Designing Android Applications with both Online and Offline Voice Control of Household Devices

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Abstract— Utilizing assistive technology to aid persons with neuromuscular disabilities, this study compares two methods for voice control of household devices through an input-output board driven by an Android application on a smart phone. Two types of voice recognition software, online Google and offline Pocketsphinx, were used and tested for accuracy of several commands on a television remote. Each application was designed to recognize keywords and send signals to corresponding pins on the input-output board. The execution of a command was enabled through the interface of the smart phone with a television remote. Applications were tested for accuracy depending on distance between person and device as well as level of ambient noise.

I. Introduction

The aim of this project is to use assistive technology (AT) to help persons with disabilities. Persons with quadriplegia are affected by limitations in physical function and independence [1]. A field of biomedical engineering, AT is dedicated to increasing the independence and mobility of these persons [2]. In this project, voice recognition is explored as a template upon which the independence of persons with neuromuscular disorders can be expanded. Previous studies have suggested that this provides a viable means for control of devices by persons with disabilities [3, 4]. For this reason, two Android applications were developed on a smart phone to operate a television remote via an input-output (IOIO) Board [5]. Online and offline voice-controlled Android applications were created for accessibility to those with and without Wifi and/or cell phone data plans. The Internet dependent application (online) was written using Google Voice Recognition technology [6]. The Internet independent application (offline) used Carnegie Mellon's PocketSphinx [7]. Electronics, in addition to the IOIO Board, were developed to interface the Android application with the remote. Both online and offline applications were tested for response accuracy with respect to distance from the user's mouth and surrounding noise.

II. Materials and Methods

A. Development

Both applications were developed in Eclipse IDE for Software Developers with the Android Development Tools plugin and Android Starter Development kit. (See reference for details on installing and configuring these programs [8].) Google voice recognition technology was implemented in Windows 7 using the sample program on the Android Developers forum [6] and tutorials by The New Boston [9]. Carnegie Mellon's Pocketsphinx voice recognition [7] was implemented in Ubuntu 11.10 using the Pocketsphinx open source code [10] and following instructions by "My Droid Experience" [11].

An IOIO Board along with corresponding code, created by Y'Tai and distributed by Sparkfun Electronics, were used to interface the voice recognition technology with the remote [5, 12]. The IOIO Board provides a means for transmitting outputs and inputs through various pins on the board, as directed by a specialized Android application.

Each Android application functioned to recognize specific key words, send appropriate signals to the IOIO Board then trigger the remote. There were seven keywords (commands) in total: channel increase, channel down, volume increase, volume down, power, on, and off. If a keyword was recognized, IOIO Board pins 10 through 16, respectively, were set to "high" or 3.3 volts. The pins were connected to four Quad Bilateral switches (CMOS 4066), which were in turn connected to corresponding buttons on a DirecTV television remote.

For this project, the phone, a Samsung Galaxy S, was connected to the IOIO Board via a micro-USB cable. It is important to note each connection to a phone will require a specific connection current. Although firmware code was written to automatically adjust the current for many phone types, it failed to adjust to the phone used in this experiment. To overcome this obstacle, the potentiometer on the IOIO Board was adjusted for a stable connection. In addition, while the IOIO Board can take a variety of input voltages, the board was powered with 5V, via a regulator (LM7805).

B. Testing

Each of the seven commands (channel increase, channel down, volume increase, volume down, power, on and off) was tested for accurate recognition using both applications. The "power" command controls the cable box while "on" and "off" control the television. The four different settings included:

1) Low ambient noise at 0.5 meters from subject
2) Low ambient noise at 1 meter from subject
3) High ambient noise at 0.5 meters from subject
4) High ambient noise at 1 meter from subject

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Each of the seven tests included ten trials done by female Caucasians between the ages of 20 and 23.

To create low and high ambient noise, a local radio was played. For consistency, a digital sound level meter (Extech instruments 407736) was used to measure and adjust low ambient noise to 55 decibels and high ambient noise to 75 decibels.

III. Results

As summarized in Fig. 1, a general decrease in the proportions of correct recognition could be seen when the distance of the phone to the subject as well as level of ambient noise increased. This is true for both the online and offline applications.

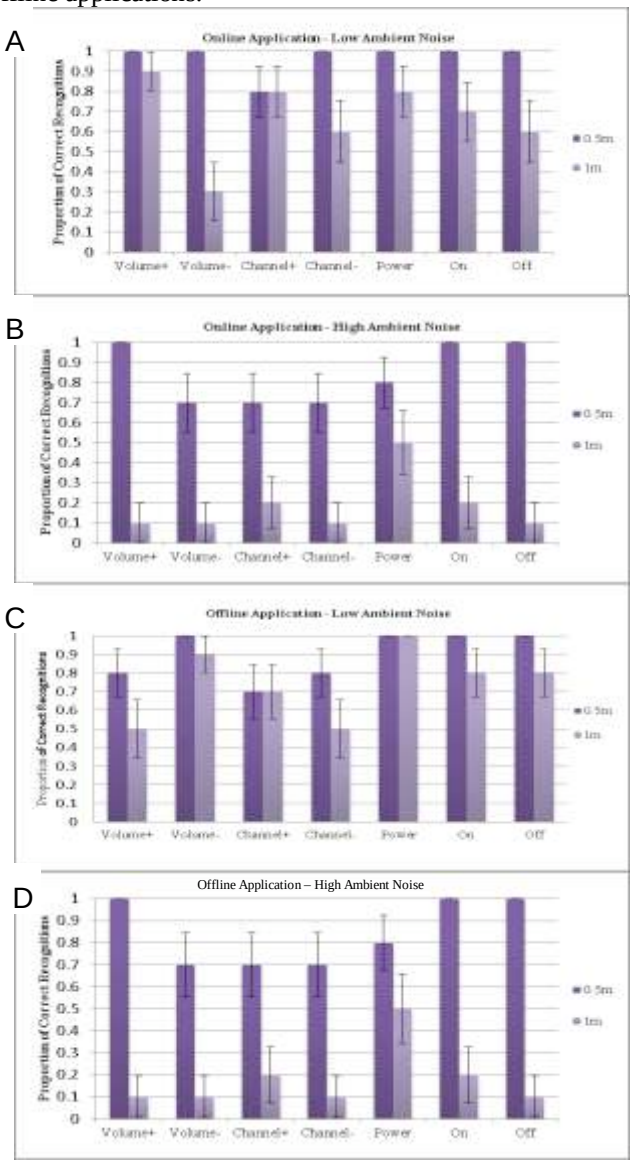

Fig. 1. Proportions of correct recognition for the seven voice commands at 0.5 m (dark purple) and 1 m (light purple): A) online, low ambient noise; B) online, high ambient noise; C) offline, low ambient noise; and D) offline, high ambient noise.

IV. Discussion

A smart phone based speech recognition system was developed to operate a television remote control with simple voice commands. This technology was implemented into a user friendly and compact device. By creating both online and offline voice-controlled applications, people are free to choose which device better suits them. This study demonstrates the capability of modern voice recognition software to increase independence for persons with disabilities. The results show that both online and offline applications provide quality recognition and execution of desired commands within a reasonable distance and level of surrounding noise. In the future, more testing will be done to solidify results and determine overall accuracy. This project provides a foundation upon which voice controls may be expanded to other household and AT devices.

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