Development of a Sign Language Recognition System Using Machine Learning

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Abstract:
Deafness and voice impairment have been persistent disabilities throughout history, hindering individuals from engaging in verbal communication and leading to their isolation from the predominantly vocally communicating society. Sign language has emerged as the primary mode of communication for people with these disabilities. However, it presents a language barrier as it is not commonly understood by those who can hear. To address this issue, various methods for recognizing sign language have been proposed. This paperaims to develop a machine learning-based system that can recognize sign language in real-time. The paper involved the acquisition of a dataset consisting of 44,654 images representing the static American Sign Language (ASL) alphabet signs. The HandDetector module was utilized to detect and capture images of the signer's hand forming each sign through a PC webcam. The dataset was split into three sets: training data (20,772 cases), validation data (8,903 cases), and test data (14,979 cases). Image pre-processing techniques were implemented on the images and a convolutional neural network (CNN) model was trained and compiled. The CNN utilized in the paper comprised of three convolutional layers and a SoftMax output layer and it was compiled using the Adam optimizer and categorical cross-entropy loss function. The performance of the system was evaluated using the test dataset. Notably, the system achieved remarkable accuracy rates, having a training accuracy of 99.86%, a validation accuracy of 99.94%, and a test accuracy of 94.68%. The results obtained from this study demonstrated significant advancements in sign language recognition, surpassing previous findings in the literature.

1. Introduction

Based on a World Health Organization (WHO) report, greater than 6% of the general population has hearing impairment while approximately 5% of the population of the world, or 430 million people (432 million adults and 34 million children), need therapy to treat their 'disabling' hearing loss [1]. Debilitating hearing loss is projected to affect about 700 million individuals by 2050, or one in ten people [2]. Treat (2016) estimates that 23.7% of Nigerians, out of a population of over 155 million people, have a hearing disability (total deafness, hearing loss, or other impairment related to hearing) [3]. Additionally, up to 84% of Nigeria's deaf population is uneducated and underdeveloped economically [4]. WHO defines someone as having loss of hearing if they are unable to hear at the level of a person with normal hearing, which is characterized by possessing hearing levels of 20 dB or higher in both ears [5]. It can range from mild to severe and can affect either or both ears [6]. The term "deaf and dumb" is frequently used to refer to those who, due to their deafness, are unable to hear what others are saying and, as a result, continue to be dumb [7]. Children who have early hearing loss due to illness or an accident quickly lose their ability to speak [8]. This is because deaf children are unable to acquire speech by imitating others [9]. Hereditary, degenerative, and accidental factors among others can lead to hearing loss [10].

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