Navigational Audio-Based Cuing for the Visually and Cognitively Challenged

ELEC 399 Interim Report

Submitted by:

Ben Mahlman - V00688989
Carissa Ouellette - V00744072
Matt Holland - V00707102
Sean Cunningham - V00744446

Group: 11

Supervisor: Dr. Fayez Gebali
Dr. Haytham El Miligi

Due: Oct. 16, 2012

Dept. Electrical and Computer Engineering
University of Victoria

Table of Contents

Background/Motivation

Visually impaired and cognitively challenged people are faced with many challenges in their day-to-day lives. Chief among these is the ability to navigate themselves around and perform daily tasks while still remaining independent. However, by utilizing existing technologies such as GPS positioning, cellular communication networks, and smartphone applications these difficulties can be overcome.

Project Overview

The goal of this project is to complete a GPS Waypoint Application for handheld mobile devices that will assist the visually impaired and cognitively challenged, while travelling in an urban setting. The initial design and proof of concept for the GPS Waypoint Application was performed by Dr. Fayez Gebali, Haytham El Miligi, and Kris Koiner in partnership with the CanAssist organization. Currently, the application is capable of recording GPS waypoints and providing written on-screen directions while travelling between these landmarks. This initial route recording process would usually be facilitated by the caregiver of the individual utilizing the device. In order for the application to be used by visually impaired users, auditory cues should be used in place of what might normally be on-screen directions. Additionally, the existing research suggests that the accuracy of the application's positioning system must be improved.

The completion of the GPS Waypoint Application will focus on three main areas: the improvement of the GPS positioning accuracy, delivery of the auditory cues to the end-user, and development of a sound-based compass to assist the user if they become disoriented.

Currently, the accuracy of on-board GPS within these handheld mobile devices is limited to between 10 and 100 meters in typical city settings. This limited accuracy will not be acceptable for this application, as it will be necessary to guide a user to a much higher accuracy. As such, both revised software methods and additional peripheral hardware will be explored in an effort to increase the accuracy to a more acceptable range.

The auditory cues for this application will be added into the existing software using the application's native code. To do so, it will be necessary to compile an audio library of standard cues, which may be played when a specific event arises (i.e. an audio file referring to turning left must be played when the user must turn left).

As these audio cues are based off the pre-programmed route, the possibility of the user straying off the designated path is an important consideration to take into account. As this application is designated to assist individuals who currently have navigational challenges, this technique must be executed using auditory techniques as opposed to visual. Tentatively, this mobile device application will serve two purposes; to provide additional direction to the end-user through each auditory cue as well as allowing the user to regain their bearings using an audio based compass. To achieve this, spatial sound techniques will be used to synthesize a complete 3D positional audio effect.

Project Plan

The project is intended to use a mobile phone application as a source of auditory cues based both on previously determined waypoints (programmed by the end-user) as well as a GPS signal available to the mobile device. This task will be achieved in two significant ways; first, the existing source code for the application must be modified and tested to accommodate these new features and, second, possible solutions to gain additional accuracy from the GPS must be explored. To accomplish these two tasks, five major steps must be taken:

- porting of the existing software's existing Python code to the provided mobile platform
- research into methods to improve the mobile device's GPS accuracy
- research into the implementation of both the audio cue system and the 3D audio compass
- amalgamation of the previously mentioned three tasks into the converted code

The current version of the application was developed in Python to run on a Nokia N8 device running Symbian. In order for the application to run on the Windows 7 mobile platform the Python code will need to be ported to C++.

Current smart-phone GPS hardware may not provide the positioning accuracy needed to successfully navigate the user from waypoint to waypoint. As such, a dedicated hardware attachment may be required to provide more accurate readings. Research will need to be done into the design of such a device, as well as methods of pairing the attachment to the user's mobile phone.

A system of audio cues would make navigation easier and more convenient for users with visual impairment. These users would receive auditory cues in place of what might normally be on-screen directions. Research into the design and implementation of such a system must be completed.

A library of audio clips must also be compiled for use with this feature. These clips will be required to represent all possible cues that may be needed throughout navigation. Two methods have been selected to achieve this, and the feasibility of each will be discovered. The first of the two methods involves attaining a free or licensed audio clip library containing the necessary phrases and words; these may be strung together when necessary to create the needed vocal instructions. Alternatively, a custom library may be compiled using digital recordings done by the development team. This approach may reduce costs and provide more fluent vocal commands at the cost of additional development time.

Two potential methods of actualizing the 3D audio compass feature will be the focus of this research. The first of these utilizes the MATLAB software package which would allow the development team to not only digitize necessary wav files but also view and manipulate these waves within the software package. This software would also provide more in-depth support for the mathematics necessary to synthesize a binaural effect with the sound.

The second of these methods includes utilizing an open-source library designed by Creative Labs to create the 3D sound effect digitally, using pre-existing functions. This method appears advantageous, as the transfer and impulse response functions will only need to be modified (and not fully developed). However, it will not provide the mathematical or visual support for the waveforms that the previous software package could offer. Because of this, both methods must be reviewed and compared in an effort to determine the most appropriate course of action.

Deliverables/Milestones

Interim Report	Due Date: October 16th
Final Report	Due Date: December 3rd
Project Website	Due Date: December 3rd
Research in required areas completed	Due Date: December 3 rd