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Smart Gloves for Deaf and Dumb Students

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Abstract: - The main objective of this project is to reduce communication barrier between normal people and special person who are not able to make a normal conversation be it a disabled one or dumb and deaf or palsied or any foreigner etc. As human Beings communicate and know each other through thoughts and ideas. The best way to present your idea is through speech. But some people don't have the power of speech; the only way to communicate with others is through sign language. The problem with sign language is that it is confined to the people who are also deprived of the power of speech. These people are often termed as deaf and dumb. We can say that it is limited to the same set of persons that cannot speak. So, there is a need of technology which reduces this gap through systems that converts sign language into speech.

Key Words: — ***Architectural Design, UML Design, WB Structure, Risk Management, Project Design, Software.***

I. Introduction

A. Motivation

Communication between speakers and non-speakers i.e. dumb and deaf people can be problematic, inconvenient etc. This project attempts to bridge the communication gap by designing a portable glove that captures the user's gestures and outputs the translated text on a device. The glove is equipped with flex sensors, to measure the flexion of the fingers, and the contact between fingers. The glove's Raspberry Pi microcontroller analyses the sensor readings to identify the gesture from a library of learned gestures. So, we are going to design and built a glove to be worn on the right hand that translate sign language into spoken English. Every person's hand is a unique size and shape, and we aimed to create a device that could provide reliable translations regardless of those differences. Our device uses five Spectra Symbol Flex-Sensors that we use to quantify how much each finger is bent. These sensors are read, averaged, and arranged into packets using a Raspberry-pi microcontroller. These packets are then sent serially to a Raspberry-pi to be run in conjunction with a Python script. The user creates data sets of information from the glove for each gesture that should eventually be translated, and the algorithm trains over these datasets to predict later at runtime what a user is signing.

B. Background

Research in the sign language system has two well-known approaches are image processing and data Glove. The image processing technique using the camera to capture the image/video. Analysis the data with static images and recognize the image using algorithms and produce sentences in the display, vision based sign language recognition system mainly follows the algorithms are Hidden Markov Mode (HMM), Artificial Neural Networks (ANN) and Sum of Absolute Difference (SAD) algorithm use to extract the image and eliminate the unwanted background noise. Human-machine interactions are through keyboard, mouse and remote infrared control. Advances in surgical technology, assessment tool based on the Body Sensor Network (BSN). It provides an accurate wireless gesture sensing.

C. Need

There is no evidence that the glove was developed further than the class project. This project is not on the market as a purchasable product, but is a good example of machine learning for gesture recognition. The problem with sign language is that it is confined to the people who are also deprived of the power of speech. These people are often termed as deaf and dumb or disabled. We can say that it is limited to the same set of persons that cannot speak. So, there is a need of technology which reduces this gap through systems that converts sign language into speech. It is specially targeted for students those with special needs who cannot speak, but can certainly be generalized to gesture recognition, not just signing. The labels for each dataset need not be converted to speech, and can be used as a "command" for other interfaces, such as interactive computing spaces or games.

II. Literature Survey

A. Existing System

Hand gesture recognition and voice conversion system for dumb people in our country around 2.78% of peoples are not able to speak (dumb). Their communications with others are only using the motion of their hands and expressions.

Therefore, we proposed a new technique called artificial speaking mouth for dumb people. It will be very helpful to them for conveying their thoughts to others. Some peoples are easily able to get the information from their motions. The remaining is not able to understand their way of conveying the message. To overcome the complexity, the artificial mouth is introduced for the dumb peoples. This system is based on the motion sensor. Per dumb people, for every motion they have a meaning. That message is kept in a database. Likewise, all templates are kept in the database. In the real time the template database is fed into a microcontroller and the motion sensor is fixed in their hand. For every action the motion sensors get accelerated and give the signal to the microcontroller. The microcontroller matches the motion with the database and produces the speech signal. The output of the system is using the speaker. By properly updating the database the dumb will speak like a normal person using the artificial mouth. The system also includes a text to speech conversion (TTS) block that interprets the matched gestures.

B. Description

The communication between a dumb and hearing person poses to be an important disadvantage compared to communication be-tween blind and ancient visual people. This creates an extremely little house for them with communication being associate degree elementary aspect of human life. The blind people can speak freely by implies that of ancient language whereas the dumb have their own manual-visual language referred to as language. Language is also a non-verbal form of intercourse that's found among deaf communities at intervals the planet. The languages haven't got a typical origin and thence hard to interpret. A Dumb communication interpreter is also a tool that interprets the hand gestures to sensibility speech.

A gesture in associate degree extremely language is also a certain movement of the hands with a particular kind created out of them. Facial expressions collectively count toward the gesture, at constant time. A posture on the other hand is also a static variety of the hand to purpose an emblem. Gesture recognition is classed into a pair of main categories: vision based mostly and detector based. The disadvantage of vision based totally techniques includes advanced algorithms for process. Another challenge in image and video method includes varied lighting conditions, backgrounds and field of scan constraints and occlusion. The detector based totally technique provides larger quality.

The primary aim of this paper is to introduce an issue that will efficiently translate language gestures to every text and sensibility voice. The interpreter makes use of a glove based totally technique comprising of flex detector, instrument sensors. For each hand gesture created, a symptom is formed by the sensors appreciate the hand sign the controller matches the gesture with pre-stored inputs. The device not exclusively interprets alphabets but cans even sort words exploitation created gestures. A training mode is gettable on the device therefore it fits every user and accuracy is inflated. The device will even be able to translate larger gestures that require single hand movement. Gesture recognition implies a method by that knowledge is collected from parts of the physical body (usually the hand) and processed to work out attributes like hand form, direction and speed of gesture being performed.

C. Advantages

- Great utility
- Useful for speech impaired and paralyzed patients
- Facilitates effective real-time communication

D. Disadvantage

- Processing of system may be slow
- Cannot express facial expressions

III. Detailed Methodology Of Solving The Identified Problem With Action Plan

A. Project Modules

“A glove that helps people with hearing disabilities by identifying and translating the user's signs into spoken English." We designed and built a glove to be worn on the right hand that uses a Python script to translate sign language into spoken English. Every person's hand is a unique size and shape, and we aimed to create a device that could provide reliable translations regardless of those differences. Our device uses four Spectra Symbol Flex-Sensors that we use to quantify how much each finger is bent, and the MPU-6050 (a three-axis accelerometer and gyroscope) can detect the orientation and rotational movement of the hand. These sensors are read, averaged, and arranged into packets using a Raspberry-pi microcontroller. The user creates data sets of information from the glove for each gesture that should eventually be translated, and the algorithm trains over these datasets to predict later at runtime what a user is signing. Then the respective letter is gets displayed on screen and further the text is converted into audio using speak library in python.

Our goal is to create a way for the speech-impaired to be able to communicate with the public more easily. With a variety of sensors, we quantify the state of the right hand in a series of numerical data. By collecting a moderate amount of this data

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for each letter or word and feeding it into an algorithm, it can train over this dataset and learn to associate a given hand gesture with its corresponding sign. We use Flex Sensors as variable resistors to detect how much each finger is bent, and the MPU- 6050 can identify the orientation and hand movements that the Flex sensors cannot capture.

Moreover, to discern between extremely similar signs, we add contact sensors to the glove to gather additional information Each Flex Sensor is treated as a variable resistor whose resistance increases as the sensor is bent. The MPU-6050 uses an SPI interface to communicate with the Raspberry-pi, and uses the dedicated SDA bus to send the accelerometer and gyroscope data to the Raspberry-pi when desired. Moreover, contact sensors in the form of copper tape are used to create a binary input value to the RASPBERRY-PI to represent any contact or lack thereof. At regular intervals (as often as possible), the RASPBERRY-PI gather the data it has read into a packet, and send the packet and convert it into text and speech. The python algorithm is composed to handle communications with the glove, a script that gathers data and stores it in a data structure, a script that performs the learning and prediction, and a few scripts that help to visualize sensor and classification data as well as some troubleshooting. Overall, the python software is in charge of gathering the data from the RASPBERRY-PI and learning the required classification.

B. Architectural Design

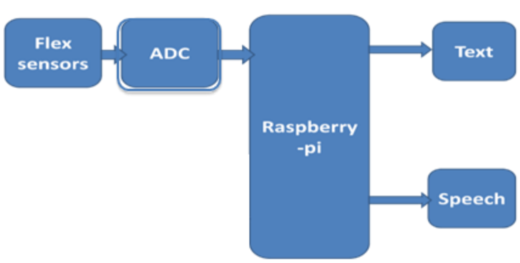

Fig 3.1. Architectural Design of Modal setup

C. UML Designs

Data Flow Diagram [DFD]:

DFD 0:

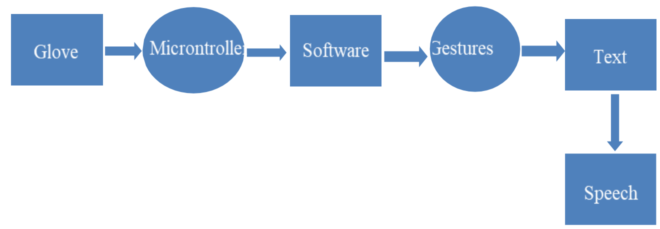

Fig 3.2. DFD Level 0 Diagram

DFD 1:

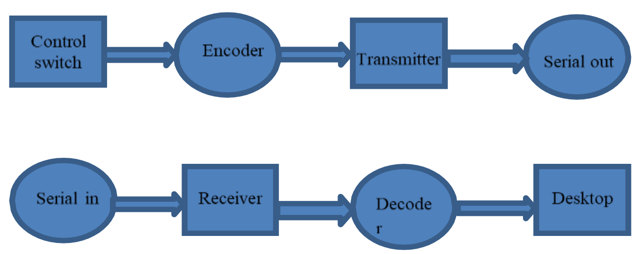

Fig 3.3. DFD Level 1 Diagram

Use Case:

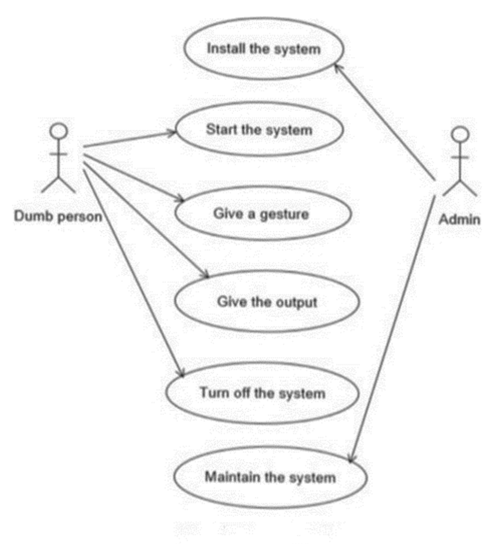

Fig 3.4. Use Case Diagram

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Activity Diagram [Indicating Flow]:

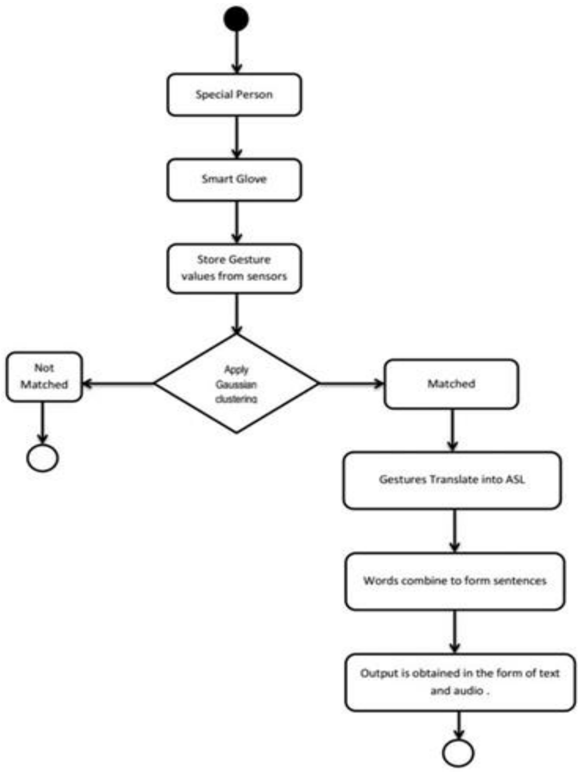

Fig 3.5. Activity Flow Diagram

Sequence Diagram:

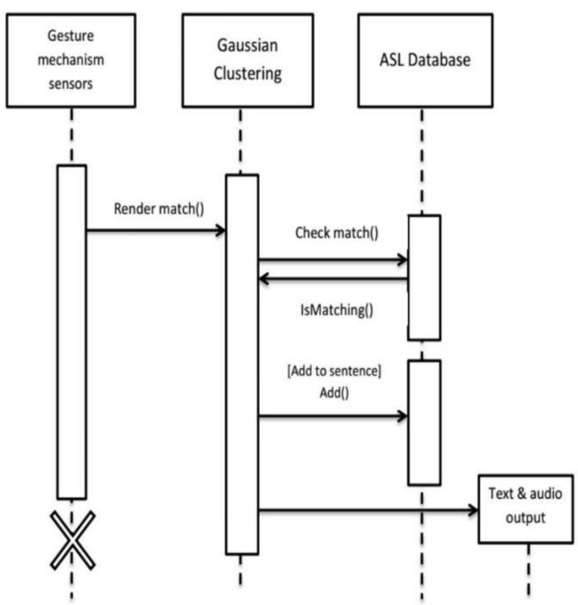

Fig 3.6. Sequence Diagram

Project Schedule:

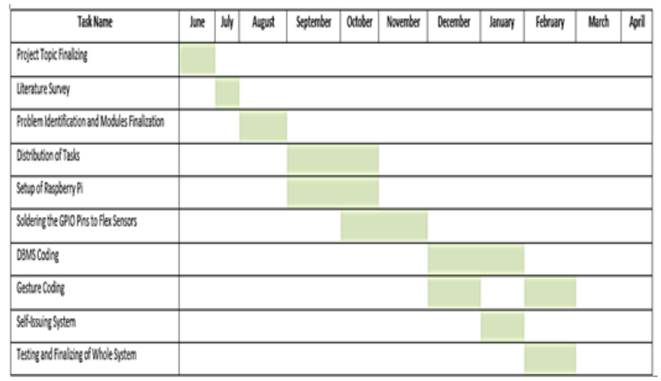

Fig 3.7. Project Schedule Diagram

IV. METHODOLOGY

Rationally, the normal approach of software development will not help us to complete the whole concept project in just 5 to 6 months as it has 2 major components that is the hardware and software side which is all full-fledged project. So, we managed to adopt the pre-defined proper WBS and with appropriate risk management we were able to complete our project. Following is the explanation of the methods we used.

Work Breakdown Structure, whose abbreviation is WBS, is a common productivity technique used to make the work more manageable and approachable.

A. WBS Method

The Work Breakdown Structure (WBS) is the tool that utilizes this technique and is one of the most important project management documents. It singlehandedly integrates scope, cost and schedule baselines ensuring that project plans are in alignment. Project Management Book of Knowledge (PMBOK) defines the Work Breakdown Structure as a “deliverable oriented hierarchical decomposition of the work to be executed by the project team.”

There are two types of WBS:

- Deliverable-Based
- Phase-Based.

The most common and preferred approach is the Deliverable-Based approach. The main difference between the two approaches are the Elements identified in the first Level of the WBS.

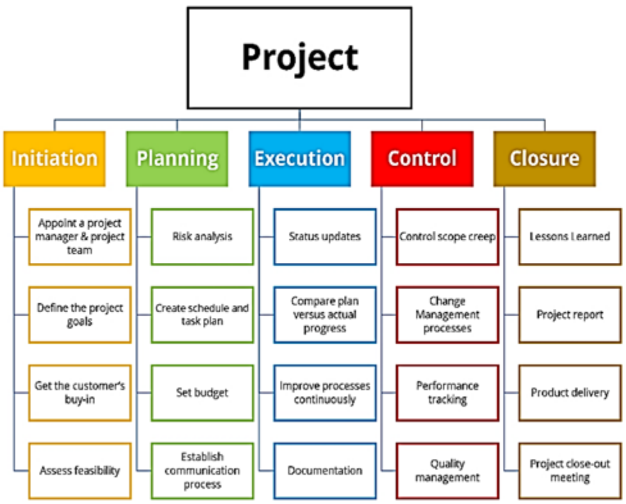

Fig 4.1. Work Based Structure for a Project Lifecycle

WBS is a hierarchical representation of the elements (tasks) that comprise a project. Creating a Work Breakdown Structure does just as the name implies, breaking down the work into smaller chunks that everyone can chew. A project seems very overwhelming at first, and the WBS helps stop these feelings. A quick glance at the WBS allows everyone on the project team to see what has been done, and what needs to be done. The WBS is a very important part of project management for this very reason.

A good Work Breakdown Structure is created using an iterative process by following these steps and meeting these guidelines:

Gather Critical Documents:

- Gather critical project documents.
- Identify content containing project deliverables, such as the Project Charter, Scope Statement and Project Management Plan (PMP) subsidiary plans.

Identify Key Team Members:

- Identify the appropriate project team members.
- Analyze the documents and identify the deliverables.

Define Level 1 Elements:

- Define the Level 1 Elements. Level 1 Elements are summary deliverable descriptions that must capture 100% of the project scope.
- Verify 100% of scope is captured. This requirement is commonly referred to as the 100% Rule.

Decompose(Breakdown) Elements:

- Begin the process of breaking the Level 1 deliverables into unique lower Level deliverables. This "breaking down" technique is called Decomposition.
- Continue breaking down the work until the work covered in each Element is managed by a single individual or organization. Ensure that all Elements are mutually exclusive.

Create WBS Dictionary:

- Define the content of the WBS Dictionary. The WBS Dictionary is a narrative description of the work covered in each Element in the WBS. The lowest Level Elements in the WBS are called Work Packages.
- Create the WBS Dictionary descriptions at the Work Package Level with detail enough to ensure that 100% of the project scope is covered. The descriptions should include information such as, boundaries, milestones, risks, owner, costs, etc.

Create Gantt Chart Schedule:

- Decompose the Work Packages to activities as appropriate.
- Export or enter the Work Breakdown Structure into a Gantt chart for further scheduling and project tracking.

B. Risk Management

What is Risk?

Risk is future uncertain event or condition with a probability of occurrence and a potential for loss. Risk identification and management are the main concerns in every software project. The likelihood that a project will fail to meet its objectives. Effective analysis of software risks will help to effective planning and assignments of work.

Categories of risks:

Schedule Risk:

Schedule risk is the prospect of failing to meet schedule plans and the effect of that failure. Uncertainty introduces the element of risk into the planning process. Schedule risks mainly effect on project and finally on company economy and may lead to project failure.

Schedules often slip due to following reasons:

- Assigning the wrong resources,
- Making sequence mistakes
- Failure to baseline your schedules.

Budget Risk:

- Uncertainty Management,
- Estimation Errors,
- Uncontrolled Scope Changes,
- Project Performance Failures,
- Errors in Project Design.

Operational Risks:

Risks of loss due to improper process implementation, failed system or some external events risks.

Causes of Operational risks:

- Loss due to errors,
- Interruptions or damages—either intentional or accidental caused by people,
- Insufficient resources
- No proper subject training
- No resource planning
- Lack of communication in the team.

Technical risks:

Technical risks generally lead to failure of functionality and performance.

Causes of technical risks are:

- Continuous changing requirements
- No advanced technology available or the existing technology is in initial stages.
- Product is complex to implement.
- Difficult project modules integration

Programmatic Risks:

These are the external risks beyond the operational limits. These are all uncertain risks are outside the control of the program.

- Running out of fund.
- Market development
- Changing customer product strategy and priority.

Now that we have all the activities and risk defined and broken down into tasks, you next have to determine the time and effort it will take to complete them. This is an essential piece of the equation to calculate the correct schedule.

V. Details Of Designs Working And Processes

A. Project design

The main objective of this project is to let disabled patient or student communicate within not only themselves but also with normal patient or student. So by designing a smart glove using various components we are at least able to help them communicate.

Design of our project is very simple. It requires very cheap component for implementation such as: Raspberry pi 3 modal b, controller, Flex sensors and audio speaker. But first we must select a suitable sign language for this project. Different countries have their own sign language but English sign language is considered as universal language. So, we can make use of English sign language for all alphabets to convert them into various gesture for all alphabets in English sign language.

We have ‘Gesture’ as key thing in our project. Sensors in the glove pick up gestures and are proceed in controller to a form word. Then word is transmitted to Raspberry pi which runs text to speech software developed using python. The sensor data are converted into text and then to voice output. This illustrated in block diagram of project.

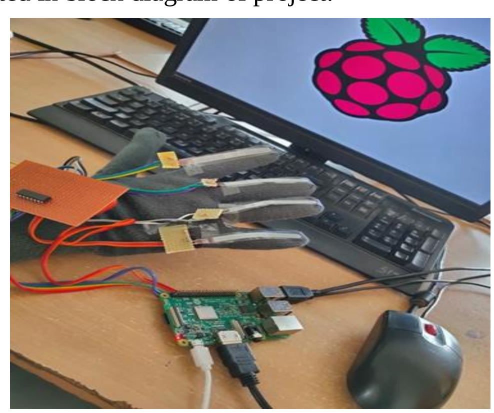

Fig 5.1. Final Components Used for Modal

B. Components Used:

Raspberry Pi 3 Model B:

The Raspberry Pi 3 Model B is the third-generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B. While maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processor, 10x faster than the first-generation Raspberry Pi.

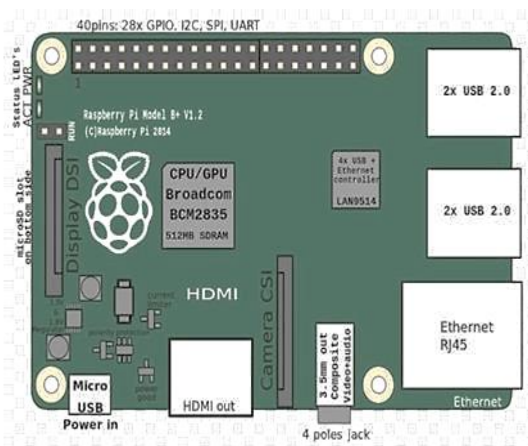

Fig. 5.2. Raspberry Pi 3 block diagram

Additionally, it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs.

- CPU: Pi 3 A+: 1.4 GHz quad-core A53 64-bit; Pi ...
- Graphics: Pi 3 A+: Broadcom Video Core IV 400 ...
- System on a chip: Pi 3 A+: Broadcom BCM283...
- Power: 5 V; 3 A (for full power delivery to USB).

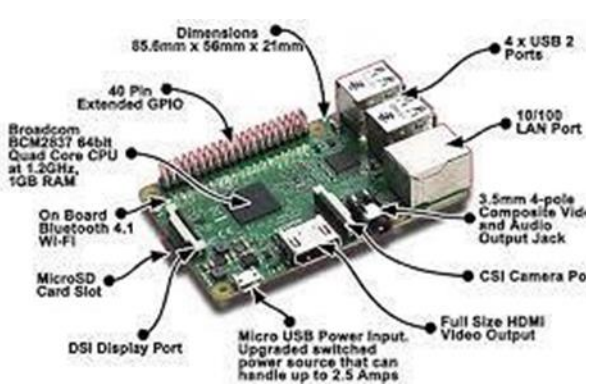

Fig 5.3. Raspberry Pi 3 Model B

2.2" SEN 10264 Flex Sensor:

Fig 5.4. 2.2" SEN 10264 Flex Sensor

Flex sensors known as bend sensors are nothing but a variable resistance sensor. They vary depending upon the bend i.e. the resistance of the flex sensor changes when the metal pads are on the outside of the bend (text on inside of bend). Flex sensors are reliable, accurate, versatile and cost effective.

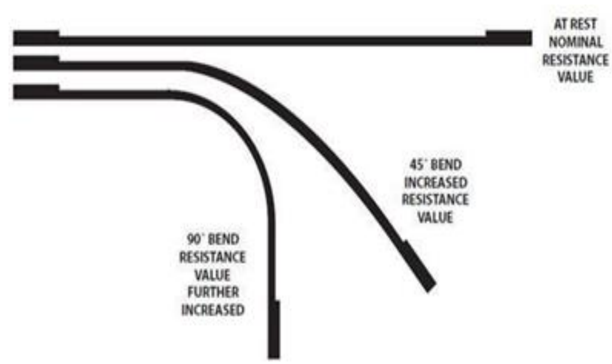

Fig. 5.5. Flex Sensor and its Bending

It offers best solution for application that needs accurate measurement and sensing of deflection, acceleration, and range of motion and hence it is used in this project. The flex sensors are placed over the finger portion of the glove. It is single, thin flexible plastic coated with a proprietary carbon/polymer. Connector is 0.1" spaced and bread board friendly. More the bend in the sensor more is the resistance value.

MCP:

As Raspberry Pi doesn't have the analog input pins which means that we cannot get the analog inputs with Raspberry Pi so, we overcame this problem by using the analog to digital converter i.e. MCP3008.

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Fig 5.6. MCP3008

Features:

- 10-bit resolution
- Eight single-ended channels
- SPI interface
- ±1 LSB DNL
- ±1 LSB INL
- 200 ksps sample rate at 5V

Peripheral Devices:

The Raspberry Pi comes without any peripheral input, output and storage devices but we can use any device by inserting them in empty slots like USB, HDMI, Audio pin etc. easily.

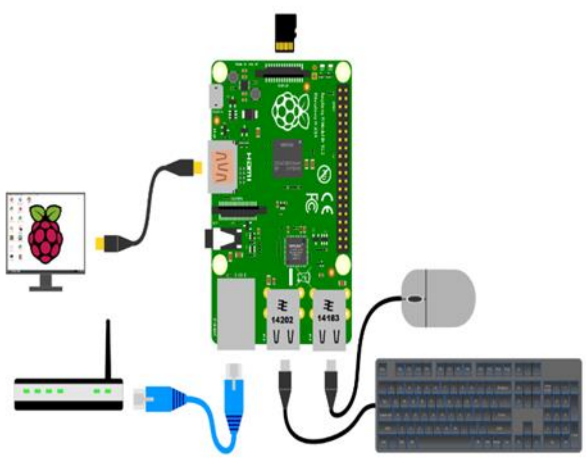

Fig .5.7. Block Diagram of Conations for Peripheral Devices

The devices which we used are:

- Keyboard (input device)
- Mouse (input device)
- Speaker/ headphone (output device)
- Monitor (output device)

C. Software

Now coming towards software which is again a major part of the project a brief explanation is given below about the software.

We designed and built a glove to be worn on the right hand that uses a Python script to translate sign language into spoken English. Every person's hand is a unique size and shape, and we aimed to create a device that could provide reliable translations regardless of those differences. Our device uses four Spectra Symbol Flex-Sensors that we use to quantify how much each finger is bent, and the MPU-6050 (a three-axis accelerometer and gyroscope) can detect the orientation and rotational movement of the hand. These sensors are read, averaged, and arranged into packets using a Raspberry-pi microcontroller. The user creates data sets of information from the glove for each gesture that should eventually be translated, and the algorithm trains over these datasets to predict later at runtime what a user is signing. Then the respective letter will get displayed on screen and further the text is converted into audio using espeak library in python.

Our software is designed in such a way that it enables anyone who knows the password of the Raspbian to access it whenever in need. As the python software is flexible and easy so any new functionalities can be implemented in the future as per requirements without much complications.

The implementation of our software is explained briefly below:

Software Implementation:

installing software's:

The Raspberry Pi's default operating system, the one it's designed to use, is Linux. Linux comes in several avers, or distributions: Ubuntu (one of the most popular), Debian, Mint, Red Hat, Fedora, and a few other, more obscure varieties. The Pi uses a version of Debian called, appropriately enough, Raspbian. Because the Pi doesn't have a hard drive, we must download and copy a disk image to an SD card. That image is what the Pi will use to boot, and it will also act as memory/RAM. As mentioned earlier, cards up to 32 GB have been tested; beyond that, your results may be kind of sketchy. It's recommended that you use a brand-name card, and it should be a class 4, which denotes for speed of the card.

Using the SD card:

The software was preinstalling in the SD card when it was bought via Flipkart. Then insert the installed card in raspberry SD card slot. That's it, now Pi is ready to boot for using the new software.

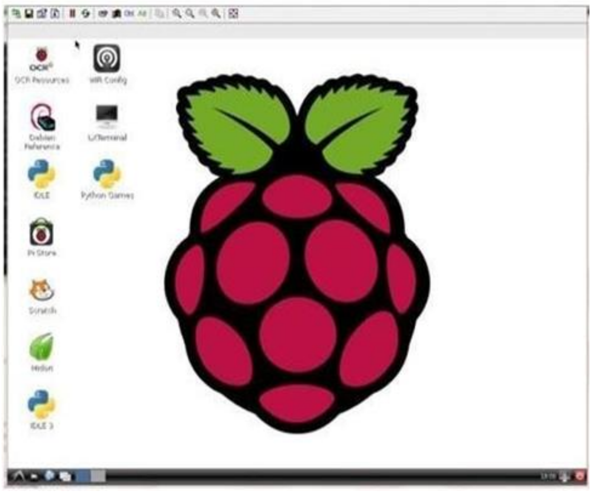

Fig 5.8. Desktop view of raspberry pi after powering it up

Connecting the Peripherals:

There's a preferred order to connecting the peripherals. Connecting power, the monitor, and the other parts in the wrong order could cause a voltage spike and fry your board. The order is as follows:

- Insert the SD card
- Connect the Monitor.
- Connect the USB peripherals (keyboard, mouse, and/or hub).
- Connect the Ethernet cable.
- Connect the power.

Some screenshots of demo project are as following:

Main Folder:

This is the main folder where all other sub-folders are saved or moved for our project.

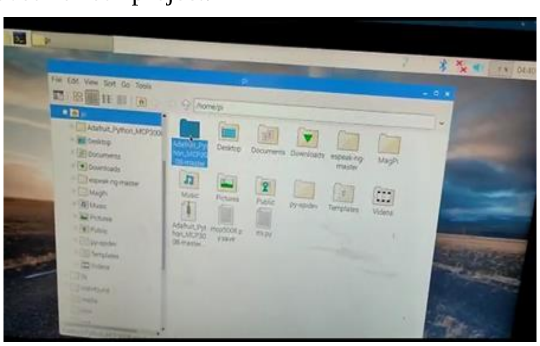

Fig 5.9. Main Folder

Subfolder: You can see all are code files in this subfolder that is named as examples.

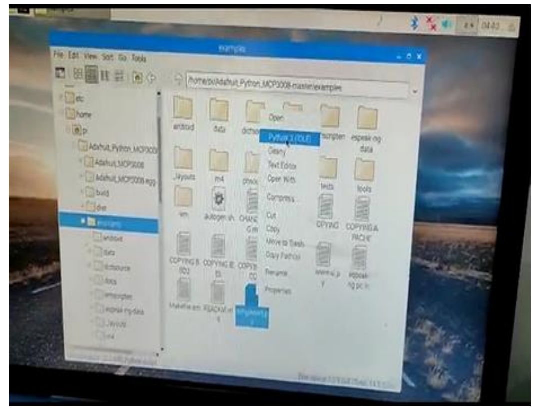

Fig 5.10. Subfolder

Python Code:

This is the main code of our project where all the interfacing can be done i.e. can get edited as wished. The python code is then run by pre-installed python3(IDLE) as shown in fig 5.11.

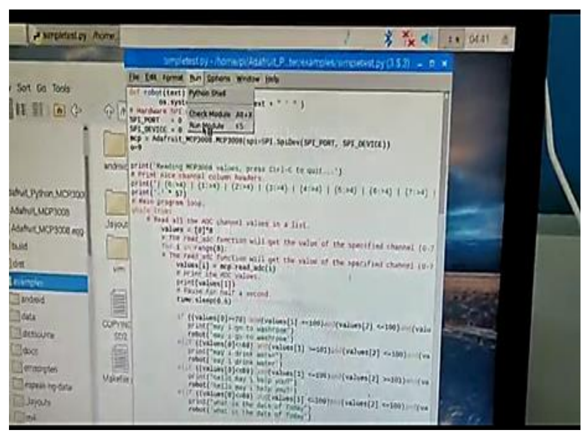

Fig 5.11. Python code

Bend testing:

We tested our sensors by trying to bend each of them at different angles. But came with the conclusion that the more we bend our flex, the more it gives us a validate text and soon that text gets converted into voice using espeak command.

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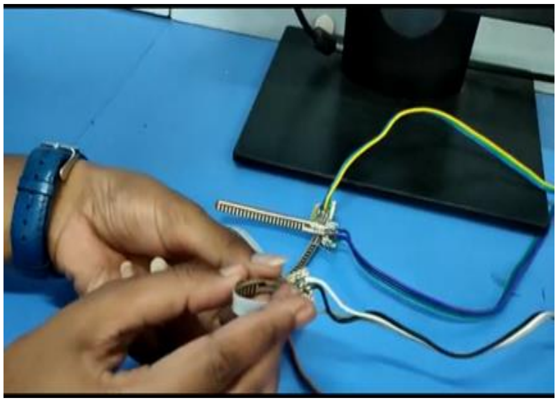

Fig 5.12. Testing of reliability of flex sensor

Output Message:

The output through which one is able to read what user want to communicate.

Fig 5.13. First Output After Bending of Sensor

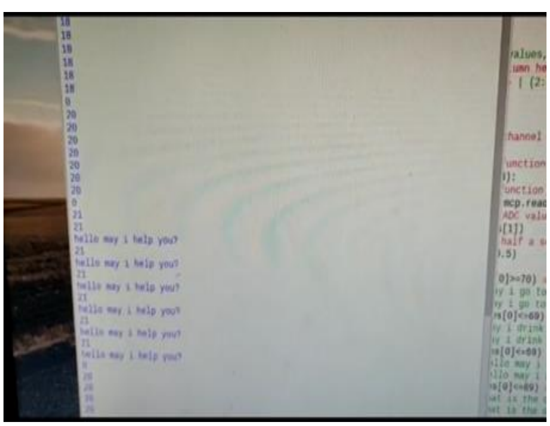

Fig 5.14. Second Output After Bending of Sensor

VI. Result And Applications

A. Result

This system is working as it was designed to work alongside the hardware and software we choose. The system will now be able to decrease ratio of Literacy and Employment of Deaf and Dumb population of students and people too.

B. Applications

- This project is useful for deaf and dumb people to communicate with normal people.
- This project is useful for deaf and dumb people to communicate with normal people.
- This project is portable. That is people with disabilities like hearing and speaking disability can carry this glove wherever they want to be.
- Robotics. It's a AI based model.
- Arts / Entertainments. Can be used for fun in schools for teaching various AI based activities.

C. Advantages

- Great utility
- Useful for speech impaired and paralyzed patients
- Facilitates effective real-time communication. Provides an easy to access search interface to the students.
- Can be worn by anyone as the glove is flexible.

D. Limitation

- The main disadvantage is processing of system may be slow.
- Cannot express facial expressions.

VII. Conclusions And Future Scope

A. Conclusions

We could recognize ASL alphabets with 100% accuracy if we use the combination of flex, contact and accelerometer sensor. When the experiment was conducted 10 times the average success rate was 91.54%. The time between two ASL alphabet recognition is 500 Ms. This time can be reduced by increasing the clock rate. Data from sensors are received in parallel while the program running on the micro controller is sequential. So, with the use of parallel programs or threads time can still be reduced or the system can be used in real time.

B. Future Scope

- The present work only includes recognition of ASL alphabets that can be further extended for ASL words and sentences.
- The system can further be added with the capability of transmitting the data wirelessly. This can be accomplished by using the Bee Module.
- This paper demonstrates the recognition of ASL alphabets using single hand that can be extended to double hand.
- The Project currently uses the serial monitor of the Raspberry pi 3 model b that displays the output of the glove formation on the computer screen.
- Text to sound converter IC may be used to speak the alphabets and words.
- The system may can also add voice talkback using an Android App that can spell out or communicate the data or the signs being developed by the user directly and simultaneously.

REFERENCES

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