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Contact Person: dpeterma@sfu.ca

January 19, 1999

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

Re: ENSC 370 project proposal for a Voice Activated Control System for a Submersible

Dear Dr. Rawicz,

The attached document, *Proposal for a Voice Activated Control System for a Submersible*, outlines our project for ENSC 370 (Transducers and Embedded Systems). Our project is to design a voice control system which will be demonstrated using a submersible capable of movements in all directions in a fresh water tank. We will use voice commands to control the thrusters on the submersible and include capability for fine control of the thrusters. Overall, we will improve the human-machine interface through the use of voice recognition, with fine control as a central issue.

This proposal provides an overview of the system, an outline of our design, our sources of information and funding, and information on project scheduling and organization. This document also discusses other potential solutions to the problem of voice control, and outlines our proposed solution.

Aqua-Acoustic Incorporated consists of four enthusiastic third-year engineering students: Scott Emery, Amy Lu, Sean Nicolson and David Peterman. If you have any questions or concerns about our proposal, please contact David Peterman by phone at 526-4724 or by e-mail at dpeterma@sfu.ca.

Sincerely,

Scott Emery Amy Lu Sean Nicolson David Peterman

Aqua-Acoustic Incorporated

Enclosure: *Proposal for a Voice Activated System to Control a Submersible*

Aqua-Acoustic Incorporated

Proposal for a Voice Activated Control System for a Submersible

Submitted by	**Aqua-Acoustic Incorporated** **Scott Emery, Amy Lu, Sean Nicolson, David Peterman**
Contact	**David Peterman** **School of Engineering Science** **Simon Fraser University** dpeterma@sfu.ca
Submitted to	**Andrew Rawicz** **School of Engineering Science** **Simon Fraser University** **Steve Whitmore** **School of Engineering Science** **Simon Fraser University**
Date	**January 19, 1999**

Executive Summary

One of the biggest problems for humans using machines is the lack of intuitive interfaces between them. Our proposal is to design a better method for people to interface with the machines and computers around them. At the moment, the tactile/visual interface that most of us are familiar with is a well-designed but inadequate system. It is our belief at Aqua-Acoustics that voice control provides a more intuitive human-machine interface.

Unlike current voice control interfaces, ours will provide the user with a high degree of precision control. We intend to design a speaker independent voice recognition system, making our human-machine interface more robust. The voice control interface will be tested on a robot submersible, also constructed by Aqua-Acoustic, because of the opportunity to demonstrate the versatility of the control system.

Aqua-Acoustic consists of Scott Emery, Amy Lu, Sean Nicolson and David Peterman. The combined expertise of this group includes circuit design, mechanical design, signal processing, board layout design and firmware design. We expect the total budget for this project to not exceed $500 Canadian and will be completed in the next 3 months. The prototype will be ready in early April.

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Introduction

One of the biggest problems for humans using machines is the lack of intuitive interfaces between them. Our proposal is to design a better method for people to interface with the machines and computers around them. At the moment, the tactile/visual interface that most of us are familiar with is a well-designed but inadequate system. It is our belief at Aqua-Acoustics that voice control provides a more intuitive human-machine interface.

We intend to design a voice recognition system that will interpret voice commands to control the motion of a submersible. The submersible itself is a demonstration tool, and the voice recognition system will be versatile enough to be used in other applications. Furthermore, the voice control system will regulate the speed of the submersible, thus demonstrating that fine control is possible with a voice recognition system.

This project proposal contains an overview of our voice recognition system, discusses possible design solutions, and outlines our proposed design solution. Also, we have included a project schedule, a budget, and a discussion of funding sources. We feel that the project schedule and budget provide realistic forecasts of the time and money necessary to complete our project.

System Overview

The voice control system will be set up as shown in Figure 1.

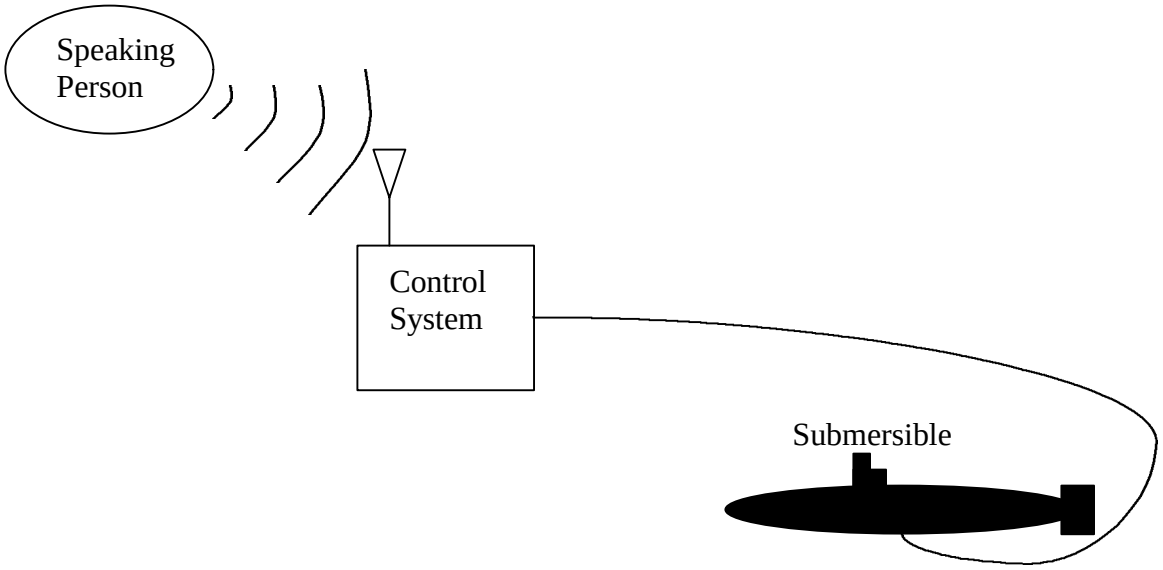

Figure 1: System Overview

The system is operated by a person speaking into a microphone. The microphone receives the analog voice signals which are converted to digital signals by the voice processor. These digital signals are transmitted to a microcontroller which sends the corresponding commands to control the submersible. The system is summarized in Figure 2.

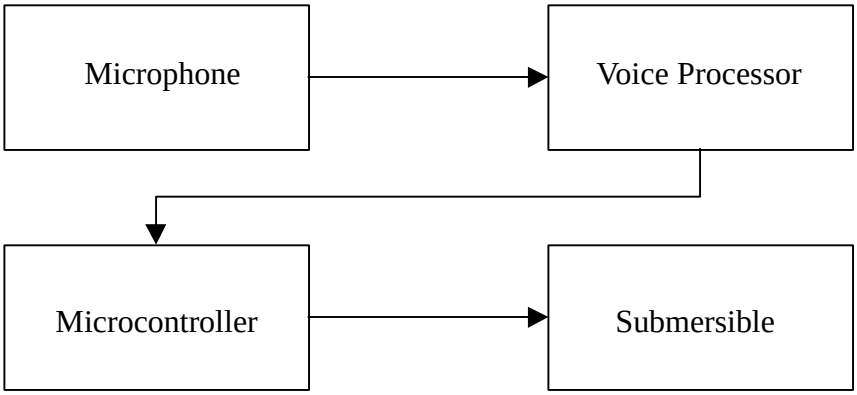

Figure 2: Control System

Possible Design Solutions

There are different ways of designing both the voice control system and the submersible. Each possible solution has its advantages and disadvantages.

Voice Recognition

The voice recognition can be done with software or hardware. There are commercially available software packages that can interpret speech, so such a package could be used to recognize voice commands for controlling the submersible. Alternatively, we could write our own software to interpret a specific set of voice commands. There are also commercial chips that can be programmed to recognize a limited set of voice commands. Another possibility would be to design our own hardware to recognize voice commands, although this task would be very challenging.

Command Structure

There are different ways of structuring the submersible control command set. The simplest would be a flat structure in which each spoken command corresponds to a direction of movement of the submersible. A more complex structure would allow voice control of the submersible's speed as well as its direction. There could also be combination of directions of movement, such as forward and down at the same time. The command structure design will depend on the design of the submersible. Besides recognizing single word commands, it may be possible to recognize multiple-word commands or even entire sentences.

Submersible

Two issues in the design of the submersible are the thruster placement and the buoyancy control. The submersible needs to be able to move in all directions, so the thrusters need to be placed to allow these movements. Certain arrangements of the thrusters are more efficient than others. There are also different types of thrusters that could be used. The submersible needs buoyancy so that it will naturally float at the water surface. The buoyancy can be achieved by attaching floats to the submersible or incorporating an air tank inside it.

Proposed Design Solution

Our proposed solution is to use a commercial voice recognition chip in the control system for the submersible. The voice recognition chip will be programmed to recognize a set of voice commands that will be used to control the submersible's motion.

The user will speak into a microphone and the signal will be sent to the voice recognition chip, which will attempt to match the signal pattern to the known patterns stored in memory. If it finds a match, the chip will output the binary code corresponding to the command it matched. The code will be transmitted to a microprocessor, which will produce a signal to activate the appropriate thrusters on the submersible.

As well as directional control, we will incorporate control of the speed of the submersible into the voice-controlled system. This could be done by using voice commands to speed up or slow down the thrusters.

We will design our own printed circuit board and casing to house the system components. We will also build our own submersible, taking the design of the prototype in the Underwater Research Lab and the designs in Harry Bohm's “Build Your Own Underwater Robot” and making improvements upon them.

As well as a voice control unit for the submersible, we will have a hand-held control unit with switches to activate the thrusters. This unit can be used if the voice control system fails or if the user prefers hand control over voice control.

Budget

Table 1 shows an estimate of the budget for the project.

Table 1: Estimated Project Budget

Item	Estimated Cost ($)
Submersible	100
Voice recognition chip and kit	150
Printed Circuit Board	50
Other electronic and mechanical components	200
Total	**500**

Funding

The Underwater Research Lab has offered to buy a working prototype of the project for up to $300. We are also applying to the Engineering Science Student Endowment Fund for funding. If approved, we should receive between $75 and $150. These sources of funding should cover most of the budget for the project.

Team Organization

The team consists of four enthusiastic third-year engineering students — Scott Emery, Amy Lu, Sean Nicolson and David Peterman. All four of us have completed work terms in various areas of engineering. Our diverse skills and experience will be valuable to the project.

A weekly team meeting ensures effective communication and discussion of the progress of individual tasks, goals and future plans for the project. The team has agreed on a flat management structure with the combined role of scribe and moderator to be cycled among the team members to develop our individual leadership skills.

A successful project requires an awareness of group dynamics. We believe that our flat management structure is conducive to expression of opinions and constructive discussion. Suggestions and constructive criticism are encouraged and will help build a feeling of collaboration. For efficiency, we decided to assign tasks of design and implementation to sub-teams of two. Since everyone is interested in learning both the hardware and software aspects of the project, sub-teams of two will consist of a person with experience and another who is interested in learning the specific area. These sub-teams of two will meet as necessary for the specific task. An important function of team meetings is reviewing individual and sub-team work to catch mistakes and ensure team members understand all aspects of our project.

Conclusion

We believe that our voice recognition system will provide a more intuitive human-machine interface. Furthermore, it can be used to control devices other than the demonstration submersible. Since our design allows variable control instead of simply ON/OFF control, it could be used to allow physically disabled people to operate appliances and devices with greater precision than current systems allow. With our technical skills, enthusiasm, commitment, and mutual respect we are confident that we will work well together and succeed in completing our project.