AUTOMATIC SPEECH RECOGNITION MODEL FOR DYSLEXIC CHILDREN READING IN BAHASA MELAYU

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AUTOMATIC SPEECH RECOGNITION MODEL FOR DYSLEXIC CHILDREN READING IN BAHASA MELAYU

A Thesis submitted to the UUM College of Arts and Sciences in full fulfillment of the requirements for the degree of Doctor of Philosophy
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IKHTISAR

Kanak-kanak disleksia mengalami masalah pembelajaran yang berkait rapat dengan sistem fonologi yang mengganggu perkembangan mereka dalam kemahiran membaca dan mengeja. Bagi mereka, membaca dan mengeja merupakan proses yang sukar, meletihkan dan kurang menarik perhatian. Konsentrasi yang lemah juga mengakibatkan mereka sebolehnya mengelak untuk belajar membaca dan mengeja. Masalah disleksia ini menyebabkan mereka melakukan kesalahan pembacaan walaupun ketika membaca dan mengeja perkataan-perkataan mudah. Walau bagaimanapun, keadaan ini tidak bermakna mereka memilik tahap IQ yg rendah berbanding kanak-kanak normal. Selalunya, kanak-kanak disleksia memiliki tahap IQ yang setara dengan rakan-rakan mereka yang lain dan mungkin juga lebih tinggi. Fakta ini merumuskan bahawa kanak-kanak disleksia mempunyai potensi jika diberikan bantuan dan sokongan padu seperti motivasi dan kaedah pengajaran yang sesuai. Dengan kemajuan teknologi dalam bidang pendidikan, aplikasi berasaskan komputer dilihat dapat membantu proses pengajaran dan pembelajaran khususnya bagi membaca dan mengeja. Justeru itu, kajian ini merupakan inisiatif yang mencadangkan sebuah model *automatic speech recognition* (ASR) yang berupaya 'mendengar' dan seterusnya mengenalpasti kesalahan bacaan bagi kanak-kanak ini. Skop kajian menghadkan kepada pemodelan dan pengecaman perkataan terpilih dalam Bahasa Melayu (BM) yang terkandung di dalam silibus pengajaran tahap satu di sekolah rendah. Untuk mengesyorkan pemodelan ASR dalam BM, sebuah model pembacaan khusus bagi kanak-kanak disleksia terlebih dahulu dicadangkan. Teknik kajian etnografi, iaitu pemerhatian dan temubual secara tidak formal, telah diguna untuk mendapatkan kesalahan-kesalahan bacaan yang juga melibatkan kesalahan ejaan. Sepuluh orang murid berusia 7 hingga 14 tahun yang mempunyai tahap kebolehan membaca yang hampir sama telah dipilih menyertai kajian. Mereka terdiri daripada murid di dua buah sekolah rendah yang menawarkan kelas khas disleksia. Sebanyak 6112 bacaan telah direkod dalam bentuk audio dan daripada itu, sejumlah 6051 kesalahan bacaan telah berjaya dikenal pasti. Antara kesalahan yang paling menonjol adalah kesalahan berkaitan penggantian huruf vokal, penyingkiran huruf konsonan, kesalahan berkaitan dengan huruf nasal dan penggantian konsonan. Justeru itu, model ASR tersebut telah mengambilkira aspek kesalahan bacaan yang paling kerap tersebut dan menjadikan ia sebagai elemen penting bagi tujuan

pengecaman. Model ASR tersebut mengambilkira kesalahan bacaan bagi sesuatu perkataan sebagai alternatif kepada sebutan yang betul di mana kesalahan-kesalahan itu telah dimodelkan ke dalam model leksikalnya. Strategi penambahbaikan fonem juga digunakan bagi tujuan meningkatkan ketepatan pengecaman, iaitu menurunkan kadar kesalahan perkataan (*word error rate*, WER). Untuk itu, sebuah prototaip pengecam (*recognizer*) telah dihasilkan bagi membolehkan proses penilaian dilakukan terhadap ketepatan pengecam yang berasaskan model cadangan. Penilaian ketepatan ini diukur menggunakan WER dan kadar pengesanan kesalahan bacaan (*miscue detection rate*, MDR) yang berkait rapat dengan *false alarm rate* (FAR). Pengecam berasaskan model cadangan tersebut berjaya mencapai tahap kepuasan WER serendah 25% dan 80.77% untuk MDR dengan kadar FAR 16.67%.

Katakunci: *Pengecaman suara automatik, model leksikal, kanak-kanak disleksia, Bahasa Melayu.*

ABSTRACT

Dyslexic children suffer from dyslexia, a condition that profoundly impedes reading and spelling ability due to its phonological origin. Often, these children found reading and spelling difficult, exhaustive, and less interesting, and thus they are self-withdrawn from the learning process. When reading and spelling, they make many mistakes even for simple, common words that they themselves found embarrassing. However, this does not mean that they have lower IQ level than normal children. In fact, dyslexic children have average or high level of IQ and thus have a lot of potential when given the right help and support such as motivational support and suitable teaching techniques. With advancement in technology in education, computer-based applications are used to stimulate the learning process of reading and spelling. Hence, this study is an initiative towards proposing an automatic speech recognition (ASR) model to enable computer to 'listen' should incorrect reading occurs. The scope of this study focuses on modeling and recognizing single Bahasa Melayu (BM) words within the school syllabus for level one (*tahap satu*) dyslexic pupils of primary schools. To propose the ASR model, a reading and spelling model of dyslexic children reading in BM is first proposed, which models reading at word recognition level. To propose such model, ethnographic techniques are employed namely informal interviews and observation, in order to obtain the reading and spelling error patterns of dyslexic children. A number of ten dyslexic children, aged between 7 to 14 years old whose reading level is similar, participated in the study. These children are recruited from two public schools that offer special dyslexia classes for the children. A total of 6112 utterances are recorded in audio form resulting in a total of 6051 errors of various types. Among these, the patterns that are most frequently made by these children are of 'Substitutes vowel', 'omits consonant', 'nasals', and 'substitutes consonant'. The ASR model is proposed taking into consideration the error patterns that make lexical model a fundamental element for speech recognition. The lexical model is modeled to treat mispronunciations as alternative pronunciations or variants of target words. To that, a phoneme refinement strategy is applied aiming to increase recognition accuracy. A prototype recognizer is developed based on the proposed model for further evaluation. The evaluation is performed to evaluate the recognizer's performance in terms of accuracy, measured in word error rate (WER) and miscue detection rate (MDR) that is closely related to false

alarm rate (FAR). The recognizer scores a satisfying 25% of WER and a relatively high MDR of 80.77% with 16.67% FAR.

Keywords: *Automatic speech recognition, lexical model, dyslexic children, Bahasa Melayu.*

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LIST OF ACRONYMS

3M	*Membaca, Menulis, Mengira* (Reading, Writing, and Calculating)
ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
ANN	Artificial Neural Network
ASCII	American Standard Code for Information Interchange
ASR	Automatic Speech Recognition
BM	Bahasa Melayu
CoLiT	Colorado Literacy Tutor
CSLU	Center for Spoken Language Understanding
C-V	Consonant-Vowel
DAS	Dyslexia Association Singapore
DC	Dyslexic Children
FAR	False Alarm Rate
HMM	Hidden Markov Model
HMM/ANN	Hybrid of Hidden Markov Model and Artificial Neural Network
ICT	Information and Communication Technology
IPA	International Phonetic Alphabet
LD	Learning Disability
LISTEN	Literacy Innovation that Speech Technology ENables
LLP	Liberated Learning Project
MDR	Miscue Detection Rate
MoE	Ministry of Education
NICHCY	National Dissemination Center for Children with Disabilities
OGI KIDS	Oregon Health & Science Univeristy (OGI) Children's Corpus (called KIDS Corpus)
PDP	Parallel Distribute Processing
PIPP	*Pelan Induk Pembangunan Pendidikan*
R&D	Research and Development
RAD	Rapid Application Development
TTS	Text-to-Speech
UTMK	*Unit Terjemahan Melalui Komputer*
WER	Word Error Rate

NAMING CONVENTION

Words	Naming Convention
Bahasa Melayu words	In italics e.g. *ibu, abang*
English words	In quotes e.g. "tyrannosaurus"
Non-words	In quotes e.g. "idu"
Error types	In inverted commas e.g. 'Reversals', 'substitutes vowel'
Alphabet or value or digit or syllable	In inverted commas e.g. 'b', '1', 'bu'
Emphasized word(s)	In bold face e.g. **dual-route model**
New terms	In italics e.g. *backpropagation*
Programming code or phonetic symbols (Worldbet) or file names or mathematical equation	In Courier New face e.g. `aku = A kh U`, `words.lexicon`

CHAPTER 1

INTRODUCTION

1.0 Introduction

Learning disabilities (LD) have gained serious attention from research communities in various fields – clinical, psychological, education, as well as computer science. LD is a condition where people have problems in acquiring skills essential in learning. Skills that are mostly affected are reading, writing, spelling, speaking, reasoning, and doing mathematics. The National Dissemination Center for Children with Disabilities, NICHCY (2004) revealed that 1:5 people are learning disabled. LD is a term generally used to refer to more specific types of learning problems such as Attention Deficit Disorder (ADD), Attention Deficit Hyperactivity Disorder (AHDD), and dyslexia.

Dyslexia is a type of LD that affects the individual's ability to learn basic literacy skills. The International Dyslexia Association (2006) defines it as a learning disability which is neurological in origin. Its characteristics are problems in accurate or fluent word recognition and also poor spelling and decoding abilities. These problems are strongly related to phonological deficits which are not clearly apparent in other cognitive abilities and from general classroom instructions. Other consequences include problems in reading comprehension and reduced reading experience that holds back the growth of vocabulary and background knowledge.

People who are dyslexics normally have average or high intelligence but found reading, spelling, and writing such overwhelmed tasks. Phonological deficit is

The contents of the thesis is for internal user only

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