The device should be safe enough that a child can use it, and reliable enough to be operated remotely.

### 2.3 Project Benefits

Our product offers a versatile and customizable array of food items with little effort from the user, and provides a service that people will love to have in their home. Food automation is an
excellent alternative to frozen meals for those short on time. The quality and freshness of ingredients from our system will offer better nutrition and taste, without the preservatives or freezer-burn. The device is also marketable for people with disabilities or physical weaknesses that limit their ability to perform cooking tasks. Likewise, children can use our device instead of operating the stove while parents are not home.

Cooking can be done in parallel to other tasks. Moreover, the product can be integrated into a smart-home system to create meals at certain times. In particular, breakfast time could be reduced to just minutes, and can cater to the user’s preference. This would offer a nutritious breakfast, which is often skipped in the morning. Very little fully-automatic cooking devices are available on the market, and most kitchen appliances require training and human input to use. For many, cooking is a burden. Like automatic dishwashers or laundry machines, this burden can be lifted from the shoulders of humans, without sacrificing delectable meals prepared by human hands.

3. Existing Solutions

Automated kitchen solutions currently exist, but as previously mentioned, they are generally tailored towards restaurant/industrial food applications. The SmartChef will be a compact, household device intended to facilitate the daily task of cooking for the physically disabled. Furthermore, the SmartChef can be extended to markets for general use, especially for those who lead a busy lifestyle. We will outline some of the current automated cooking systems to delineate how the SmartChef can be an imperative device for domestic use.

3.1 Home Automated Kitchen Devices
There are many household devices that facilitate the process of cooking, however many require multiple stages of human interaction. For example, automatic breakfast machines eliminate the need for users to cook the ingredients of a breakfast sandwich separately. Rather, bread, eggs and ham are placed into one machine that simultaneously cooks all the elements to perfection. While seemingly an effective cooking instrument, it requires a degree of dexterity to crack the egg, place the ingredients in the correct order, and to serve the meal onto a dish. The SmartChef will be advantageous compared to these types of home automated cooking devices in that it eliminates the bulk of human interaction required to cook.

3.2 Restaurant Automated Kitchen Devices
Many cooking systems exist in the restaurant industry that automate the mechanisms of stirring, flipping, and ingredient dispensing. To some extent, these are the designs that the SmartChef will gravitate towards, but on a smaller scale. One drawback of the restaurant automated cooking systems is that they require the chef to measure the ingredients prior to cooking. With the SmartChef’s ingredient dispensing system, users will not have to go through
this process. Compared to restaurant automation, the SmartChef will certainly be more cost-friendly, and will have more freedom in the level of dexterity required for use.

4. Budget and Funding

4.1 Budget Breakdown and Contingencies
Table 1 reflects the details of the estimated cost to ensure a successful project. Taking a realistic approach, the equipment/parts and their individual costs are listed below. The prices listed in our budget take into consideration an approximate 14% in tax, and leave a price flexibility of an additional 15% to allow for contingencies. For simplicity in budget breakdown detail and difficult price predictions, some items have been grouped together.

<table>
<thead>
<tr>
<th>Equipment List</th>
<th>Estimated Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>High torque Servo motor #1</td>
<td>CAD $250</td>
</tr>
<tr>
<td>High torque Servo motor #2</td>
<td>CAD $250</td>
</tr>
<tr>
<td>Kitchen Appliances (Pans, lids, pipes, spatula etc.)</td>
<td>CAD $100</td>
</tr>
<tr>
<td>Potentiometer</td>
<td>CAD $50</td>
</tr>
<tr>
<td>Other metal pieces (Mounted on the motors)</td>
<td>CAD $50</td>
</tr>
<tr>
<td>Wireless component (Transceiver)</td>
<td>CAD $50</td>
</tr>
<tr>
<td>DC motors</td>
<td>CAD $50</td>
</tr>
<tr>
<td>Motor drivers</td>
<td>CAD $100</td>
</tr>
<tr>
<td>Arduino Microcontroller</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>CAD $900</strong></td>
</tr>
</tbody>
</table>

4.2 Funding
We have submitted our budget proposal to the Engineering Science Student Endowment Fund (ESSEF) team. The ESSEF will be our major source of funding to accomplish this project, and we are waiting for a positive response. Upon not receiving our proposed fund, we have agreed on equally sharing the incurred cost between the SmartChef team members. We have our own microcontrollers which has helped reduce our project cost. Moreover, we are absolutely open in looking for any potential donors/sponsors who might help us with supplying more trivial items such as kitchen appliances.

5. Schedule

5.1 Project Planning
For this project, our timeline is divided into three main tasks: Schematic Design, Prototype Construction, and Debugging and Integration, as shown in the Gantt chart blow. The Milestone
The chart shows the deadline of different documents that are due over the time period of 13-weeks.

Table 2: Gantt Chart

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Research</td>
<td>6 13 20 27</td>
<td>4 11 18 25</td>
<td>8 15 22 28</td>
<td>6 13 20 27</td>
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<td>2</td>
<td>Proposal</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3</td>
<td>Functionality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Design Schematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ordering Parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Implementation of Scheme/Build Prototype</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Testing/Modifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Documentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Final Write-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Prototype Demo</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Figure 3: Milestone Chart

- **Project Proposal**: Begin Project on Sept. 28th
- **Design Specifications**: Functional Specifications on Oct. 19th, Design Specifications on Nov. 9th, Final Product on Dec. 15th
- **Written Progress Report**: Written Progress Report on Nov. 23rd
6. Company Profile

Christine Huang – Chief Executive Officer (CEO)
Christine is a 5th year Biomedical Engineering student. She has previously worked as a Quality Assurance technician at a software company, as well as a research assistant in the Engineering Science and Biomedical Physiology and Kinesiology departments at Simon Fraser University. During her time as a research assistant, she built a medical imaging system. Throughout this process, she developed skills with electric circuits, and implemented computational algorithms to post-process data acquired from the imaging system. Christine is proficient in programming in MATLAB, and also has experience using C++ and assembly languages. Aside from having a diverse background, Christine has the ability to communicate and collaborate well in team environments.

Wesley Kendall – Chief Operating Engineer (COE)
Wesley is a 6th year Biomedical Engineer, with previous work on large-scale team and small-scale projects in both industry and academia. This includes work at Tantalus System, working on automated system verification, and at PMC-Sierra developing new tools for visualizing system bugs caused by assembly language. Wesley brings excellent implementation and debugging skills in the realm of embedded systems and digital electronics. The challenges in the realm of mechanical engineering design will be no match for Wesley’s proven dedication, perseverance, and intuition. He will focus on bringing together the mechanical components, and ensuring the best possible solutions for electromechanical and system-level problems that are found.

Pasang Sherpa – Vice President of Operations (VP Operations)
Pasang is a final year Electronics Engineering student. He recently finished his one year work term at BlackBerry where he was involved in certifying BlackBerry handheld devices operating with GERAN, UTRA, E-UTRA, NFC and Bluetooth to meet 3rd Generation Partnership Project (3GPP) standards. He is very passionate about IoT (Internet of Things) device development that includes software and hardware components along with network communication for data transfer. With the experience of working in various projects, he is knowledgeable in C++ for real time embedded systems, FPGA programming, responsive web application design and multimedia signals. Pasang’s experience will absolutely be an asset towards the development of the automated cooking machine with the SmartChef team.

Amandeep Singh Mand – Chief Finance Officer (CFO)
Amandeep is a fourth year Electronics Engineering student at Simon Fraser University. He completed a full year of his work term at Blackberry. At Blackberry, he was a member of the RF Design team where he was responsible for testing and debugging the RF technology such as 2G, 3G and LTE in handheld devices. In the past years, he has completed projects and taken courses including Electric Circuits, Microelectronics, Digital System Design and Real Time Embedded
Systems that have helped him develop his hardware and software skills. Amandeep’s knowledge acquired from all these past courses and projects will be a great asset in the SmartChef project.

7. Conclusion

Automated technologies can provide people with disabilities the invaluable tools to perform activities of daily living. Present-day devices have helped both caregivers and the disabled with important daily living tasks, however, there is still room for improvement. As a person’s ability declines, both the technology and/or the amount of personal assistance must be adjusted, therefore new strategies are needed to support the independence of individual needs. The proposed project in this document is a unique automated cooking device that helps people with physical limitations to maximize their independence. SmartChef is a fully automatic cooking system which is capable of portioning, mixing and cooking ingredients. SmartChef, an intelligent cooking device, can also improve the quality of life for people with a busy lifestyle or help children to prepare their food independently. The main objective that we hope to accomplish is to develop an assistive device that improves independence and quality of life for everyone, especially for those with physical impairment.
8. References

