SMART GLOVE USING ARDUINO WITH SIGN LANGUAGE RECOGNITION SYSTEM

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ABSTRACT

Now a days different methods are available for physically disabled like deaf and dumb people. But till now the effective solution for the problem is not yet implement completely. By comparing all this existing methods here we are proposing a new method "SMART GLOVE" by using Arduino with sign language recognition system. This paper is mainly focused on the disabled people and aged people who can't speak and hear properly. The main purpose of the smart glove is to provide an ease of sharing basic ideas minimize communication gap and an easier collaboration for the hard of hearing and speechless people. For this purpose an automatic sign language recognition system has been developed by using Arduino. Smart Hand Gloves help disable people to live with normal people. As dumb person cannot speak then this smart gloves fitted with flex sensors will helps him to convert his hand gesture into text and pre-recorded voice. This also help normal person to understand what he is trying say and reply accordingly. This also aims to design a health care system which will be helpful for paralyzed and mute people as well as for the detection of heart attack by a pulse sensor.

Keywords- *Flex sensors, Pulse sensor, Gesture Recognition, Sign Language*

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1. INTRODUCTION

In the recent years there has been a rapid increase in the number of hearing impaired and speech disabled victims due to birth defects, oral diseases and accidents. When a speech impaired person speaks to a normal person, the normal person find it difficult to understand and asks the deaf-dumb person to show gestures for their needs. Dumb person have their own language to communicate with us; the only thing is that we need to understand their language. The language used by the deaf and dumb people for their communication is known as sign language. The sign language do not have a common origin. Since regular people are not trained on hand sign language, so the communication becomes very difficult. In emergency or other times when a mute person travelling or among new people communication with nearby people or conveying a message becomes very difficult. Here we propose a smart speaking system that helps mute people in conveying the message to regular people using hand motions or gestures. The main aim of this paper is to facilitate people by means of a glove based communication interpreter system. The hand talk glove is a normal, cloth driving glove fitted with flex sensors along the length of each finger and the thumb. The sensors output is a stream of data that varies with degree of bend. The output from the sensor is analog value and is converted to digital and processed by using microcontroller and then it will be transmitted through wireless communication (RF), then it will be received in the receiver section and processed using responds in the voice using speaker. In this paper flex sensors plays the major role, Flex sensors are sensors that change resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance-the more the bend the more the resistance value.

Another problem faced by the mute people is their health condition mainly in the heart related areas. This paper is also aimed to design a healthcare system which will be helpful for paralysed and mute people as well as for the detection of heart attack. The heart attack is the major reason for the death among both genders men and women. However its occurrence is not predictable. The most common device used to detect heart related problem is ECG machine which is reliable to normal user, but it's not mobile enough to be used as a monitoring for a patient continuously. So here we use a pulse sensor to measure the heart rate. The heart rate monitoring system depended on the pulse sensor, Arduino is capable of data storage and it is worn in the finger and is portable models if heart rate counter have been designed based on analysing infrared light reflection from the body parts. The overall device is simple to use and a very user friendly device.

2. LITERATURE SURVEY

2.1 Gesture recognition to voice conversion using electronic hand glove, K.Hemavani

This paper presents a smart glove system that can continuously recognize sign language gesture and translate that into spoken words. The glove is fitted with a flex-sensors and magnetometer sensor to sense the movement made by fingers. New gestures can be added to the existing gesture library. This gives the system the flexibility to meet the high degree of variation among sign languages, and also the need to do some custom gestures for those industrial work.

Sign language is used by deaf and mute people and it is a communication skill that uses gestures instead of sound to convey meaning simultaneously combining hand shapes, orientations and movement of the hands, arms or body and facial expressions to express fluidly a speaker's thoughts. Gesture is a non-verbal form of communication. The series of gestures such as hand movements and facial expressions indicating words are referred to as sign language. Sign language recognition systems are used to convert sign language into text or speech to enable communication with people who do not know these gestures. Usually, the focus of these systems is to recognize hand configurations including position, orientation, and movements.

The proposed work Hand gestures are strong medium of communication for hearing impaired society. The deaf and dumb make use of sign language to communicate which is difficult to interpret by the individuals who are not well-aware of it. Thus, there is a need of building up a device that can interpret the gestures into text and speech. The main goal of this project is to create a smart glove system that can continuously recognize sign language gesture and translate that into spoken words. It is a new technique called artificial speaking mouth for dumb people. The glove is fitted with a flex-sensor and a magnetometer to sense the movement made by fingers. A low power ARM Cortex-M4 microcontroller recognizes the movement by means of acquiring, processing and running a sensor fusion algorithm. The system translates the sign recognized into meaningful text. This text is then transferred to a smartphone app over a Bluetooth channel where the text will be converted into speech. Another feature that makes this project interesting is that users can teach the system new gestures and add them to the existing standard gesture library.

2.2 Digital text and speech synthesizer using smart glove for deaf and dumb, KhushbooKashyap, Amit Saxena, Harmeet Kaur, Abhishek Tandon, Keshav Mehrotra

Perhaps the single quality most central to humanness is the ability to exchange thoughts, ideas, and feelings with others. The importance of the capacity to connect with other people cannot be overstated. Helen Keller was once asked, if she could have either her vision or her hearing, but not both, which would she choose? Without hesitation, she replied, "My hearing." When asked why, she responded, "Blindness separates a person from things, but deafness separates him from people". Persons with severe and profound disabilities may be especially vulnerable to this problem of separation from the mainstream of society. Federal legislation has defined persons with severe disabilities as those "who because of the intensity of their physical, mental, or emotional problems, need highly specialized education, social, psychological, and medical services in order to maximize their full potential for useful and meaningful participation in society and for self-fulfilment. Many individuals who have severe disabilities experience substantial difficulties in communicating effectively with those around them with the advent of wearable technology, it is now possible to implement numerous and extremely creative ideas to serve humanity in unprecedented ways. Thus, came the idea of such a system which can act as a medium for deaf and dumb people to communicate and convey their feelings in a more appropriate and efficient manner. Due to communication gap deaf and dumb community is restricted in a small social circle and is not able to mix up and interact with normal masses. This proposed system is a path towards the breaking of this communication gap.

Smart glove is a system which comes under the category of Augmented and alternative communication. Augmentative and alternative communication (AAC) is a prominent component in the development of support services for individuals with disabilities, especially those with severe disabilities. Technologies such as augmentative and alternative communication (AAC) systems can help to minimize this separation from other people. An AAC system is an―integrated group of components, including the symbols, aids, strategies, and techniques used by individuals to enhance communication‖. These technologies range from relatively low-tech systems (i.e., simple adaptations with no batteries or electronics, such as communication boards). AAC systems may be roughly classified into one of two categories: unaided communication systems and aided communication systems. Unaided AAC systems do not require any sort of external communication device for production of expressive communications. Sign language, facial expressions, gestures, and non-symbolic vocalizations are all unaided modes of communication. Aided systems require an external communication device for production.

2.3 Smart glove for deaf and dumb using flex sensors and tactile sensors, AmbikaGujrati et al.

Proposed a system which consisted of flex sensors, tactile sensors and accelerometer. Their hardware requires 5V DC and hence a voltage regulator of 7800 series (7805) is used. LED"s are used which informs about the supply being activated. A 330Ω resistor is used to drop the voltage and make it 2-2.5V as required by the LED. The deflection of the flex with a minimum angle of 40°, a resistance is obtained which is increased by bending and voltage is obtained. Four flex sensors along with their connection ports are placed. The voltage is in millivolts so op-amp (LM358) was used to amplify it. The op-amp used is a non-inverting type with high voltage gain. Rf resistor is variable resistor with (0-10) kΩ and RI is 2.2kΩ. A 33k resistor is used at the output of op-amp which stops the voltage from being grounded. PIC16F877 a peripheral interface controller is used with flash memory 8kb and an inbuilt ADC converter with 10 bit resolution. The microcontroller converts the analog output into digital and provides a high and low voltage. A crystal oscillator with 12MHz is used which provides the microcontroller with frequency clock pulse. Two 33pF capacitors are used along with the oscillator. The high or low voltage is then passed to an NPN transistor which gives the output which is further sent to relays. Relays used have internal magnetic field. They act as an ON-OFF switch. One relay acts as play button and the other as forward , for the 3rd flex sensor to act the forward relay will be forwarded 2 times and then played and similarly others will operate. The message is now forwarded to voice recorder ISD1720 which has mike and speaker connected to it. Electrolytic and ceramic capacitors are used which removes the ripples and cancels noise. An RF circuit is used which provides automatic gain control which gives constant output. The voice can be recorded through mike and according to the flex deflected the output is received from loudspeaker. Their circuit diagram shows the capability to measure or translate 7 potentials sign language ―Word A, B, C, D, F, K and number '8'.

3. HARDWARE IMPLEMENT

The block diagram represents the complete architecture of Smart Gloves for Disable People where it include components such as Flex Sensors, Arduino Mega, 16*2 LCD Screen, APR33A3 Voice Playback module, Transmitter, Receiver with Electronic Switches. The Arduino Mega Microcontroller Board is the heart of smart gloves device, it has interfaced with flex sensor, voice module, transmitter, and LCD screen. This whole assembly works on voltage of 5 volts and 9 volts supplied by power supply block.

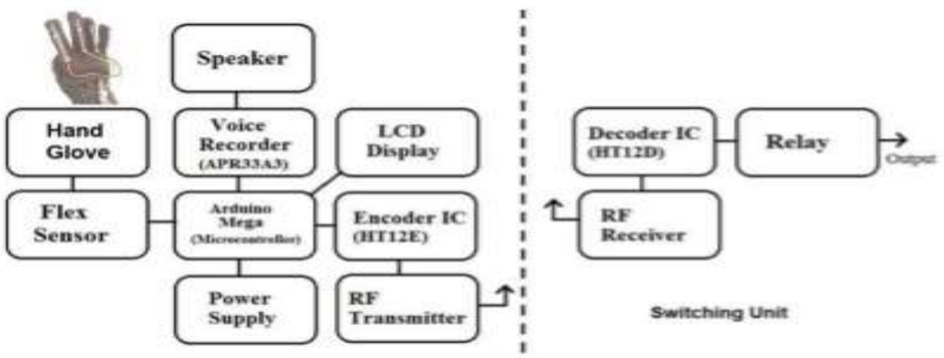

Fig 1. Block diagram of smart glove

3.1 Arduino UNO

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. The Arduino Uno is a microcontroller board based on the ATmega328, which is shown in the figure below. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm centre-positive plug into the board's power jack. Leads from a battery can be inserted in the Ground and VIN pin headers of the POWER connector. It is a microcontroller board developed by Arduino.cc and supported Atmega328. Electronic devices are becoming compact, flexible and cheap that are capable of doing more function as compared to their predecessors that happened to cover more space, turned out costly with the ability to perform fewer functions. 6Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using TX and Rx pins. The ATmega328 on the Arduino Uno comes preprogramed with a boot loader that allows uploading new code to it without the use of an external hardware programmer and programmed as a USB-to-serial converter.

Fig 2. Arduino board

- ❖ The main features of Arduino and Microcontroller

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
DC Current per I/O Pin	40 mA

Table-1 Features of arduino and microcontroller

3.2 Flex sensor

The flex sensors also referred as the bend sensor is a type of sensor that measures the amount of bending or deflection or flexing as the name itself has it. As the sensors are bent the sensors provides us with an electrical resistance value, the sensor gives so the more the sensors are bent, more resistance value. When measured with a multi meter, the flex sensor at a flat and steady position gives a resistance value near to 25k ohm whereas when the sensors are fully bent they give a resistance value near to 72k ohm. They are usually in the form of a thin strip, are very comfortable to use, as they are very light in weight, and are easily bent. One side of the sensor is printed with a polymer ink that has conductive particles embedded on it, and note that the fl ex sensors gives a proper change in resistance value only when it is bent away from the ink like and provides very minimum change in resistance value when it is bent in the reverse direction.

Fig 3. Flex sensor

3.3 Pulse sensor

The pulse sensor module includes a lightweight that helps in measurement the heart beat rate. When we place the finger on the heart beat device, the light reflected can modification supported the quantity of blood within the capillary blood vessels. During a heartbeat, the volume inside the capillary blood vessels will be high. This affects the reflection of light and the light reflected at the time of a heartbeat will be less compared to that of the time during which there is no heartbeat. This variation in lightweight transmission and reflection are often obtained as a pulse from the output of pulse device. This pulse can be then conditioned to measure heartbeat and then programmed accordingly to read as heartbeat count. The Pulse Sensor can be connected to arduino .The front of the sensor is that the pretty aspect with the heart logo. This is the side that makes contact with the skin. On the front you see a little round hole, which is where the LED shines through from the back, and there is also a little square just under the LED. The square is associate close light-weight sensing element, precisely just like the one utilized in cell phones, tablets, and laptops, to regulate the screen brightness in several lightweight conditions. The LED shines light into the fingertip and sensor reads the light that bounces back. The back of the device is wherever the rest of the components area unit mounted.

Fig 4. Pulse sensor

3.4 LCD display

LCD (Liquid Crystal Display) screen is associate electronic display module and realize a large range of applications. A 16x2 LCD display is extremely basic module and is extremely normally utilized in various devices and circuits. LCD screen works on the principle of blocking light rather than emitting light .It is a combination of two states of matter Solid and liquid .Light is projected from a lens on a layer of liquid crystal. The passive matrix LCD has grid of conductors with Pixels located at each junction in the lattice. A current is sent across two conductor on the lattice control the light for any pixel. It make a small identification and do away with potentiometer that normally required to adjust the screen contrast .As a Substitute use one of arduino PWM output smoothed by a capacitor to create a simple digital to analog output which allows to control the screen contrast digitally from within our program .Pin 9 is used as the PWM output and it is connects to the V0contrast pin on the LCD. The contrast pin on the LCD requires small voltage for ideal display condition. Lower voltage and high contrast should be reversed. A voltage approximately 0.5-1v but it depends on the ambient temperature. If set the PWM output initially to 50 to give a value approximating 1v. If increases or decrease to get the correct contrast on your LCD. If able to control the contrast manually then the addition of two push buttons and a bit more coding would allow increase and decrease the contrast.

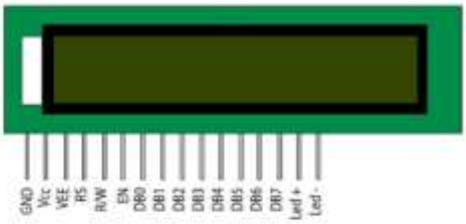

Fig 5. LCD Display

3.5 Recorder and voice playback system

This voice recorder and playback system built around a recording and playback chip that supports voice recording for 16 to 30 seconds and reproduce it clearly it consist of dynamic recording and playback buttons.

This can be interfaced with any micro controller and the audio output to drive a speaker.

Fig 6. Speaker

3.6 Block diagram of voice playback system

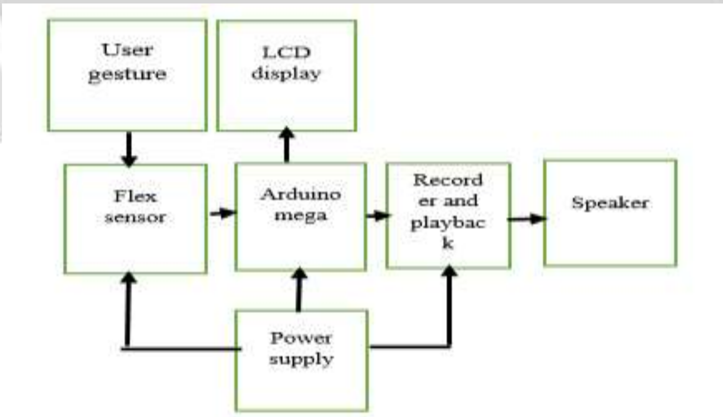

Fig 7. Block diagram playback system

This is the block diagram of audio and playback system. Flex sensor is connected to the arduino mega microcontroller. An LCD display is interfaced with the microcontroller. The data from arduino is given to the recorder and playback system. Also a speaker is connected to the recorder and playback system.

A 5v power is given to the sensor and a 9v power is given to the recorder and playback system.

3.7 Power supply

A power supply is an electrical device that supplies electric power to an electric load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. Power supply is essential for the working of smart glove. The flex sensor and Arduino Mega reed 5v and the recorder and playback system need 9v power.

Fig 8. Power supply

4. DESIGN IMPLEMENTATION

The work of this paper start from movement of hand gloves where the flex sensors are attached, and the value of sensor changes when its experiences the bending. The flex sensor is another type of potentiometer are attach to the fingers when we bend the figure the value of the sensor get changes. The changing value of the sensor is depend upon the resistance and applied angle of the bending when we bend the sensor at some particular angle we can see the value of the resistance is increase and accordingly the output get reduced. On the other way we can say that it's like an inversely proportional when the resistance of the sensor is increase at that instant the value of output decrease and accordingly we can make this by getting the advantage of this process. After looking at the changing value of the output, the value of the get recorded by the arduino and show from the display attached to it. Here the process gets started the arduino gets different value from the sensor. The output value we can continuously see from the LCD which attached to it.

When system get ON, it stays initially in Mode 0 where glove give status about user; his finger sensor value and position of palm and all these get displays on LCD Screen Attached to it. The user can generate different gesture and user can change Mode by particular patterns as coded. According the programming we have made there are three modes and modes are change when all the sensor give low output. Here we are trying to create the project such that it can work in the two different applications.

In this stage, user can use feature of Voice and Playback by generating desired gestures then recorded voice can be played. When the mode gets activated, the sensor gives some value to the Arduino and according to the programming the signal passes from the Arduino to the voice and playback recorder (APR33A3). The recorder check which port or section is active at that time and sound which already recorded in the recorder it play. The sound we hear from the speaker which attached to the recorder.

In this last stage a user can control the home appliances where we deal with the major part of the project. Here the output of the sensor is recorded to the Arduino and this value is matched with the programming by the Arduino. The Arduino check the value and matched us the programming and the output we can see from the LCD attached to the Arduino. The output value is send to the transmitter for transmit the data. The transmitter is attached with IC HT12E which encodes the data and finally sends from the antenna. At Receiver end the data get decode with the IC HT12D and send to the relay for switching purpose. The relay we use only for switching purpose which use to ON or OFF the switch.

5. SIGN LANGUAGE RECOGNITION

Sign language is a visual–spatial language based on positional and visual components, such as the shape of fingers and hands, the location and orientation of the hands, and arm and body movements. These components are used together to convey the meaning of an idea. The phonological structure of SL generally has five elements. Each gesture in sign language is a combination of five building blocks. These five elements represent the valuable elements of SL and can be exploited by automated intelligent systems for SL recognition (SLR). The 5 main sign language elements are given below,

- Articulation point
    - Fingers joint
    - Wrist joint
- Hands configuration
    - Finger bend
    - Palm bend
- Movements type
    - Forward
    - Backward
    - Left
    - Right
- Hands orientation
    - Palm up
    - Palm down
    - Palm inward
    - Palm sloping
- Facial expressions
    - Happy face
    - Lip movement
    - Head shaking

Scholarly interventions to overcome disability-related difficulties are multiple and systematic and vary according to the context. One of the important interventions is SLR systems that are utilized to translate the signs of SL into text or speech to establish communication with individuals who do not know these signs. SLR systems based on the sensory glove are among the most significant endeavours aimed at procuring data for the motion of human hands. Three approaches, namely, vision based, sensor-based, and a combination of the two, are adopted to capture hand configurations and recognize the corresponding meanings of gestures.

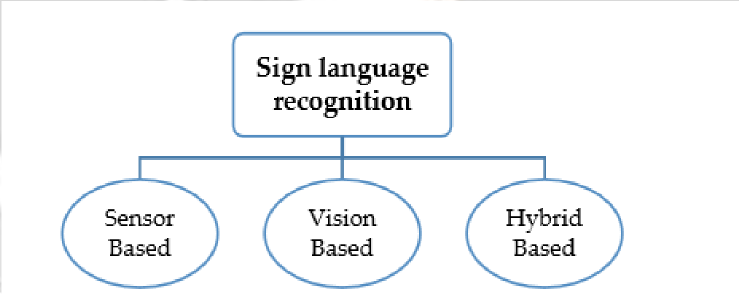

Fig 9. Sign language recognition approaches

Vision-based systems use cameras as primary tools to obtain the necessary input data. The main advantage of using a camera is that it removes the need for sensors in sensory gloves and reduces the building costs of the system. Cameras are quite cheap, and most laptops use a high specification camera because of the blur caused by a web camera. However, despite the high specification camera, which most smartphones possess, there are various problems such as the limited field of view of the capturing device, high computational costs and the need for multiple cameras to obtain robust results (due to problems of depth and occlusion these issues are inherent to this system and render the entire system futile for the development of real-time recognition applications. In two new feature extraction techniques of Combined Orientation Histogram and Statistical (COHST) Features and Wavelet Features are presented for the recognition of static signs of numbers 0 to 9, of American Sign Language (ASL). System performance is measured by extracting four different features—Orientation Histogram, Statistical Measures, COHST Features, and Wavelet Features—using a neural network. The best performance of the system reaches 98.17% accuracy with Wavelet features. In a system using Wavelet transform and neural networks (NN) is presented to recognize the static gestures of alphabets in Persian sign language (PSL). It is able to recognize 32 selected PSL alphabets with an average recognition rate of 94.06%. In [30], ASL recognition is performed using Hough transform and neural NN. Here, only 20 different signs of alphabets and numbers were used. The performance of the system was measured by varying the threshold level for canny edge detection and the number of samples for each sign used. The average recognition rate obtained was 92.3% for the threshold value of 0.25. In a vision-based system with B-Spline Approximation and a support vector machines (SVM) classifier were used for the recognition of Indian Sign Language Alphabets and Numerals. Fifty samples of each alphabet from A–Z and numbers from 0–5 were used, and the system achieved an average accuracy of 90% and 92% for alphabets and numbers, respectively. In a 3D model of the hand posture is generated from two 2D images from two perspectives that are weighted and linearly combined to produce single 3D features aimed at classifying 50 isolated ArsL words using a Hybrid pulse-coupled neural network (PCNN) as the feature generator technique, followed by nondeterministic finite automaton (NFA). Then, the ‘‘best-match” algorithm is used to find the most probable meaning of a gesture. The recognition accuracy reaches 96%. In a combination of local binary patterns (LBP) and principal component analysis (PCA) is used to extract features that are fed into a Hidden Markov Model (HMM) to recognize a lexicon of 23 isolated ArSL words. Occlusion is not resolved, as any occlusion states are handled as one object, and recognition is carried out. The system achieves a recognition rate of 99.97% in signer-dependent mode. A dynamic skin detector based on the face colour tone is used in for hand segmentation. Then, a skin-blob tracking technique is used to identify and track the hands. A dataset of 30 isolated words is used. The proposed system has a recognition rate of 97%. Different transformation techniques (viz. Fourier, Hartley, and Log-Gabor transforms) were used in for the extraction and description of features from an accumulation of sign frames into a single image of an Arabic Sign language dataset. Three transformation techniques were applied in total, as well as slices from an accumulation of sign frames. The system was tested using three classifiers: knearest neighbour (KNN), SVM, and. Overall, the system’s accuracy reached over 98% for Hartley transform, which is comparable with other works using the same dataset.

The second method is the use of a certain type of instrumented gloves that are fitted with various sensors, namely, flexion (or bend) sensors, accelerometers (ACCs), proximity sensors, and abduction sensors, is an alternative approach with which to acquire gesture-related data. These sensors are used to measure the bend angles for fingers, the abduction between fingers, and the orientation (roll, pitch, and yaw) of the wrist. Degrees of freedom (DoF) that can be realized using such gloves vary from 5 to 22, depending on the number of sensors embedded in the glove. A major advantage of glove-based systems over vision-based systems is that gloves can directly report relevant and required data (degree of bend, pitch, etc.) in terms of voltage values to the computing device thus eliminating the need to process raw data into meaningful values. By contrast, vision-based systems need to apply specific tracking and feature extraction algorithms to raw video streams, thereby increasing the computational overhead.

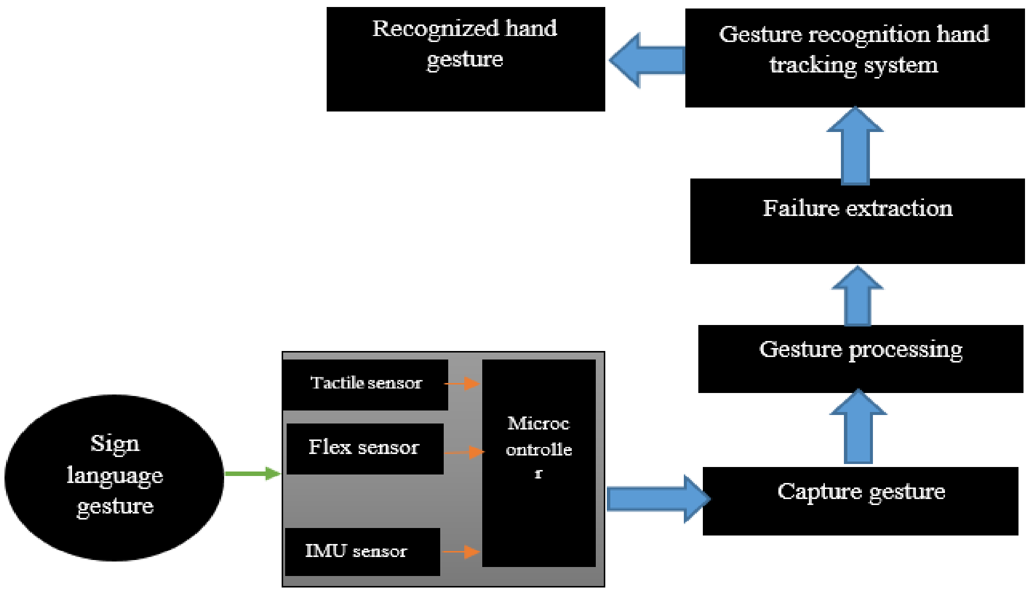

Fig 10. Collecting and recognizing SL gestures data using the glove based system

The third method of collecting raw gesture data employs a hybrid approach that combines glove- and camera-based systems. This approach uses mutual error elimination to enhance the overall accuracy and precision. However, not much work has been carried out in this direction due to the cost and computational overheads of the entire setup. Nevertheless, augmented reality systems produce promising results when used with hybrid tracking methodology.

6. MATERIALS AND METHODS

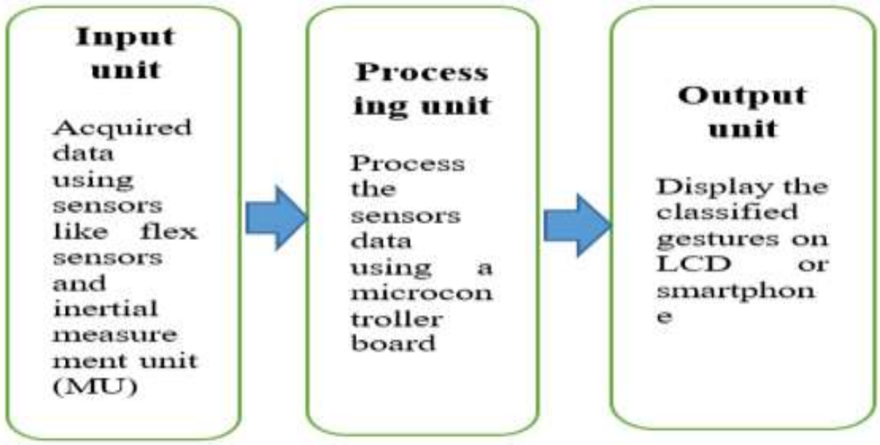

Fig 11. The main hardware components of the glove- based system

6.1 Input unit

The input unit consist of the flex sensors the sensors have attracted attention, which have resulted in investments in sensor features in many small and large applications. The sensor is the main player in measuring hand data in terms of bending (shape), movement, rotation, and position of the hand.

6.2 Processing unit

The microcontroller is the system's mind that is accountable for gathering the data from the sensors provided by the glove and performing the required processing of these data to recognize and transfer the sign to the output port to be presented in the final stage.

6.3 Output unit

Customarily, a user interacts with the device through output devices, so the output devices play an important role in achieving the best performance of devices implemented in the field of SLR. The main device adopted by researchers as the output was the screen of computer. Other devices attracting the attention of researchers are the liquid-crystal display (LCD) speaker or both. Ultimately, the smartphone is another alternative chosen for system output.

7. CONCLUSION

The no. of disabled people like deaf and dumb are increasing day by day and it is found that the device used to assist them are very expensive and not much effective for all. Most of them can't afford the price so they spend their whole life in a single room. This product is very cost effective and user friendly and the main advantage of this product is the device is portable that means they can go anywhere and communicate with others easily. So the device help them to live a free life in the society without the help of a third person. This device is very helpful for both deaf-dumb and physically disabled people. By introducing the Smart Hand Gloves for Disable People, It will provide the more reliable, efficient, easy to use and light weight solution to user as compare to other proposed papers. This will responsible to create meaning to lives of Disable People.

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