MOTION CONTROL USING VOICE FOR WHEELCHAIR APPLICATION

HASHIMAH BINTI ISMAIL

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ABSTRACT

This paper describes the significant design to build a voice-controlled wheelchair. This project is intended to increase the ease of mobility for disabled/injured people. The design would allow these people to live more independently. Presently, people use blow-tubes or chin-joysticks to control motorized wheelchairs. Speech recognition is a prominent technology which can give an alternative to people to interact with machines or devices especially to those who are quadriplegics. We have resolved the disabled problems by implementing voice control interfacing, over a microphone, for the wheelchair. In this project, the manual wheelchair has been modified so that it can be actuated by two DC motors. The motions of the wheelchair are then controlled by the verbal instructions of the user. The results show that the design is applicable and feasible. The speech processing can be done in real-time and is therefore deemed a viable alternative to present methods of motorized wheelchair control. The design and the analysis of the project are presented in this report.

ABSTRAK

Laporan ini menerangkan tentang merekabentuk kerusi roda yang boleh dikawal dengan menggunakan suara pengguna. Projek ini adalah bertujuan untuk mempermudahkan pergerakan orang-orang cacat atau yang cedera anggota. Hasil rekaan ini akan membolehkan orang-orang tertentu untuk menjalani kehidupan dengan kurang bergantung kepada orang lain. Sekarang kerusi roda dilengkapi dengan alat yang memerlukan pergerakan fizikal untuk digunakan. Pengenalan suara menjadi satu teknologi penting yang mana boleh menyediakan suatu jalan yang baru dalam interaksi manusia dengan mesin atau alat. Ini adalah penting bagi mereka yang tidak boleh menggerakkan tangan dan kaki. Masalah mereka yang tidak berkemampuan ini dapat diselesaikan dengan menggunakan teknologi pengenalan suara bagi mengerakkan kerusi roda. Ini dapat direalisasikan dengan mennggunakan mikrofon sebagai perantara. Projek ini menggunakan kerusi roda yang telah diubahsuai dengan memasang dua DC motor sebagai penggerak. Pergerakan kerusi roda tersebut akan dikawal dengan hanya menggunakan suara. Hasil dari projek yang dijalankan ini, dapat dirumuskan rekabentuk yang telah digariskan adalah boleh digunapakai dan. Kesemua hasil ciptaan dan analysis akan diterangkan dalam laporan ini.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

DC	-	Direct Current
SR	-	Speech Recognition
RAM	-	Random Access Memory
SRAM	-	Static Random Access Memory
LED	-	Light Emitting Diode
R	-	Relay
V	-	Velocity
ECU	-	Environmental Control Unit
ANN	-	Artificial Neural Network
BPA	-	Back Propagation Algorithm
FFT	-	Fast Fourier Transform
LVQ	-	Learn Vector Quantization
DTW	-	Dynamic Time Warping
DSP	-	Digital Signal Processing
HMM	-	Hidden Markov Model
AC	-	Alternate Current
CLR	-	Clear
TRN	-	Train
PIC	-	Peripheral Interface Controller

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

While the needs of many individuals with disabilities can be satisfied with power wheelchairs, some members of the disabled community find it is difficult or impossible to operate a standard power wheelchair. This project could be part of an assistive technology. It is for more independent, productive and enjoyable living. The background, objectives, significance and scopes of the project will be discussed in this chapter.

1.1 Project Background

The idea of using voice activated technology for controlling the motion of the wheelchair is to prove that it can be a unique concept that would stand apart from the rest of the average projects. The use of this new technology in conjunction with a mechanical system in order to simplify everyday life would spark interest in an ever growing modern society. Many people with disabilities do not have the dexterity necessary to control a joystick on an electrical wheelchair. This can be a great for the quadriplegics who is permanently unable to move any of the arms or legs. They can use their wheelchair easier only using voice commands. The aim of this study is to implement an interesting application using small vocabulary word recognition system. The methodology adopted is based on grouping a microprocessor with a speech recognition development kit for isolated word from a dependent speaker. The resulting design is used to control a wheelchair for a handicapped person based on the vocal command. It therefore involves the recognition of isolated words from a

limited vocabulary. In order to gain in time design, tests have shown that it would be better to choose a speech recognition kit and to adapt it to the application.

There are five options for basic motions of a wheelchair to be applied by the user. The five conditions of the wheelchair can be described as the following:

i. Moving forward to the front of the user
ii. Moving backward to the back of the user
iii. Turning to the right
iv. Turning to the left
v. Static or stop condition

In this project the extra options are designed so that the user can choose the speed. The speed is divided into two parts. The user can select either slow or fast speed to move. This speed selection is in important for safety and extra maneuverability of the user. For example if the user need only to move in a short distance or to approach object, he should use the slow speed. This paper describes the design and development of the motion control using voice recognition for a wheelchair application.This design then been tested and analyzed.

1.2 Problem Statements

Research from University of Notre Dame, 2000, suggests that the current power wheelchair control interfaces used may not, be adequate to provide truly independent mobility for substantial number of person with disabilities. The Respondents to the survey reported on average that approximately ten percent of the patients trained to operate a power wheelchair cannot use the chair upon completion of training for activities of daily living or can do so only with extreme difficulty (Linda Fehr,2000). The data of the patients is as the table 1.1 below. From the table, we can see the list of the main types of control interfaces employed by power wheelchair users and the adequacy of these controls.

Percent of patients using	Simple Average	*Weighted Average
Joystick	81	81
Head or chin control	9	9
Sip and puff	6	9
Others- eye gaze; tongue pad; head, hand, foot switch controls	4	1
TOTAL	100	100
* weighted by total number of power wheelchair users reported in survey		

Table 1.1: Power wheelchair control interfaces used

The challenge for engineering is to provide safe and effective mobility in a dynamic environment. Through thoughtful research and design, power wheelchair control will progress along safe and effective pathways towards providing users independent and self-guided mobility. This project will give the severely disabled people an innovative solution to control their wheelchair using voice interfacing.

1.3 Project Significances

User interface is an important component of any product handle by the human user. The concept of the design is to make a voice activated wheelchair, which can replace the use of a joystick. In the past decades GUI (Graphical User Interface), Keyboard, Keypad, Joystick is the dominating tools for Interaction with machine. Now from them SR system is one of the interesting tool to the researchers for interaction with machine. The reason draws attention to the researcher, because people are used to communicate with a natural language in the social context. So this technology can be widely-accepted to the human user fairly and easily. But for the wheelchair application more researches and more analysis have to be done. This is because this will include the human safety and more over this kind of application is very new especially in Malaysia. Thus the project is significant because:

i. Speech processing can be done in real time and has long been considered as a natural to assist powered wheelchair user.

ii. Many disabled people exist in today's world and require help in order to overcome physical challenges. Thus this project will provide an alternative to the disabled in controlling the motion of the wheelchair using their voices.

iii. The efficiency of using voice controlled wheelchair can be identified.

1.4 Objectives

i. To implement voice of the user as an input to control the speed of a wheelchair.

ii. To develop a voice interface system for wheelchair control.

iii. To construct an effective algorithm for voice recognition.

iv. To provide an extra alternative to the wheelchair users so that this can increase the ease of mobility for severely disabled/injured people.

1.5 Scopes

i. To study the currents systems, researches, components used for wheelchairs.

ii. To design and develop a wheelchair system which can be controlled using voice.

iii. To build up the speech recognition interfacing using voice recognition processor and to train the system accordingly.

iv. To design switching modes for controlling the motion of the wheelchair.

v. To build up the interfacing between the hardware and software to realize the real time application.

vi. Integration of all of the components needed and testing.

1.6 Organisation of the report

In the following chapter we are going to discuss more about the literature review in chapter 2, the methodology in chapter 3, result and analysis of the system in chapter 4, and final chapter is the conclusion plus the recommendations. At the end of the report the list of references and related appendices are attached.

We start with the literature review about the wheelchair evolution and voice recognition system (Chapter 2 on page 6). Then we discuss about the flow of the project and the important components of the project development in Chapter 3 (on page 19). This includes speech recognition Chip, circuit interfacing and the hardware development. In the result and analysis chapter, Chapter 4 (on page 40) contains the description about the implementation part of our project. There, we discuss about the result of the system, and also we have presented our test result in that chapter. We conclude in the project as well as suggestions for future works in Chapter 5 (on page 44).

REFERENCES

A. Fattouh, M.Sahnoun and G. Bourhis. *Force Feedback Joystick Control of a powered Wheelchair: Preliminary Study*. University of Metz, France

Ali Kaya, Sidar Ok and Metin Yorulmaz. (2002). *Smart Wheelchair*. Eylul University: Final Report.

Cooper, R.A. (2002). Intelligent Control of Power Wheelchair. *IEEE Engineering in Medicine and Biology Magazine*. 14: 423-431.

David Spencer Lees. (1994). *A Graphical Programming Language For Service Robots In Semi-Structured Environments*: Stanford University: Ph.D. Thesis.

G. Davinder, A. Caleb, C. Michael, H. David, C. Randy.(2003). *Remote Access Trainable System.* University Of British Columbia: Final Report.

G.Maiocchi. Driving DC Motor, ST AN 281 Application Note.

Holly A. Yanco and James Gips. *Driver Performance Using Single Switch Scanning With A Powered Wheelchair: Robotic Control Versus Traditional Contro*l. MIT

Linda Fehr, MS. W. Edwin Langbein, Steven B. Skaar. (2000). Journal of Rehabilitation Research and Development. *Adequacy of power wheelchair control interfaces for persons with severe disabilities: A clinical survey*. 37 (3):353-360.

Inderscience Enterprises Ltd.(2005) *Intelligent Systems Technologies and Applications*. 1(1/2): 49.

Pan Min, Sun Yihe. *ASIC Design of Gabor Transform for Speech Processing*. Tsinghua university.

Propenta (PTY) LTD. (1999). Wheelchair Survey Project For The National Department Of Health. South Africa: Propenta (PTY) LTD.

Q.P.Ha,T.H.Tran and G. Dissanayake.(2005). Int. J .Intelligent System Technologies and Applications, *A Wavelet and Neural Network-based voice interface*

system for wheelchair control. 1: 49 – 64.

Richard Mensik.(2001). *Voice Control Enhances Application*. EE Times. Czes Republic.

Simon P. Levine, David A. Bell, Lincoln A. Jaros, Richard C. Simpson, Yoram Koren, and Johann Borenstein. (1999). The NavChair Assistive Wheelchair Navigation System. *IEEE Transaction on rehabilition Engineering*.7(4): 4.

Shafkat Kibriar. (2005). *Speech Recognition For Robotic Control*. Umea University Sweeden: Master Thesis.

Richard Simpson, Edmund LoPresti, Steve Hayashi, PhD; Illah Nourbakhsh,David Miller.(2004). Journal of Rehabilition Research and Development. *The Smart Wheelchair Component System*. 41(3B):429 -442.

Peter R. Brown. (2003). Nightside Test Design Ltd. *Automating Embedded System Testing for SHARK Powerchair Controllers*. New Zealand.