Chapter 24
Speech Disorders Recognition using Speech Analysis

Khaled Necibi
University of Annaba, Algeria

Halima Bahi
University of Annaba, Algeria

Toufik Sari
University of Annaba, Algeria

ABSTRACT

Speech disorders are human disabilities widely present in young population but also adults may suffer from such disorders after some physical problems. In this context, the detection and further the correction of such disabilities may be handled by Automatic Speech Recognition (ASR) technology. The first works on the speech disorders detection began early in the 70s and seem to follow the same evolution as those on the ASR. Indeed, these early works were more based on the signal processing techniques. Progressively, systems dealing with speech disorders incorporate more ideas from ASR technology. Particularly, Hidden Markov Models, the state-of-the-art approaches in ASR systems, are used. This chapter reviews systems that use ASR techniques to evaluate pronunciation of people who suffer from speech or voice impairments. The authors investigate the existing systems and present the main innovation and some of the available resources.

INTRODUCTION

When a person is unable to produce speech sounds correctly or fluently, or has problems with his or her voice, then he/she has a speech disorder. Difficulties pronouncing sounds, or articulation disorders, and stuttering are examples of speech disorders. When a person has trouble understanding others (receptive language), or sharing thoughts, ideas, and feelings completely (expressive language), then he/she has a language disorder. A stroke can result in aphasia, or a language disorder. Both children and adults can have speech and language disorders. They can occur as a result of a medical problem or have no known cause.

Recent advances in ASR promoted developments of ASR-based applications dedicated to people with disabilities like blindness or physical

handicaps. However, in this chapter, we are particularly, interested with researches which address the problem of speech disorders.

The first works on the speech disorders detection began very early by the beginning of the 70s and seem to follow the same evolution as those on the ASR. Indeed, these early works were more based on the signal processing techniques (Childers, 1990). Later, systems dedicated to speech disorders incorporate more ideas from ASR technology, particularly, Hidden Markov Models, which are the state-of-the-art approaches in ASR systems.

This chapter is particularly dedicated to the presentation of available works in speech disorders detection based on speech recognition technology. In the following section we introduce the principles of the use of ASR technology in the speech impairments evaluation. This is done throughout the presentation of an illustrative example: Vocaliza which is a system devoted to speech disorder assessment.

We make an overview of the available researches in the field. The works are mainly grouped by the kind of disorder. Thus, disorders like: apraxia, dysarthria, or stuttering are presented.

We present the available resources in the field in terms of dataset for speech impairments and available software. We give the new trends in the fields and we suggest some possible directions to investigate.

ASR IN SPEECH IMPAIRMENT DETECTION

Speech disorders are human disabilities widely present in young population but also adults may suffer from such disorders after some physical problems. So, the detection and further the correction of such disabilities may be handled by ASR technology. At the beginning, works were essentially based on signal processing techniques. In particular, these works were mainly based on the fundamental computation and the harmonics of the signal, and then the principal of the detection consists on looking for dissimilarities between the normal speech and the abnormal one.

Recently, the need of the computer-aided speech therapy systems has increased. Such systems are getting more attention for researchers since the number of persons suffering from speech impairment is great. The main purpose of these systems is to provide methods for improving the communication skills of person who suffer from disorder in speech or voice.

Among the available systems devoted to speech disorder, we would like first to present Vocaliza, a system which is developed in the context of the National Project TIN in Spain.

Vocaliza (Vaquero et al., 2008a), is a Speech-Technology-based application for computer-aided speech therapy in Spanish language. This software provides a user interface especially designed to be attractive even to the youngest users. It works on three level of language: phonological, semantic and syntactic. Each level was trained by a different method which was shown as a game, in order to attract young users. In fact, all games were based on ASR techniques. The goal here was to decide if the user has completed the game successfully. The system includes speech synthesis to show how a word must be pronounced, speaker adaptation to estimate the acoustic models adapted to the user and utterance verification to evaluate user pronunciation.

Most of Vocaliza functionalities are provided by different Human Languages Technologies (HLTs) like ASR which is the core module of Vocaliza application. Each game needs an ASR decoder to decode the user utterances, and to decide which word sequence has been pronounced, so that the application will be able to let the user know if the game has been completed successfully.

The ASR integrated in Vocaliza uses an utterance verification procedure in order to decide if the user has pronounced the requested word or if there is a phoneme sequence with more probability.

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