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Smart Glove for the Disabled: A Survey

Hrishikesh P Athreya, G. Mamatha, R. Manasa, Subhash Raj and R. Yashwanth

***Abstract*---**Smart Gloves helps the disabled people to lead a normal life. Their interaction with others is only by using their hands and expressions. They usually have tough time talking to others and hence this will help them communicate .It helps him/her to convert his/her hand gesture into text and voice. This helps normal people to understand what he/she is trying to say and reply accordingly. This device recognizes and understands every motion of the user using the motion sensors. A Smart Glove with flex sensors and accelerometer is attached to recognize hand gesture. Based on the gesture, raspberry pi code converts it into text and sends it to the cloud. That message is stored in a database. Every movement made is matched with the database and speech signal using Google speech API is produced which can be heard through the mobile speaker. The aim of the project is to make a smart hand gloves which might minimize the obstacles for the disabled.

***Keywords*---**Smart Gloves, Communication, Disabled, Flex Sensors, Accelerometer, Raspberry Pi, Google Speech API.

I. INTRODUCTION

COMMUNICATION Is an important tool for any human being. In present days, we can overcome the problems being faced by the disabled with the help of smart glove. The sign languages decided to bridge the gap between the disabled and normal person. By analyzing the finger movements, the gesture made can be converted to voice as well as text. The smart glove recognizes the gestures with help of flex sensors that run the length of each finger and with the help of Google speech API we can hear the output. The output is also shown in the android application which can be read easily. This glove is cost effective and is easy to use.

Fig. 1 Challenges of Glove based Sign Language Recognition

Fig. 2 Three Main Units of Glove-Based Recognition System

II. FEATURES OF THE SMART GLOVE:

- It is affordable as the components required are veryfew and is user friendly.
- This reduces the communication gap faced bythe disabled.
- It also provides communication between dumband blind.
- It is also useful for speech impaired and
- Paralyzed patient.
- Its light weight and flexible to users.
- Easy to operate and real time translation.

III. COMPONENTS OF THE GLOVE:

A. Flex Sensors:

Flex sensor is a sensor which changes opposition dependent on the bend made by fingers on the sensor. Flex Sensor protected innovation depends on resistive carbon components

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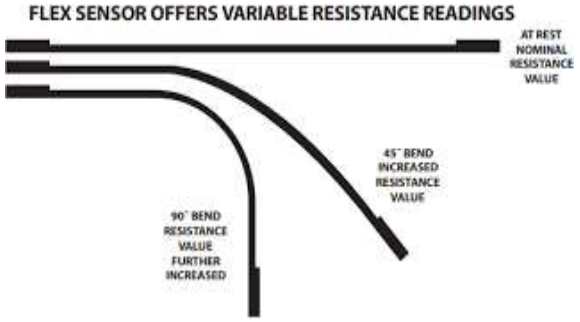

Fig. 3 Flex Sensor

B. Accelerometer:

Accelerometer is an electromechanical gadget used to gauge quickening powers. It is dynamic to detect development or vibration. This sensor quantifies the redirection of the surface and gives the avoidance relating to specific pivot. The accelerometer and the Gyroscope are inserted inside a solitary chip.

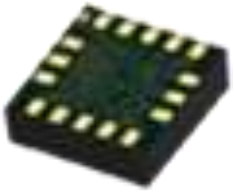

Fig. 4 Accelerometer

C. Raspberry Pi:

Raspberry Pi is the chip which is utilized to complete the handling exercises. Raspberry Pi acknowledges contributions from both the sensors [Flex Sensors and Accelerometer]. The estimations of both the sensors are discovered independently in various places of the glove as indicated by the signs.

Fig.5 Raspberry Pi

D. Firebase:

Firebase is a platform created by Google for making portable and web applications. Information is put away as JSON and synchronized in real-time to each and every related customer. The Firebase Realtime Database is a cloud facilitated information base. JSON represents JavaScript Object Notation. JSON is a lightweight arrangement for putting away and moving information. The real time database is shared with the user when we fabricated the application with our iOS, Android, and JavaScript SDKs. The Database is auto refreshed.

E. Google Speech API:

Google Cloud Speech-to-Text is a mechanized discourse acknowledgment (ARS) API. It depends on profound neural organizations that can be utilized in applications, for example, voice search and discourse text change.

Google Speech API underpins both live streaming and pre-recorded sound.

Google Cloud Text-to-Speech empowers engineers to incorporate characteristic sounding discourse with 100+ voices, accessible in various dialects and variations. As a simple to-utilize API, you can make similar associations with your clients, across numerous applications and gadgets.

IV. Applications

The evolution in technologies has now made it possible for the normal person to understand the gestures made by the disabled. There are lot of researches going on in the field of smart gloves and it applications is various fields are being recognized. These are some of the sectors where smart glove technology is used:

A. Government Sector:

The smart glove can be used in banks, hospitals, railway stations, airports and restaurants where the hand gestures are recognized and real time translation is made which helps in easier communication.

B. Medical Sector:

The gesture recognition project can be used for communicating with the sick and disabled patients with minimal effort from them. It reduces the need for 24/7 presence of a helper around them since it can be used to monitor patient's needs remotely.

C. Educational Sector:

Differently-abled children can learn sentence formations, prepositions, grammar, with the help of this glove.

D. Industrial Sector:

Vast industrial floors often find themselves being extremely unfavorable for vocal or visual communication. Our gloves help solve this issue by helping people communicate about the various activities that happen on the floor regardless of the distance or background noise levels.

E. Virtual Reality Sector:

The sensory glove is implemented in interactive applications which also include much other virtual reality technology, such as a computer games, simulated environment, wearable mouse glove, virtual musical appliances, wearable keyboard glove, etc.

Fig. 6: Categories of Recommendations for SL Recognition Using Gloves.

V. Innovations And Research Made

A. Database set:

The amount of signs and gestures, along with samples, for the database set of the recognition system, has to be increased depending on the recommendations noticed and agreed by the big proportion of the researches. This should be taken into account in their further and future implementations to upgrade the performance of the recognition system. The database set that is belonged to several researchers in this particular background is very limited and it might only contain alphabets, numbers or a very finite number of words. Gestures are picked and selected by noticing the capability to perfectly verify the proficiency. The generation of dictionary assures that the database of gestures involves and covers the full gap of all predictable centers of Sign Language (SL) expressions.

B. SL Analysis:

SL is having its own grammar syntax rules to form sentences and phrases that include series of gestures, as a spoken language. These rules need to notice when implementing an SL translation system. The imposition of strict context and grammar simplifies the Sign Language Recognition (SLR) process. In addition to this, the target spoken language rules must be followed. It is important to notice that each community has its local sets of SLs; hence, it is necessary to create a standard universal SL around the world. In addition, a global should be implemented that would interpret such sigh language.

I. Hybrid System

Hybrid system looking towards SLR, the sensor Vision-based and glove-based approaches are much essential. Each of these approaches have both advantages and limitations; so, designing an architecture is totally based on the suitable combination of these two approaches to to come up with an aspire system. Facial expression, body motion and two hands: As supported by many other studies, scanned data is taken from specified number of fingers, which helps in system improvement and glove development; readings of all these fingers need to be captured to increase the value of collected data. Misspellings caused by similar signs of letters are avoided with the help of appending a pressure sensor to the middle fingers and index fingers. The sensor discrimination between ‘U’ and ‘V’ is possible by adding a new filter to the character recognition program that enables the complete use of sensor. Just by incorporating the investigation of arm joint angles by placing sensors on the arm the problem of Arm gesture and dynamic posture defects can be resolved. We will have to place the sensors on the shoulder and elbow as well. So that the features of at most sign languages can be recognized. It would also be necessary to gather the two-hand parameters concerning sign language recognition, along with head movements, facial expressions, and body posture.

II. Threshold value:

Adding up the maximum and minimum values of the threshold is necessary to pass around wrong inputs and defects in communication. Numbers and types of sensors: several substantial factors, like using more and extra sensors with higher quality, must be accounted to fully apprehend the meanings of real SL gestures, recognize many SL gestures, improve system performance, and overcome errors.

A fusion of various and various types of abduction sensors like contact sensors, gyroscope, flex sensors, all these can capture more complicated gestures, and also differentiate among similar letters to obtain a robust, accurate and reliable, recognition system. However, using lightweight and lesser sensors helps to reduce the hardware complexity.

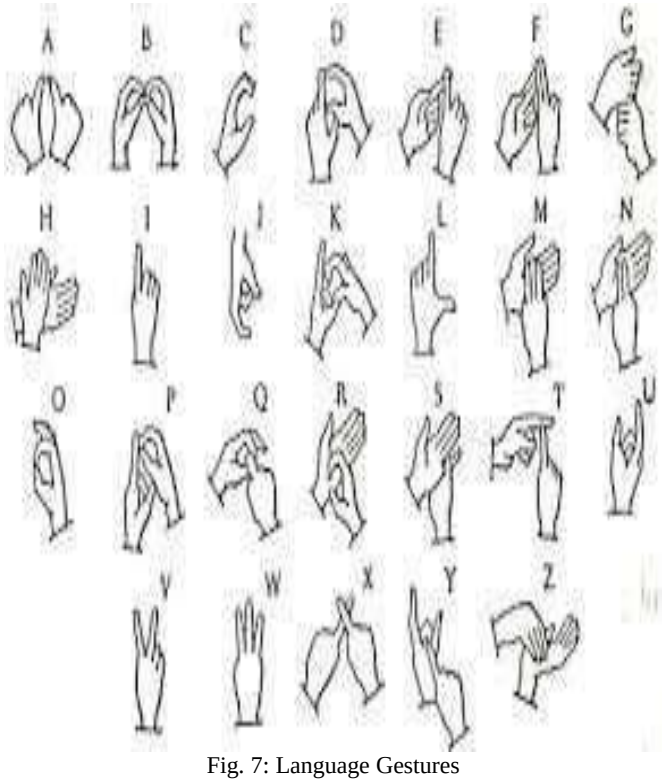

Fig. 7: Language Gestures

VI. Literature Survey

A. Gesture Recognition:

Gesture recognition technique can be classified into two categories. Such as Software based classification and hardware-based classification.

I. Software based Classification

[12] Uses a CNN to recognize hand gestures and, a static hand gesture recognition system is developed for American Sign Language using a deep Convolution Neural Network. The system design is lightweight to make the system efficiently deployable and mobile. To achieve high accuracy in live scenarios we employ, several image processing techniques which assist inappropriate background reduction and frame segmentation. Their system achieved a testing accuracy of 96%.

II. Hardware based Classification

1) Smart glove approach: Recognizing gestures using different hardware implements is now examined in two broad ways from the papers surveyed.[1],[2],[3] and [7] came up with a glove that interprets American Sign Language Standard into text or speech to break the information transmission gap between the disabled and the ordinary public. This glove has been actualized withthe support of accelerometer, flex sensors, microcontroller (Arduino Nano) [7],[2], (Arduino Atmega 2560) [1] (Intel Galileo Gen 2) [3], and the Bluetooth chip[7].

Fig. 8 Smart Glove Prototype

2) IR eye band approach: [9] this tells about a system where three Infrared sensors modules are mounted on an eye glass to trace the movement of the iris. The IR sensors captures only the white objects henceforth, a unique sequence of digital bits is generated according with each eye movement. In this system, IR sensors emit a continuous beam of IR rays. Spectacles are drilled with three pairs of IRsensors. Whenever an obstacle comes in front of a receiver, these rays are reflected back and captured. This system has a drawback, when it is used for a long time, the eyes get spoiled because of too many IR sensors.

Fig. 9 Eye gear with 3 IR Sensors

III. Hybrid classification

This kind of classification uses a mixture of hardware and software methodologies to classify gestures. [6] Deals with the usage of a glove fitted with an accelerometer and flex sensors to obtain data points and apply the Gaussian Clustering algorithm. This algorithm assumes an apriori that there are 'n' Gaussian and then the algorithm tries to fits the data into the 'n' Gaussian by expecting the classes of all data points and then maximizing the maximum likelihood of Gaussian centers.

The algorithm used in the matching module is namely Gaussian algorithm and is a type of clustering method which is set up This algorithm assumes theoretically that there are 'n' Gaussian and along with then maximizing the maximum likelihood of Gaussian centers, the algorithm tries to fits the data into the 'n' Gaussian by expectingthe classes of all data points and.

B. Gesture Outputs:

The output of the gesture recognition system can be in various forms based on the needs and objectives of the system. [12] is a software approach to gesture recognition and uses a CNN to detect the various gestures made. It outputs the detected gesture as text on a computer monitor display. [1],[2],[3],[4] output alphabet that the gesture corresponds to on a backlit LCD screen. [4],[10] makes use of a speaker and APR33A3 recorder and playback module [4] to record and play the recorded audio for corresponding gestures.

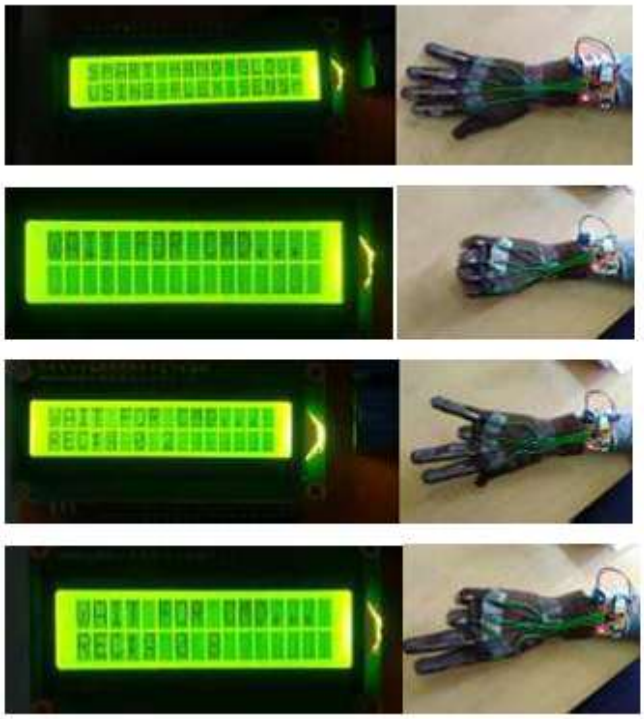

Fig. 10: LCD Screen Displaying the Output of Glove

C. Text to Speech Conversion (TTS):

Text to voice conversion technology implemented by the papers we have surveyed fall under the following categories:

I. Using Preloaded Voice:

[4] Makes use of the APR33A3 recorder and playback module. Voice messages are prerecorded using it and ADC values obtained from the transmitting unit is mapped to corresponding values in the receiving using and the voice is played back. A major disadvantage using this approach is that the gestures that can be played back is limited to the ones that have been prerecorded. This disadvantage is overcome in the nexttwo categories

II. Using TTS Algorithms:

[11] It tells about the use of discriminative algorithmssuch as Convolution Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Multilayerperception's (MLPs) in the field of audio generation. It also describes the downsides in using the same suchas in real time applications, it is found that the performance of the RNNs decreases when data sequences are long. Exploding gradients and vanishing gradient problems result in an uncontrolled Propagation of the gradients in the training procedure

[10], [11] Tells about the usage of generative algorithms that is being used such as Deep Belief networks and Variational Auto-encoders in Text too speech conversions. Recently generative models have been picked out as powerful tools for speech waveform production. Deep Mind group of Google had proposed the Wave Net that has caught the attention of the speech analysis community. Wave Net is nothing but a deep generative model of raw audio waveforms and can easily capable to create a human voice that sounds very natural. It is the composition of completely convolution neural networks, containing various dilation factors.

COMPARISON OF THE WORK

Title of the Paper	Components	Application	Limitation
[1] Development of Device for Gesture to Speech Conversion for the Mute Community	Flex sensors, Arduino, Bluetooth module, LCD display, and Android phone.	The device will be portable by using a battery. By introducing different languages flexibility is obtained. A total of ten flex sensors can be used to increase the precision of this system.	Overall System is effective and efficient because of the use of Arduino microcontroller and android phone and android applications.
[2] Augmentative and Alternative Communication usingSmart Glove	Flex Sensors and Accelerometer, A flex sensor is glued to eachfinger of the glove thus making the glove utilize five flex sensors for one glove. microcontroller, Arduino NANO	The project will aim to lower the communication gap between the deaf or mute community and the normalworld	The usability of smart gloves has to be extended to another different language. One more technical issue can be handled is to assist multi-gestureat a higher speed
[3] Smart Glove for Sign Language Communications	Five Flex sensors, XBee transceivers, Intel Galileo Gen 2loT kit, loT edition Grove Starter Kit -light sensors and LEDs.	home automation gaming purposes tracking users' movements inreality	Portability is limited Lack of accuracy
[4] Multipurpose Smart Glove for Deaf andDumb People	flex sensor, gyroscope, and accelerometer, Raspberry Pi. Espeak, speaker connected to the glove.	The system can be dynamically reconfigured to work as smartdevice	The output is only through the voice. The system has limited gestures

[5] A Survey of Glove-Based Systems and Their Applications	Flex sensor, Accelerometer, five- pixel LED scanner/receiver sensor	Medicine and Rehabilitation Entertainment Robot control and Teleoperation	limited portability The cloth support has also beenfound to affect measurement performance poor robustness and poordurability
[6] Smart Glove using Gesture Recognition Techniques for Speech Impaired and Deaf People	Flex sensor, Microcontroller, LCD	Single equipment's – multiple Applications	Range up to 100m only Facial expressions are notconsidered
[7] Smart Gloves for Hand GestureRecognition	flex sensors, Raspberry Pi, IMU module, TTSengine	Gaming industry Controlling a robotic armusing the gloves Remote medical surgery	Physically fits to a specific size, Low robustness. Computational complexity and calibrations difficulties
[8] Smart Glove for Hearing-Impaired	flex sensors, accelerometer, Arduino Nano, Bluetooth link to an Android Smartphone or aprivate laptop	Physically challenged persons. Conveying information related operations Helping hand for people with Cerebral Palsy	Enhancing the quality of the mobile application which can be used to produce a lot of technical quality researchis required It can be implemented in various fields like in airport and railway stations to assist the speech impaired
[9] A survey on advanced technology for communication between deaf/dumb people using eye blink sensor and flex sensor	Flex sensors, IR sensors, Slot sensors, PIC microcontroller	Help disabled people move around using a wheelchair Movement and control usingeye	Causes damage to the eyes of the user
[10] Design of voice to	Android, Ubuntu,	Records voice around user and	Would require user to be
text conversion and management program based on Google CloudSpeech API	MySQL, JavaScript, Google speech API	transcripts to text to combat sexual harassment at workplace	constantly connected to the internet throughout the day
[11] Application of deep learning to audiogeneration	Python, sklearn, Tensor Flow	Discusses the various approaches to audio generation using machine learning	N/A
[12] Gesture recognition system using convolution neural networks	Python, Tensor Flow	Performs gesture recognition using CNN	Is not portable and hence is not practical for daily use.

VII. Conclusion

As we have found that Deaf-quiet individuals make use of communication via gestures to cooperate with others anyways numerous don't understand this motion dialect. Our work makes sure that it breaks the communication gap between the mute community and the standard world. The implemented methodology interprets language into speech. The system improves the time difficulties of disabled people and upgrades their manner. Comparatively this system is very much efficient, portable and easy than the present systems.

One of the most considerable property of this project is that the gesture recognizer may be an autonomous system, that's imposed in normal place of living. This technique converts the language into an associate passing voice which is easily understandable by blind and common people. The language is translated into some text and it is displayed on the digital display screen, to allow the deaf people. In the world applications, this project is very much helpful for those dumb and deaf people among us who are unable to communicate with normal, common people.

By virtue of this device, the communication of the deaf and dumb person with the normal person is made real. This device also eliminates the need for an interpreter and also avoids miscommunication. Thus, the final system will not be much expensive making it accessible to every needed person. It's an added advantage for speech impaired and paralyzed patients, which means those who can't speak properly and in addition used for industrial applications and Intelligent Home Applications. The process while building this project made us face various types of challenges. We have tried to minimize the number of problems.

Thus, the final system will not be much expensive making it accessible to every needed person and also our main intention is to come up with a model, which can solve or minimize the communication problem for disabled people.

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