September 20, 2005

Dr Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia

Re: Ensc 340 Project Proposal

Dear Dr. Rawicz,

The following document describes our project for ENSC 340. Our goal is to create a device that will translate American Sign Language (ASL) into speech using a commercially available glove to recognize hand positions.

This proposal will provide an overview of the problem we are facing, current market potential, and our solution. Included are our sources of funding, proposed timeline, and a tentative budget.

FivePoint Technologies is comprised of four motivated Engineering students from Simon Fraser University. These are Ganesh Swami (President and CEO), David Brayden (Vice President, Research and Development), Phoenix Yuan (Chief Operating Officer), and Kjell Eggen (Chief Technical Officer). Questions and concerns can be directed to 604-992-1404 or ensc340-fivepoint@sfu.ca.

Sincerely,

Ganesh Swami
President and CEO
FivePoint Technologies
Vancouver, BC

FIVEPOINT technologies

Project Proposal for Voiceture System

Translation of American Sign Language into Speech

September 20, 2005

Project Team: Ganesh Swami
David Brayden
Phoenix Yuan
Kjell Eggen

Executive Summary

Being deaf or mute in today's society is not easy. Something as trivial as ordering food in a restaurant can be a slow and frustrating task. Few people know how to communicate properly with a deaf person, and even fewer understand American Sign Language (ASL). This is surprising, considering that the number of people using ASL as their primary language in the United States is estimated to be between 200,000 and 2 million [1].

Our Voiceture system will translate signs and gestures into speech, providing a cheap and effective way to bridge the gap with those who do not understand ASL. Sensors will detect hand position and movement and transmit the data to a microcontroller. There it will be analyzed, and letters or words will be identified and converted to English. The result will be projected from a small speaker as spoken English.

Although this is not a new idea, no commercially available ASL translation system exists. Using a commercially available glove to detect hand position and movement, we can provide a cheaper and more portable solution that will be easy to integrate on a large scale.

The first stage of Voiceture will be the development of the sensing and analysis system. A commercially available glove will provide data on hand position. Then, a computer will analyze the data and output the correct letter. This is the first and most important step of Voiceture's development. Only the first stage will be submitted for Ensc 340.

Four fourth year engineering students at Simon Fraser University founded FivePoint Technologies in August 2005. Their experience and training includes hardware design, signal processing, mathematical computing, and mechanical systems; all essential skills in developing the Voiceture system.

Our team has proposed a four month development time for the first stage of this product, with a tentative budget of $325. The project is already underway, and is scheduled to be completed by December 1, 2005.

Table of Contents

Introduction

Communicating with the English speaking population has always been a problem for deaf and mute people. In today's communication oriented society they are at a distinct disadvantage. FivePoint Technologies is developing the Voiceture system to help people who use American Sign Language (ASL) communicate more effectively with those who speak English.

The Voiceture system will utilize a commercially available glove to track the position and movement of the signer's hand. This data will then be checked against user input and predefined values to form letters and words.

Stage one of the Voiceture system will focus on the data input phase. The goal is to import hand position data from the glove and recognize the letters of the alphabet. This stage will also include adding a push button switch between the index and middle fingers to help differentiate between letters signed with the fingers open or closed. Our Ensc 340 project will be to implement this phase.

Further stages will include adding motion detection, portability, and a larger vocabulary. This will require extensive grammar and spell checking along with very sophisticated algorithms to classify the input data.

Included in this proposal are an overview of ASL, existing designs, our solution, and details on the glove we chose. Also provided are Gantt and milestone charts, and a tentative budget along with sources of funding.

System Overview

Figure 1 shows a functional block diagram of how our system will translate ASL into speech.

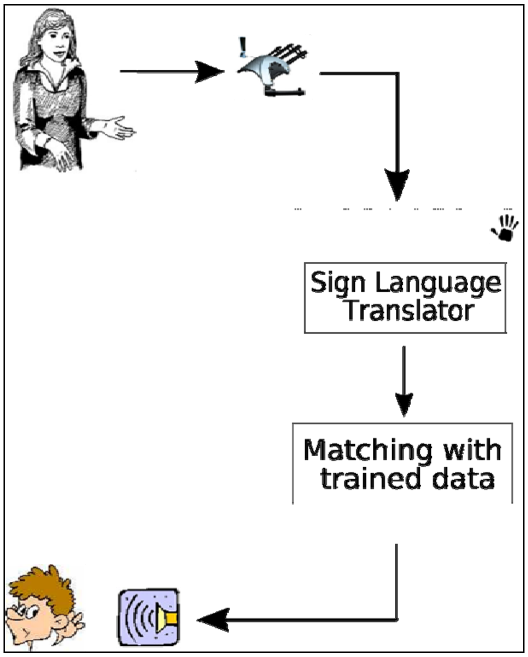


Figure 1: Functional diagram of the Voiceture system

An Introduction to the American Sign Language

American Sign Language, commonly abbreviated as ASL, is the forth most commonly used language in the United States [2]. Although no reliable survey of the exact number of users exists, up to 2 million people are estimated to be using ASL as their primary language [1].

The grammar used in ASL is quite different from spoken English. ASL has a topic-comment syntax, instead of the subject-object-verb form used in spoken English. Hand configuration, movement, and position of the body make up individual signs in ASL. Additionally, it incorporates the signer's facial expression and surrounding space to convey additional information.

Although the ASL vocabulary includes signs for many words, the alphabet is still required when the only option is spelling individual letters (such as with locations or names). All twenty-six letters have distinct gestures. Unlike some other sign languages, such as the British Sign Language and Australian Sign Language, signing the ASL alphabet requires only one hand (usually the right) [3].

Existing Market Solution

In general, sign and gesture data collection has been divided into one of two schools - device-based techniques and vision-based techniques. Vision-based techniques use cameras to record the movement and position of body parts. Due to the vast amount of raw image data, extracting hand signs from the surrounding environment in real-time applications requires an enormous amount of computing power. Typically, for simple data acquisition, the signer wears a special glove with paint on the joints of interest. Doing so allows the system to capture hand movement with reasonable 2-D resolution. Nevertheless, acquiring hand position remains difficult compared to the device-based approach, especially when factoring in the 3-D aspect of hand positioning.

The obvious advantage of the device-based motion capture technique is that hand movement and position data can be acquired directly from the input device, which allows for a high degree of portability. However, a device-based approach can suffer from the fact that the human body comes in varying shapes and sizes. Thus, the device software must be prepared to deal with this issue through user calibration.

GesturePlus

Currently, GesturePlus is the only commercially available product that has the ability to recognize hand formations. It is an advanced and complete system, utilizing a CyberGlove virtual glove, a GesturePlus dedicated gesture processing system, and a host computer. The GesturePlus computer uses a gesture recognition algorithm to translate data acquired by the CyberGlove into matching gesturing, thus freeing the host computer CPU to analyze the data and incorporate it into its applications. GesturePlus' powerful features come with an expensive price tag: the CyberGlove alone costs $9800 and the entire system costs $13,300 [4]. Moreover, the existence of the PC-size GesturePlus system implies that the technology is not intended to be portable. Instead, its best ability is the input of hand movement into a custom designed virtual reality application.

Proposed design solution

The P5 Reality Glove

There are many competing gloves available commercially with a wide range of features. The glove that really struck a chord with our team was the P5 Reality glove. The P5 Glove is a lightweight, ergonomic device that is intended for gaming input. It has five independent finger sensors and a tracking system that offers six degrees of freedom.

Figure 2: The P5 reality glove

The P5 Glove provided features that were sufficient for our first prototype at a very reasonable cost. It will enable our team to provide a cheap and accurate solution that will be easy to implement on a large scale.

We will purchase two of these gloves to use in the parallel research and development of our first prototype.

The First Stage

As the translation of ASL into English is a very complicated process, we have decided to break it up into stages. The first stage of our Voiceture system will be submitted for Ensc 340 credit.

ASL is a natural language, in the sense that it uses hand shapes, orientation and movement of the hand to fluidly express ideas. Linguistically speaking, the sign language is as rich and complex as any other spoken language. To support the full extent of the sign language is considerable work. Therefore, we decided to only support the ASL alphabet for the first stage.

Although the P5 reality glove supports translation motion in the X, Y and Z directions, we decided not to support translation motion for the first prototype. For example, the only difference between the letters I and J is the movement of the hand, which our first stage will not support.

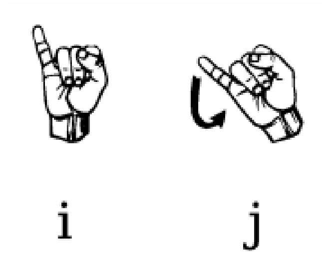


Figure 3: Signs for the letters I and J

We observed that all letters, with the exception of J and Z, are uniquely determined through hand posture [3]. Hand postures are the subset of hand gestures that require no hand movement. Thus, using just the finger positioning data, we could recognize 24 characters of the alphabet. For the first stage, the complexity of the system could be tremendously reduced by omitting the letters J and Z.

Since our data acquisition device is chosen to be the P5 Glove, its shortcoming must also be taken into consideration. The finger sensors are only able to account for the bend of fingers and are incapable of determining the distance between two fingers. However, the ASL letters U and V differ only in the distance between the index and middle fingers. We have decided to add a simple push button switch between these two fingers to assist in this and other situations.

With more time and money, we will improve our product to support not only the full alphabet, but also gestures. We will also incorporate other features such as grammar and spell checking.

Benefits and Shortcomings

Our system will provide a cheap and effective way to communicate through ASL. The P5 Reality Glove provides the necessary accuracy to translate signs at a very reasonable price. Also, using a commercially available glove significantly decreases our time to market.

Speech processing and computational linguistics is a very complicated field. There is significant knowledge and computing power required to recognize and separate gestures in ASL. This is why we are first focusing on the alphabet, and plan to expand from there.

Currently, the only commercially available solution costs over $13,000, and uses a much more complicated glove. As this design was not intended for portable use or use in sign language, we have very little in the way of competition.

Sources of Information

During research for this project we have obtained several academic contacts. One of which is Dr. Anoop Sarkar, a computational linguistics professor at SFU. He also recommended a colleague of his currently doing research at the University of Toronto.

There is much research currently being done in voice and text recognition, as translating requires powerful grammar and spell checking algorithms. In fact, a significant portion of this research is being done right at SFU. These researchers will be an invaluable resource for us in development of the Voiceture system.

As with much research today, the internet will be a powerful tool for information on computing algorithms, grants and funding, and previous products. For example, an online forum exists for developers of P5 Reality Glove applications.

Budget and Funding

Budget

Table 1 outlines a tentative budget until the end of our first stage. It is hard to estimate component costs at this time, but we have included a 30% contingency to accommodate deviation from our projected values.

Table 1: Tentative Budget

Equipment	Estimated Cost
Gloves	$140
Electronic components	$40
Textbooks/Journals	$40
Stationary	$10
Webspace	$20
Contingency (30%)	$75
Total	**$325**

Funding

The first stage of this project requires a relatively small amount of capital. By using the off the shelf P5 glove we do not need to engineer a hand motion capturing device. Instead, we can focus on enhancing and utilizing the device. The use of external sensors will eliminate the need to reverse engineer and redesign the P5 control hardware.

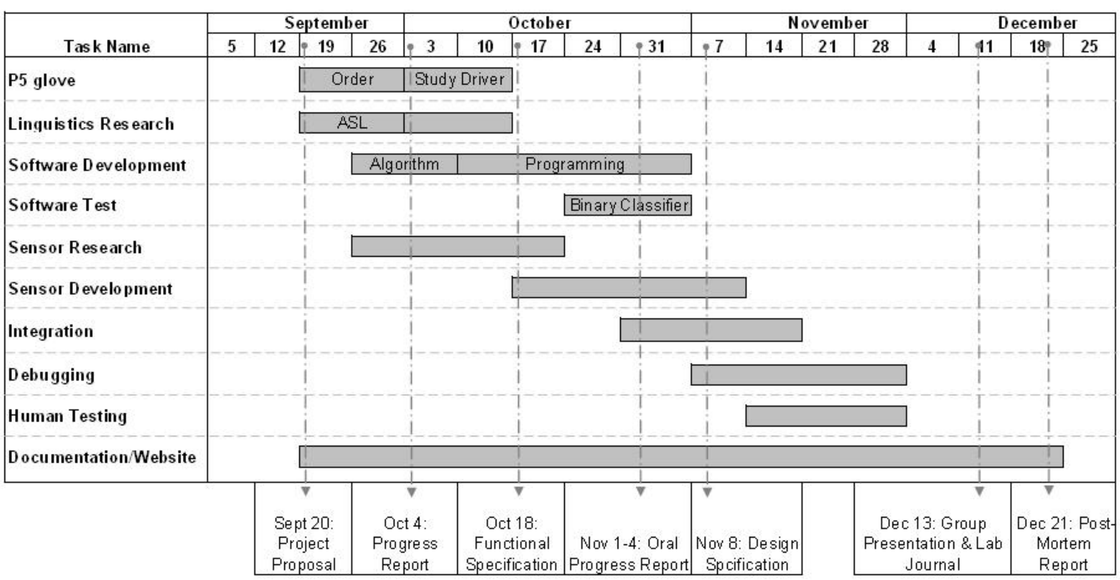
In order to meet funding needs we are submitting an application to the Engineering Science Student Endowment fund. This is expected to cover all development costs through the first stage.

Any additional funding needed is expected to be minor. Our executive team is willing to use their own capital to make this project a reality.

Schedule

Table 2 shows the proposed design timeline and milestones for the development of the first stage of Voiceture.

Table 2: Gantt Chart and Projected Milestones



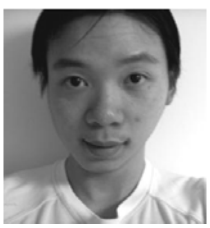
Company Profile

Ganesh Swami (President and CEO)

Ganesh Swami is a fourth year Engineering Physics student at Simon Fraser University. His expertise lies in writing high performance scientific computing applications. He has patents pending for his work in protein simulations on a coop work term, and is currently working as a consultant for a small biotech company.

David Brayden (Vice President, Research and Development)

David is a fourth year Engineering Physics student at Simon Fraser University. His interests centre on integrating applied physics and mathematics into engineering solutions. During a coop term at QLT Inc, he worked developing software for use with LASER and LED light devices.



Phoenix Yuan (Chief Operating Officer)

Phoenix is a fourth year Computer Engineering student at Simon Fraser University with deep interests in real-time embedded systems. He is skilled in both hardware design and software programming. During his recent coop at Dyaptive Inc, he developed firmware systems for wireless telecommunications devices.

Kjell Eggen (Chief Technical Officer)

Kjell is a fourth year Systems Engineering student at Simon Fraser University with interests in electro-mechanical systems. He has patents pending with Ballard Power Systems Inc. on thermal management for automotive fuel cells. He is experienced in integrating conflicting customer requirements against design considerations.

Conclusion

The need to communicate quickly and efficiently is steadily growing in today's society. At FivePoint Technologies, we believe the Voiceture system will significantly enhance a deaf or mute person's daily life.

We have acquired many academic contacts to aid us in our research. This, along with the decision to use a commercially available glove significantly reduces our cost and time to market. Our projected budget and milestones outline the development of our first stage. We believe the Voiceture system has the opportunity to be a profitable and beneficial tool in today's society.

References

[1] Wikipedia, “American Sign Language,” September 15, 2005, http://en.wikipedia.org/wiki/American_sign_language.

[2] K. Nakamura, “About American Sign Language,” March 18, 2002, http://www.deaflibrary.org/asl.html

[3] J. Gallagher (james@deafblind.com), “The American Sign Language (ASL) Alphabet,” September 29, 2004, http://www.deafblind.com/asl.html.

[3] Unknown, “sci.virtual-worlds Glove FAQ,” September 2005, http://www.faqs.org/faqs/virtual-worlds/glove-faq/.