Chapter 46
Comparisons of Speech Parameterisation Techniques for Classification of Intellectual Disability Using Machine Learning

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ABSTRACT

Classification of intellectually disabled children through manual assessment of speech at an early age is inconsistent, subjective, time-consuming and prone to error. This study attempts to classify the children with intellectual disabilities using two speech feature extraction techniques: Linear Predictive Coding (LPC) based cepstral parameters, and Mel-frequency cepstral coefficients (MFCC). Four different classification models: k-nearest neighbour (k-NN), support vector machine (SVM), linear discriminant analysis (LDA) and radial basis function neural network (RBFNN) are employed for classification purposes. 48 speech samples of each group are taken for analysis, from subjects with a similar age and socio-economic background. The effect of the different frame length with the number of filterbanks in the MFCC and different frame length with the order in the LPC is also examined for better accuracy. The experimental outcomes show that the projected technique can be used to help speech pathologists in estimating intellectual disability at early ages.

1. INTRODUCTION

In social communication, speech performs an important role to express feelings, emotions and thoughts. Communication impairments affect the process of initial cognitive development which continues to further stages. Neurodevelopment disorders, specifically, Intellectual Disability, Autism, Stuttering and Down Syndrome directly affect the speech and language development. Intellectually disabled children are highly prone to developing some speech, vocal or language disability, which has adverse effect on language development.

According to (World Health Organization, 1980), children with intellectual disability usually have impairments in language and speech which further classifies in use and comprehension of the language, deficits of the linguistic function, learning disabilities and impairments of communication. ID children also face difficulties in speech production, voice functions and speech content. The disorder causes restrictions in effective verbal communication which affect social involvement, educational attainment or professional performance, independently or in a group.

Communication is a vital component of quality of life, and speech considered as the primary mode of human communication out of various communication medium. In intellectually disabled (ID) children, the speech communication frequently disturbed by impairments in voice production and weakened hearing (Roberts, 2007), resulting in lack of communication and impairing both adaptive behaviour and intellectual functioning.

A authenticate clinical outcome shows the fact that a typically developing child achieve a remarkably good lexical and verbal system from their environment (De Villiers JG and De Villiers PA, 1974; Slobin, 1973; Pinker, 1994; Culter and Klein, 2005) but an ID child can't do the same at a similar age. Speech impairment is among the frequently addressed issue with the children with intellectual disability (Kumin, 2006). First, 3-5 years of a child's lifespan are highly crucial time for speech and language development. Typically developing children can learn the basic structure of language till this age (Tager-Flusburg, 1998) while children with ID can only acquire limited language components and understating of some common words. Researches on speech and language development are also affected due to less number of the speech pathologist and analyst for analysing recorded speech samples (Oller, 1980; Sheinkopf et al., 2000; Wetherby et al., 2004).

Intellectually disabled children participate in fewer activities in and outside school than their control peer groups (Abells, Burbidge & Minnes, 2008). Involvement in outside school activities is essential for all children as it enhances physical and mental growth, social awareness, and psychological security and creates community relationships (Murphy & Carbone, 2008). Children heaving intellectual disability may have lower communication, motor and social skills and have reduced cognitive functioning than their typically developed peers (Pratt & Greydanus, 2007; Westendrop, Houwen, Hartman, & Visscher, 2011). Due to less participation in outside school activities, children with intellectual disability may lead to social isolation (Rimmer, Rowland, & Yamaki, 2007) and inactive behaviour (Frey & Chow, 2006) which is generally reported in the literature.

Speech intelligibility is measured as how clear a person speaks so that his or her voice is understandable to the listener (Leddy, 1999). Lesser speech intelligibility often leads to lack of interest by others, frustration and misunderstanding. Social interaction helps in acquiring speech and language capabilities. Speech intelligibility is generally considered as voice pattern recognition in social communication (Smith, 1985). Although it is a combined effort of both speaker and listener who are participating in the recording process (Tjaden, 1995). Acquaintance with the speaker is especially helpful in case of

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