



DESIGN AND DEVELOPMENT OF PHONEME BASED SIGN LANGUAGE RECOGNITION SYSTEM FOR THE HEARING IMPAIRED

by

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
ASL	American Sign Language
AUSLAN	Australian sign language
BIM	Basha Isyarat Melayu
BP	Backpropagation
DCT	Discrete Cosine Transform
DEC	Digital Equipment Corporation
ENN	Elman Neural Network
GUI	graphical user interface
HCI	Human Computer Interaction
HMM	hidden markov model
IPA	International Phonetic Alphabet
ISL	Indian Sign Language
JSL	Japanese Sign Language
KSL	Korean sign language
KTBM	Kod Tangan Bahasa Melayu
MEMS	microelectronic mechanical system
MLP	Multilayer perceptron
PC	Personal Computer
PSL	Pakistan Sign language
RNN	Recurrent Neural Network
S2V	Sign to voice
TWL	Taiwanese Sign language
USB	Universal Serial Bus
VPL	Visual Programming Language
VSL	Vietnamese Sign Language
WHO	World Health Organization

PENGHASILAN DAN PEMBANGUNAN SISTEM PENGECAMAN BAHASA ISYARAT BERDASARKAN FONEM UNTUK MASYARAKAT CACAT PENDENGARAN

ABSTRAK

Pengecaman bahasa isyarat adalah salah satu cabang penyelidikan pengecaman isyarat yang paling menjanjikan. Bahasa isyarat biasanya dibangunkan untuk masyarakat cacat pendengaran, yang termasuk penterjemah, rakan-rakan dan keluarga orang cacat pendengaran serta orang-orang yang mengalami masalah pendengaran itu sendiri. Tesis ini membincangkan pembangunan system pengecaman bahasa isyarat berasaskan fonem untuk golongan yang terjejas pendengaran. Penyelidikan mengenai pengecaman bahasa isyarat sebelum ini tertumpu pada pengecaman ejaan jari atau pengecaman perkataan yang terpencil. Penyelidikan ini memberi tumpuan kepada pembangunan sistem pengecaman bahasa isyarat untuk mengecam 44 fonem Bahasa Inggeris. Untuk mewakili 44 fonem Bahasa Inggeris tersebut, sebagai langkah pertama, 11 gerak isyarat yang berbeza telah dimajukan. Dengan memilih kombinasi yang sesuai untuk tangan kiri dan kanan daripada 11 gerak isyarat ini, 44 kombinasi isyarat yang berbeza telah dirangka. Pengumpulan data daripada tujuh orang subjek dibuat menggunakan kamera web biasa pada resolusi 640×480 . Data tersebut diproses dan pengecakan ciri-ciri dibuat terhadap kawasan yang disegmen. Algoritma baru bagi pra-proses pencantuman yang telah dicadangkan digunakan dalam pembangunan sistem pengecaman bahasa isyarat ini dan dibincangkan dalam tesis ini. Rangkaian saraf tiruan (ANN) membolehkan bentuk pengkomputeran alternatif yang cuba untuk meniru fungsi otak. Set ceciri kemudiannya disuap kepada model rangkaian saraf untuk pengelasan isyarat fonem. Satu sistem audio dipasang untuk memainkan perkataan tersebut untuk komunikasi di antara rakyat biasa dan masyarakat cacat pendengaran. Keputusan uji kaji menunjukkan bahawa penggunaan kaedah pra-proses pencantuman dicadangkan menghasilkan ketepatan pengelasan yang lebih baik berbanding dengan kaedah konvensional.

DESIGN AND DEVELOPMENT OF PHONEME BASED SIGN LANGUAGE RECOGNITION SYSTEM FOR THE HEARING IMPAIRED

ABSTRACT

Sign language recognition is one of the most promising sub-fields in gesture recognition research. Sign languages are commonly developed for hearing impaired communities, which can include interpreters, friends and families of hearing impaired people as well as people who are hard of hearing themselves. This thesis discusses the development of a Phoneme based sign language recognition system for the hearing impaired. Previous research on sign language recognition systems have concentrated on finger spellings recognition or isolated word recognition. This research focuses on developing a sign language recognition system for recognizing 44 English phonemes. To represent the 44 English phonemes, as a first step, 11 different gestures were developed. By selecting suitable combination of these 11 gestures for the right and left hand, 44 different gesture combinations were formulated. The signed data are collected from seven subjects using an ordinary web camera at a resolution of 640×480 pixels. The data is preprocessed and features are extracted from the segmented regions of the signed data. A newly proposed interleaving preprocessing algorithm used in developing the sign language recognition system is discussed in this thesis. Artificial Neural Network (ANN) provides alternative form of computing that attempts to mimic the functionality of the brain. The feature set is then feed to the neural network model to classify the phoneme sign. An audio system is installed to play the particular word for the communication between the ordinary people and hearing impaired community. Experimental results show that the use of proposed interleaving method yields a better classification accuracy compared to the conventional method. The vertical interleaving method using combined blur and affine moment invariant features and Elman network yields the maximum classification accuracy of 95.50%.

CHAPTER 1

INTRODUCTION

1.1 Overview

Normal people can communicate their thoughts and ideas to others through speech. However, the only means of communication for the hearing impaired communities is the means of using sign language. A sign language is a language used by the hearing impaired to communicate or convey their thoughts and ideas to others. Hearing impaired people use sign patterns instead of acoustic sound signal to communicate. These sign patterns are obtained by combining hand-shapes, orientation and movement of the hands, arms or body, facial expressions and lip-patterns ("Sign language"). Sign languages are non-verbal visual language, different from the spoken language, but serving the same function. The sign language consists of a vocabulary of signs which are exactly similar in the same way as in the spoken language (Johnston et al., 2007).

Each country and each region has its own sign language. Even a hearing impaired person from one country can't communicate with another hearing impaired person from another country because the signs used in their country are different. Even in the same country there might be a number of different sign languages. In addition, only very few people who are not hearing impaired learn these sign languages. Most of the normal people don't understand these signs, which in turn increase the isolation of the hearing impaired people; they have the constraint of communicating only with their hearing

impaired counterpart by means of the sign language (Harling et al., 1996; Sagawa et al., 1997) .

It is often very difficult for the hearing impaired community to communicate their ideas and creativity to the normal humans. To overcome this communication barrier sign language recognition systems are developed specially for the hearing impaired all over the world for various sign languages.

Vision based sign language recognition has drawn considerable attention from researchers in recent years. The development of sign to voice conversion system will be more useful for the hearing impaired to communicate with the normal people more fluently. Many researchers have developed automatic sign language recognition system for various sign languages. From the previous research works it was observed that the systems proposed by earlier researchers were based on the conversion of an action based verb to an equivalent sign. These systems have the restriction of handling a maximum number of action verbs in the specific language. In order to overcome this limitation, a phoneme based sign conversion system has been formulated. The aim of this research work is to develop a sign language recognition system using neural network model which can visually recognize the English phoneme sign language performed by the signer. The features extracted from the left and right hand gesture signs are used in developing the neural network model. The proposed model is trained and tested for its validation. The proposed system is designed to visually recognize the 44 English phonemes. The proposed system can recognize phoneme signs for any word in English. Since phoneme is directly related to speech, this system gives the hearing

impaired a real life speaking experience. The main motivation and objectives of this research work has been discussed in this chapter.

1.2 Problem Statement

The hearing impaired people always have problems in communicating with normal people. They have problems in conveying their thoughts and ideas to normal people who have very limited or sometimes no knowledge in sign language. This makes the hearing impaired community lose interest in common activities and they avoid communicating with normal people at times and live in isolation. To overcome this situation many sign language recognition systems were developed by researchers but there is still a need for accurately and more effectively recognizing the signs. Currently the systems proposed by earlier researchers are based on the conversion of an action based verb to an equivalent sign. These systems have the restriction of handling maximum number of action verbs in the specific language. This research aims to develop a sign language recognition system for the English phonemes. The proposed system should be easier to use and more user friendly for the hearing impaired people. The proposed system will convert symbolic phoneme sign into equivalent text and voice more accurately and efficiently.

1.3 Significance of the Study

The hearing impaired people are in lack of contact with normal people because of their communication problems. They have problems in conveying their thoughts, ideas and creativity to normal people acoustically. Moreover the lack of sign language knowledge to the normal people makes the hearing impaired people to live in isolation. This research work will be helpful for the hearing impaired community in many ways.

The primary advantage would be the hearing impaired people's communication. The hearing impaired people can communicate with normal people more fluently with the help of such system. The proposed system is developed in such a way that it can be used in other languages too. The system is a phoneme based and uses the 44 English phonemes, hence any word from any language can be developed. This helps the hearing impaired community to use this system to communicate more effectively with their counterparts from other countries too.

1.4 Research Objectives

The purpose of this research is to develop a phoneme based sign language recognition system for the hearing impaired community using neural network. The objectives of this research are as follows.

- i. To develop the sign language and sign language dataset for English phonemes.**

Developing a sign language is a demanding task in the area of Linguistics. There is no sign language formulated for the English phonemes, in this research the first and foremost objective is to develop the sign language for English phonemes and the data are to be collected using a web camera along with a suitable software interface.

- ii. To develop an interleaving preprocessing method.**

In image processing, the size of the image plays a major role in reducing or increasing the processing time. In this research it is proposed to develop a simple interleaving preprocessing method which will reduce the processing time and increases the accuracy of the system.

- iii. **To develop feature extraction algorithms to extract valuable features from the signed image frames.**

Feature extraction plays an important role in sign language recognition system. There are many types of feature extraction methods used in the previous work. In this research it is proposed to develop simple invariant feature extraction algorithms.

- iv. **To develop an intelligent phoneme based sign language classification tool.**

Neural network provides an alternative form of computing that attempts to mimic the functionality of the brain. In this research it is proposed to develop a sign language recognition system using neural network model.

- v. **To develop a user friendly graphical user interface (GUI) platform for phoneme based sign language classification**

The development of personal computer (PC) based automatic recognition system for sign language recognition is an important task of this research. It is proposed to develop a GUI for the sign language recognition system.

1.5 Thesis Organization

This thesis explores the topic of sign language recognition system using image and video processing algorithms along with artificial intelligence techniques. The research works carried out in this thesis are presented in six chapters.

Chapter 1 current chapter, provides the introduction of this research and an overview on how the dissertation is organized. The problem statement, Significance of the Study and the research objectives were discussed in this chapter.

The literature reviews on hearing impaired, the causes of hearing impaired, discussions on sign language and various sign language recognition systems developed by previous researchers are presented in Chapter 2. The previous work of sign language recognition is surveyed and discussed.

Chapter 3 describes the development of sign language for phonemes. Experimental protocols, the image processing and feature analysis techniques that are being used in this research are also described.

Chapter 4 presents the concepts of a feedforward neural network model trained by Backpropagation Algorithm and the Elman Network model. The network architecture and the training methods used to develop the phoneme based sign language classification are explained in detail.

Chapter 5 presents the results obtained for the developed system. The results for the different feature extraction methods are discussed. The development of GUI is also presented.

Chapter 6 Summarizes the contribution made in this research and suggestions for future research works are discussed.

CHAPTER 2

A Review on Sign language Recognition System

2.1 Introduction

Gesture recognition is a field where the gesture made by human is recognized using a computer or any other electromechanical device. The primary application of the gesture recognition system is sign language recognition. There are other applications of gesture recognition system, such as human computer interaction (HCI), Remote control, Noisy Environment, Game technology ("Gesture Recognition,"). This chapter begins with the discussions on the causes of hearing impairment and a brief discussion on the various sign language recognition systems developed in the past. The applicability of neural network to this application is also discussed. Finally, at the end of this chapter a summary is presented.

2.2 Hearing Impairment and Its Cause

Hearing impairment is a condition wherein the ability to detect certain frequencies of sound is completely or partially impaired (Umat, 2006). Each human have a hearing level called as the Hearing threshold. The quietest sound level that can be detected by a human is called the hearing threshold. If the hearing threshold is low or null, then it is understood that the person hearing is impaired. Hearing impairment is also termed as deafness and hard-of-hearing. Hearing impairment may be inherited or caused by complications at birth, certain infectious diseases, such as meningitis, use of

ototoxic drugs, and exposure to excessive noise. Around half of all deafness and hearing impairment can be prevented ("Deafness,").

The following are some facts about hearing impairment ("Deafness and hearing impairment,")

- i) In 2005, about 278 million people had moderate to profound hearing impairment. 80% of them live in low-and middle-income countries.
- ii) Infectious diseases such as meningitis, measles, mumps and chronic ear infections can lead to hearing impairment. Other common causes include exposure to excessive noise, head and ear injury, ageing and the use of ototoxic drugs.
- iii) Half of all the cases of hearing impairment are avoidable through prevention, early diagnoses and management.
- iv) Current production of hearing aids meets less than 10% of global need. In developing countries, fewer than 1 out of 40 people who need a hearing aid have one.

2.3 Sign Language

Sign language is a form of manual communication which has been developed as an alternative to speech for the hearing impaired people. Wherever hearing impaired communities exist, sign languages develop (Perlmutter). Sign language comprises facial expressions, body movements or body Language, hand shapes, hand positions, hand movements and gestures. Sign language is often used by people who are hearing impaired. There are different sign languages all over the world, just as there are different spoken languages. In the United States, for example, American Sign Language