To: Dr. Chesney, Professor

Chun-Han Chen, Client

From: Kathryn Clark, Student

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Re: Project Proposal

As Chun-Han stated on the ninth, there are two main programs that he uses to control his computer: Dragon Natural Speaking, and NaturalPoint’s SmartNav. These programs each provide a different functionality, but are in direct opposition to one another, making it impossible to control one program while the other is in use.

The purpose of this project is to develop a device that will allow Chun-Han to easily switch between these two programs.

The project is composed of two main elements. The first is a mechanized device (referred to as the “arm”) that will physically move the straw away from Chun-Han’s mouth so that he can speak, and a computer application that will allow Chun-Han to control the arm through mouse clicks.

# Project Description

The arm will either be mounted on a chair arm or on a stand beside Chun-Han, depending on preference. I considered attaching the arm to the straw directly in some manner; however, we do not want the arm to interfere with Chun-Han’s ability to move the straw freely. Instead, when the program is activated, a proximity sensor will be used to calculate the distance between the arm and the straw. The arm will grasp the straw and move it a predetermined distance away from Chun-Han’s mouth, then move the straw either down or to the side so that it does not block Chun-Han’s view of his monitor. The exact movement path will be determined based on preference or convenience.

When Chun-Han wishes to return to the SmartNav, he can signal the arm by pressing the left mouse buttons. Once this signal is received, the arm will follow the reverse of its original path in order to return the straw to Chun-Han’s mouth. The arm will move at a low speed, and will stop once the mouse button is released. Pressing down the left mouse button again will resume the arm’s movement, allowing Chun-Han to adjust the straw’s position slightly. Once the straw is properly positioned, pressing the right mouse button will cause the arm to release its grip and move to the side.

# Project Requirements

In addition to the obvious requirements that are inherent to the project described (such as the fact that the arm must be able to grab and move the straw), the following requirements are necessary to ensure that the end product is useable.

* While the SmartNav can be used to open the application and select options initially (if applicable), the arm must be able to move the straw to/from Chun-Han’s mouth based on input from his mouse clicks alone.
* The arm must be positioned in such a way that it can move the straw without interfering with the microphone on Chun-Han’s headset. The straw must also be able to move freely without colliding with the microphone.
* The arm must not interfere with the straw’s movement during normal use, and similarly should not obstruct Chun-Han’s vision while it is not actively removing or placing the straw.

# Hardware Design

## Sensor Type

I will most likely use an ultrasonic sensor, as they have a high degree of accuracy, even when detecting extremely small objects. While they do have a slower response time than some other sensor types, the difference is small enough that the delay shouldn’t be noticeable to the human eye. However, cloth can dampen the ultrasonic sound waves used for detection, which means that care must be taken to ensure that no cloth (such as clothing, etc.) interferes with the results. This should not be an issue so long as nothing obstructs the path between the sensor and the straw.

An infrared sensor could also be used, however my research indicates that these sensors tend to work best in settings with low light, and I am unsure of how well they would function during everyday use in a well-lit room.

If necessary, a pixy camera (or similar device) can be used to detect the straw. The pixy camera is an image sensor that can be taught to detect specific objects based on hue. While the pixy camera is very useful for finding a specific object, it is difficult to use an image sensor to detect distance, so we would still need to use a sensor to determine how far the arm must move. That being said, I believe that the sensor alone will be sufficient.

## Building the Arm

While there are multiple ways that the arm could be developed, I believe that the MeArm would be the most suitable base. The MeArm was chosen because it is open source and compatible with Arduino, which simplifies the development process and allows us to combine it with other Arduino-compatible hardware, such as the aforementioned sensors.

Furthermore, the MeArm is designed for simple construction. While customization will be necessary in order to achieve the desired functionality, using the MeArm as a base will allow for more time to spend on the software development.

## Challenges

* A downside of the MeArm is that it is designed to move in a specific way, which likely will not be exactly what the project requires. Modifications will therefore need to be made.
* The straw is a fairly small target, and the arm must be able to detect and grasp it with a high degree of accuracy.
* Because the arm will be controlled with two mouse buttons, it would difficult to devise a design that would allow the arm to be positioned manually. For this reason, the arm will follow a predetermined path when it removes the straw, so that reversing this path will theoretically return the straw to its original position. In practice, it is possible that this method could cause difficulties.
* I don’t have personal experience with Arduino or the hardware described above. While extensive research has convinced me that this project is both possible and feasible, I do not know all of the hardware that exists for Arduino, and it is possible that there are other tools that would be better suited for this project. This challenge can be addressed by including at least one group member with Arduino experience, or by consulting with someone who does.

# Software Design

The main software deliverable will be the computer application which controls the arm.

## Programming Language

This project will be coded using the Arduino programming language. Not only does it contain built-in functionality for working with the Arduino microcontrollers, it also contains libraries for both controlling and detecting a computer’s mouse clicks, which will be important when building this project.

## Challenges

* The SmartNav will continue to take in input from the straw’s location while it is being moved by the arm, which complicates the fact that the arm must be controlled via mouse clicks. Care must be taken to ensure that the mouse presses do no accidentally select anything on the monitor.
* This project must interact properly with Dragon. While my research indicates that Dragon can run in the background, the program must be able to select the text editor that Chun-Han wishes to use without Chun-Han needing to click on it himself. Arduino’s libraries for controlling a computer’s mouse could be useful here, as a way to select a program that has been set up before the application is run.

# Division of Labor

This project can be divided into three parts.

* Building a functional arm that is capable of moving, sensing, and grasping the straw
* Writing the program that controls the arm while it is removing the straw
* Writing a mouse-controlled program that will run in the background while Dragon is in use, allowing Chun-Han to indicate when he is ready to begin using the SmartNav once more

The last two parts are both reliant on the creation of the arm in order to work. For this reason, building the arm would be the first priority so that we have a functional tool to use while testing the programs, though the arm will likely have to be changed/edited throughout the semester depending on need. However, it would be possible to begin development on the programs while the arm is being built, admittedly without the ability to test their programs.

The two software elements can be developed independent of one another, though of course the developers must communicate to ensure that the final products would work together.

I believe that the most sensible division of labor would be to assign two team members to the arm’s construction while the remaining two members each begin work on one of the software portions. Once the arm has been built, the members who had been working on it will join the rest of the team to work on the software development, while also continuing to make changes to the arm as the project develops.

# Conclusion

Rather than developing a new method of computer navigation, I believe that my project will allow SmartNav and Dragon to be used in accordance with one another by creating a simple way to switch between the two programs.