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HAND GESTURE RECOGNITION AND SPEECHCONVERSION USING MACHINE LEARNING FOR DEAF AND DUMB PEOPLE

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ABSTRACT

People with the inability to speak use sign language for communication. Sign languages are developed primarily to aid deaf and dumb people. Ordinary people usually find it difficult to communicate with mute people due to their lack of understanding of sign language. Sign language recognition is a technology that aims to bridge the communication gap between deaf and dumb people and normal people. This paper presents a solution by developing a system for hand gesture recognition using an Arduino Nano 33 BLE board and flex sensors with the support of an artificial neural network (ANN) and converting it into speech. The Flex sensors and Arduino Nano 33 BLE are attached to a glove, which is used to capture fingers and wrist movements with the help of the inbuilt IMU sensors in the Arduino Nano 33 BLE. The ANN is then used to classify and identify the different hand gestures made by the user. The output of Nano 33 BLE is then converted into speech with the help of Android Studio using the Text-to-speech (TTS) library.

***Keywords* - Hand gesture recognition, ANN, Arduino Nano 33 BLE, Flex sensors, Text- to-Speech(TTS).**

I. INTRODUCTION

Communication is a vital aspect of human interaction and plays a crucial role in our personal, social, and professional lives.Despite this fact, normal human beings do not have much difficulty interacting with each other and can express themselves easily through speech. However,deaf and dumb people finds it difficult to communicate more effectively with those who do not understand sign language.This implies a requirement for sign language recognizers which can recognize and convert sign language into speech.

In this work ,the idea is to use Arduino Nano 33 BLE and Flex sensors for the gesture detection using machine learning algorithms like artificial neural networks to recognize the hand gestures and training the model and then to convert these gestures into speech or text for others to understand.

In earlier days for recognizing hand motion, vision based technique is used. It is basically a system which uses a camera to sense the finger movements.But in this method the environmental effect in the recognized image is high and they have to show their hands in front of tha camera.So we go for more portable setup by using Arduino Nano 33 BLE for the hand movement detection.

Overall, hand gesture recognition and speech conversion using machine learning have the potential to greatly improve communication and accessibility for deaf and dumb individuals, and could be an important step towards creating a more inclusive society.

II. LITERATURE SURVEY

As most people will not be able to understand the Universal Sign Language,it is very difficult for them to communicate with mute people.A device is designed that makes use of an Arduino Uno board, a few flex sensors and an Android application to enable effective communication amongst the users.According to various pre-defined conditions for the numerous values generated by the flex sensors, corresponding messages are sent using a Global System for Mobile(GSM) module to the wearer's android device, which houses the application that has been designed to convert text messages into speech. The GSM module is also used to send the sensor inputs to a cloud server and these values are taken as input parameters into the neural network for a time series based prediction of gestures[1].This paper evaluates the possibility of performing fine gesture recognition including finger movements on a low-tech device.Several different Machine Learning techniques are employed and their individual advantages and drawbacks are explored for the task at hand. The results indicate an average of 95% accuracy during real-time testing for Recurrent Neural Network approach, that runs on the low-tech device, namely an Arduino Nano 33 BLE[2]. It presents a technique that uses the Bag of Visual Words model (BOVW) to recognize Indian sign language alphabets (A-Z) and digits (0–9) in a live video stream and output the predicted labels in the form of text as well as speech.Segmentation is done based on skin colour as well as background subtraction. SURF (Speeded Up Robust Features) features have been extracted from the images and histograms are generated to map the signs with corresponding labels.The Support Vector Machine (SVM) and Convolutional Neural Networks (CNN) are used for classification.An interactive Graphical User Interface (GUI) is also developed for easy access[3].The system is designed to work with American Sign Language fingerspelling and aims to translate a pangram into speech. The system consists of three subsystems, namely, gesture detection, gesture classification, and text-to-speech subsystems and relies on a power bank for its power supply.The gesture detection subsystem makes use of five flex sensors, each placed on the finger of a glove,as well as a three-axis accelerometer.Gesture classification is achieved through a supervised machine learning approach - five different algorithms are compared to determine the best configuration for this system[4].

III. SYSTEM DESIGN

Hand gesture recognition using an Arduino Nano BLE and an Artificial Neural Network (ANN) is a hardware-based system that recognizes hand gestures and converts them into speech using an Android app.The system utilizes a combination of hardware and software components to capture and process the hand gestures.The block diagram of our proposed system has Data collection, Data preprocessing, Neural network training, Real-time gesture recognition, App Deployment, Text-to-Speech is shown in Fig. 1.

The hardware components of the system include an Arduino Nano BLE board, which serves as the microcontroller unit (MCU) and it also have inbuilt IMU Sensor that communicates with flex sensor to capture the hand gestures and convert them into electrical signals that can be processed by the MCU. The sensors are typically placed on the fingers or the wrist, depending on the desired level of accuracy and complexity of the hand gestures.

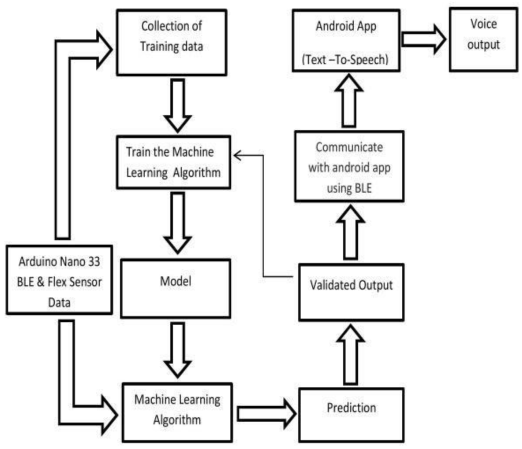

Fig. 1 Block Diagram

Then the data collected for each hand gesture that is to be recognized. The collected data needs to be preprocessed before it can be used to train the neural network. This may involve normalizing the sensor readings, splitting the data into training and testing sets, and encoding the labels as numerical values.

The software components of the system include an ANN algorithm, which is a type of machine learning algorithm that is capable of recognizing patterns and making predictions based on input data. The preprocessed data is then used to train an artificial neural network. The network architecture can be customized based on the specific requirements of the hand gesture recognition task, but may typically involve one or more hidden layers with activation functions, and an output layer with softmax activation.

The ANN is trained using a dataset of hand gestures and their corresponding actions or commands. Once the neural network is trained, it can be used to recognize hand gestures in real-time. The Arduino Nano BLE can be used to read the sensor values from the flex sensors and inbuilt IMU Sensor, and feed them into the neural network for classification. The output of the neural network can be sent to the Android app using Bluetooth Low Energy (BLE) communication.Finally, the Android app can convert the recognized hand gesture into speech using a text-to-speech (TTS) engine.

IV. METHODOLOGY

A. Sensor Calibration

Flex sensors are analog sensors that measure the degree of bending. Before using the sensor for gesture recognition, it needs to be calibrated to obtain accurate readings. This can be done by measuring the resistance values of the sensor in its fully extended and fully bent states, and then mapping those values to a range of 0-100% to calculate the sensitivity of the sensor .

B. Data Collection

Flex sensors and Arduino Nano 33 BLE are attached to the fingers or wrist to detect the hand movements. As the hand moves, the flex sensors generate analog signals that are converted to digital signals using an analog-to-digital converter (ADC) on the Arduino board. These signals are processed to identify the hand gestures.Then the data needs to be collected for each hand gesture that is to be recognized. This involves measuring the flex sensor and inbuilt IMU sensor readings while the gesture is being performed, and recording these values along with a label for the gesture.

C. Gesture Recognition

The Arduino board uses an Artificial Neural Network (ANN) algorithm to recognize the hand gestures. ANN is a type of machine learning algorithm that can be used to recognize patterns in data. The ANN is trained on a dataset of hand gestures, and the weights and biases of the network are adjusted to minimize the error in the output. Once trained, the ANN can recognize the hand gestures with a high degree of accuracy.

D. Wireless Communication

The Arduino Nano BLE board communicates wirelessly with an Android app using Bluetooth Low Energy (BLE) technology. The app receives the gesture data from the Arduino board and converts it into speech output using text-to-speech (TTS) technology**.**

E. Android App Development

The Android app is developed using Java programming language. The app receives the gesture data from the Arduino board through BLE communication and uses the TTS engine to convert the gestures into speech output. The TTS engine can be programmed to output different speech for different gestures, allowing for a customized user experience.

V. RESULTS

This proposed system has five flex sensors and an imu sensor. These flex sensors are integrated with the inbuilt imu sensor of Arduino nano 33 ble to capture accurate finger and wrist movements. As we make hand gestures , the change in position of the wrist is detected by using the values of accelerometer and gyroscope of the IMU sensors and the results are shown in Fig. 2 and Fig. 3. Dataset for this system consists of these value changes for each hand gesture and their corresponding gesture labels. This collected dataset is used to train an ANN model. As we have trained the ANN model, the gesture we perform now can be read and passed through the ANN model for prediction.Then the predicted gesture is convertedintospeech using an Android app with the help of text-to speech(TTS) library.

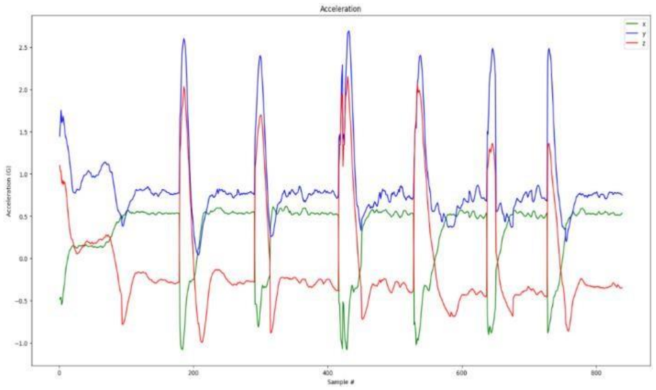

Fig. 2. Graph of accelerometer

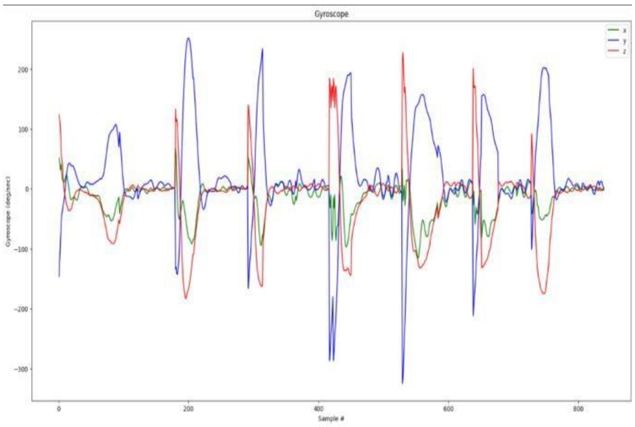

Fig. 3. Graph of gyroscope

VI. CONCLUSION

This work led to the design and construction of a system that translates sign language into speech, with the aim of assisting the hearing impaired. This system used Arduino Nano 33 BLE and Flex Sensors for recognizing wrist or finger movement and artificial neural networks for training large datasets. However, it is important to note that these technologies are still in the early stages of development, and there are challenges that need to be addressed, such as the recognition of different accents and hand movements. Nevertheless, the potential benefits of these technologies for the deaf and mute communities are significant, as they can improve social inclusion and enable these individuals to lead more independent lives. Overall, hand gesture recognition and speech conversation using machine learning offer a promising solution to address the communication needs of people who are deaf and mute.

VII. FUTURE SCOPE

In future work ,we can modify this system such that it can be used by wearing hand gestured glove in both hands and by integrating two Arduino Nano 33 BLE in each hand to recognize more number of signs and to support different language mode. This improves the efficiency of sign recognition for universal sign languages.

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