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Assistive Smart Glove for Paralyzed Individuals with Home Automation Control

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Abstract: *It is a device that helps the disabled or the paralyzed in the world. Paralysis is a disability that prevents someone from moving their muscles and doing things on their own. The disabled or the paralyzed have little time to talk to other people and need someone to take care of them.*
Assistive Smart Glove has sensors that go inside the glove that someone can wear. The sensors can tell if the person's fingers are moving and can send that as a message on the screen in front of them. This helps the disabled or the paralyzed talk to other people in the world.
Assistive Smart Glove has something that can tell if the person is falling down. It can send a message to the people taking care of the disabled or the paralyzed person if that happens. The Assistive Smart Glove can also control the lights and the fans in the disabled or the paralyzed person's home. The disabled or the paralyzed person can do this using their voice and their hands.
The aim of the Assistive Smart Glove is to make the lives of people who are paralyzed better. It wants to do this by making their lives safer, more independent, and happier. The Assistive Smart Glove is designed to be cheap and easy to use to ensure that many people can use it.
The Assistive Smart Glove uses something called the Internet of Things, which is a collection of devices that can talk to one another. This enables the Assistive Smart Glove to work with other devices in the persons home. The Assistive Smart Glove is a device to assist people who have paralysis because it enables them to communicate and call for help as well as controlling their home using only one device that they can wear.

Keywords: Assistive Technology, Smart Glove, IoT, Gesture Recognition, Home Automation, Flex Sensors

I. INTRODUCTION

The technological developments observed in the healthcare sector and embedded systems have created new opportunities for enhancing the lives of people suffering from physical disabilities. Among the many health conditions, paralysis is a major challenge, as it affects the voluntary movement of the muscles, often resulting in the loss of the ability to communicate. People suffering from paralysis often require the support of caregivers to carry out even the most basic functions, like communicating, controlling domestic equipment, or seeking emergency services.

The assistive technology has limited capabilities and is usually tailored to address a single aspect of the user's life, like communication or mobility. Nevertheless, current research is focused on creating integrated assistive technology devices with the capability to incorporate various assistive features to cater to the needs of the disabled. The wearable technology has been identified as an efficient method of creating integrated assistive technology devices since it enables the user to interact with electronic devices.

Smart gloves are an example of a wearable device that can identify hand gestures based on sensors. The sensors can identify finger movement to send a message or command based on hand gestures. This means that a person with a

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speech or movement disability can easily communicate. Besides helping a person communicate, smart wearables can also have sensors to track body movement to identify accidents such as falling.

Another significant aspect of assistive technology is the inclusion of Internet of Things (IoT) technology. IoT is a network of various electronic devices that can communicate with each other using the internet. This allows a person with paralysis to become more independent by automating various tasks performed by IoT-based home automation systems. The person can control various appliances such as lights, fans, etc., using voice commands or gesture inputs.

The objective of the proposed research is to develop an "Assistive Smart Glove" that has the ability for gesture recognition, fall detection, and IoT-based home automation. The glove has the ability for finger movement detection using a flex sensor and the ability to send the detected movement as a text message. The glove also has the ability for fall detection using an accelerometer sensor that detects sudden movement of the body. The proposed system has the ability for smart home automation using IoT technology and allows the person with paralysis to control the appliances using voice commands..

The proposed system has the ability for multiple assistive technologies that can benefit the person with paralysis in communication and increase the degree of independence while reducing dependency on caregivers.

II. LITERATURE SURVEY

Assistive technologies have been widely researched in the last few years to improve the quality of life for people suffering from disabilities. Several research works have been carried out on wearable sensors, gesture recognition technology, and IoT-based technology for health care applications.

Several research works on gesture recognition technology were carried out on sign language translation technology to assist people suffering from hearing and speech impairments. The technology uses flex sensors to detect the movement of fingers and converts them into digital signals. The signals are then converted into text and speech outputs. This technology showed the potential of wearable sensors to facilitate communication between disabled people and their caretakers.

Another important research work carried out on assistive technology is fall detection technology. Accidental falls are a major concern for elderly and paralyzed people, and immediate medical assistance is required to avoid severe health complications in such situations. Several research works have been carried out on fall detection technology using accelerometers and gyroscopes to monitor the movement of the body. The sensors detect sudden changes in acceleration and orientation to send alert notifications to caretakers.

Another type of system that has attracted considerable attention in the last few years is the Internet of Things (IoT) technology in home automation systems. These systems allow users to remotely control various electronic devices in their homes. For paralyzed individuals, an IoT-based home automation system acts as an effective means to control their environment without requiring physical effort. Various researchers have successfully demonstrated the effectiveness of implementing an IoT platform, such as Blynk, Google, or Alexa, with a microcontroller to control various home appliances.

Some researchers have tried to implement gesture recognition and IoT technology in wearable devices. However, most of the systems are designed to perform either communication assistance or home automation, but not both.

The main purpose of the proposed research is to develop a multifunctional smart glove that incorporates gesture recognition for communication, fall detection for safety, and IoT technology for home automation. This system acts as an effective solution to provide a comprehensive platform for paralyzed individuals.

III. PROPOSED SYSTEM

The proposed system of Assistive Smart Glove is a wearable technology system with the capability to assist paralyzed patients with communication, safety monitoring, and control of home automation. The system consists of various hardware and software components that work together to achieve the desired functionality.

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The glove is equipped with flex sensors to sense the bending of the fingers. The sensor generates analog signals based on the amount of finger movement. The signals are then processed by the microcontroller to recognize the pattern of gestures and then transform it into predefined text messages, which are then displayed on the connected app or the LCD screen.

To provide safety to the user of the glove, the system is equipped with an accelerometer sensor to sense any sudden movement of the body. In case of a sudden fall or abnormal movement of the body, the system will immediately send an alert message to the emergency contacts through IoT communication.

For the purpose of controlling the home automation system, the microcontroller is connected to a Wi-Fi module to communicate with the IoT platform. The user is then able to control the home appliances such as lights and fans with the help of voice commands or gestures.

The overall architecture of the system is comprised of the following components:

- Smart glove using flex sensors
- Microcontroller unit
- A accelerometer sensor for fall detection
- Wi-Fi module for IoT communication
- A mobile application for monitoring and controlling
- Smart home appliances using IoT

The above components of the system integrate to provide a comprehensive system that is capable of improving the lives of paralyzed individuals.

IV. HARDWARE COMPONENTS

ESP32:

The ESP32 is a useful tiny computer that people use to control things in lots of Internet of Things systems to control devices and process sensor data from sensors. It has a dual-core processor, which means the ESP32 can do things at the same time. The ESP32 has built-in Wi-Fi and Bluetooth so the ESP32 can talk to the internet and other devices. The ESP32 can look at data away and connect with different sensors using the GPIO pins on the ESP32. The ESP32 also has power modes, which makes the ESP32 a good choice, for devices that run on batteries. Because the ESP32 is so good and does not cost a lot people use the ESP32 in lots of home systems and automation systems and monitoring systems.

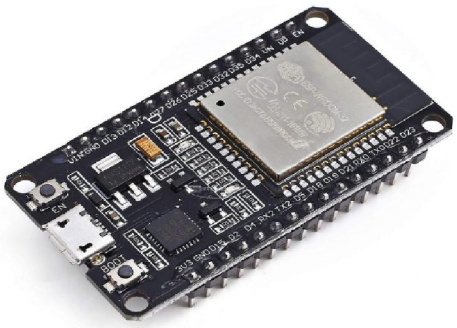

Fig 1. ESP32

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7805 Voltage regulator:

The 7805 voltage regulator is really useful because it helps to give a 5V output from a higher input voltage. This is important for circuits because they can get damaged if the voltage is not stable. The 7805 voltage regulator protects these circuits from voltage fluctuations. It makes sure that the power supply is always constant. The 7805 voltage regulator also has some important features like thermal protection and current limiting. These features prevent the 7805 voltage regulator from getting too hot. They also prevent too much current, from flowing through the electronic components. This is a deal because overheating and too much current can really damage electronic components.

Fig 2. ***7805 Voltage regulator***

Relay Module:

A relay module operates by utilizing a low-power signal to manage high-power devices such as motors, lights, and appliances, enabling safe and effective switching. It provides isolation between the control and load circuits, accommodates both AC and DC loads, and permits remote operation.

Relays enable automation, timed functions, and high-current switching while safeguarding control systems. Their energy efficiency and ability to handle multiple channels render them suitable for automation and power management applications.

Fig 3. Relay Module

18650 Battery:

The 18650 battery is a kind of battery that we can use again and again. It helps store energy in things like laptops and power tools. The 18650 battery is really good because it is small and lasts a time so we use it in lots of things, like electric vehicles and portable devices.

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Fig 4. 18650 Battery

Flex Sensor:

Designed to measure both temperature and humidity, the DHT11 sensor provides a digital output that facilitates processing by microcontrollers. It uses a thermistor for temperature assessment and a capacitive sensor for humidity measurement, making it suitable for basic environmental monitoring in environments such as homes, workplaces, and greenhouses.

Fig 5. Flex Sensor

Arduino Uno:

Arduino Uno is like the brain of a project. It helps control everything. The Arduino Uno gets information from things like sensors. It then uses a program to figure out what to do with that information. After that it can make things happen, like turning on lights or making motors spin. People use Arduino Uno for making things work on their own watching things in time and trying out new electronic ideas. It is really good, for projects. The Arduino Uno is used by lots of people for things.

Fig 6. Arduino Uno

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16 * 2 LCD:

The 16×2 LCD display is a thing that you can find in a lot of devices. These devices can be things like thermostats or projects that people make with Arduino. The 16×2 LCD display is basically a screen. It has two rows. Each row can show 16 characters. This is enough to show the temperature or a message that says what is happening.

What makes the 16×2 LCD display so popular? The 16×2 LCD display is cheap. It does not use a lot of power. The 16×2 LCD display can work with any microcontroller. You do not need a computer to see what your system is doing. The 16×2 LCD display shows you what is happening on the device. This is very helpful when you are trying to fix a problem with your code at 2 AM. You can see why your sensor is not working the way it should be.

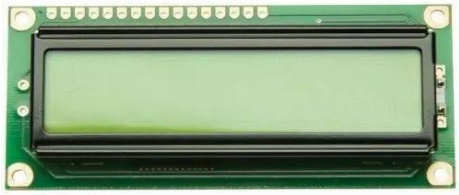

Fig 7. 16 * 2 LCD

Resistors:

A resistor is something that helps control the flow of electricity in a circuit. It stops much electricity from going through and hurting other parts. The resistor also helps divide the voltage and control the signals. We use resistors in lots of circuits to make sure devices work safely and do not get damaged. Resistors are really important, for keeping everything running smoothly.

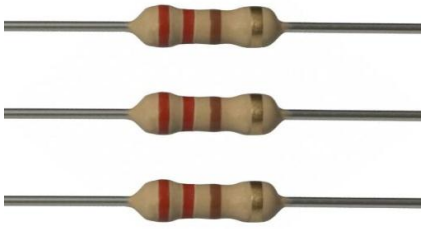

Fig 8. Resistors

Connecting Wire:

Connecting wires are really important because they help connect all the parts in something that uses electricity. These wires let electricity flow from one thing to another. They are like a bridge that helps devices talk to each other and work right. Some of these wires have a cover on them which is a good thing because it helps keep us safe. This cover prevents things, like short circuits and electric shocks from happening. Connecting wires are a part of making sure that

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things that use electricity work well and do not break easily. They make sure everything is connected and working like it should be. Connecting wires are used in all sorts of things that use electricity.

Fig 9. Connecting Wire

Zero PCB:

A Zero PCB is what people use to put and connect electronic parts when they are making circuits. This thing is really helpful when you want to try out a circuit design and see if it works. You can also use a Zero PCB to test and change your circuit designs before you make a version of the PCB. Using a Zero PCB is an idea because it does not cost a lot of money and it is very flexible. A lot of people use Zero PCB for learning about electronics trying out things and making small electronic projects with Zero PCB.

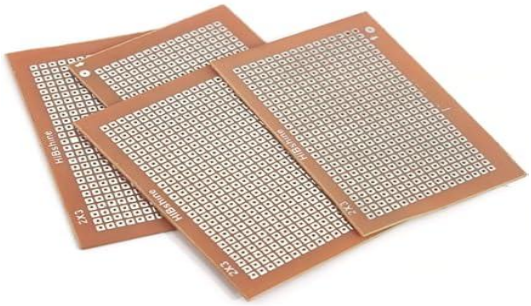

Fig 10. Zero PCB

Power Supply:

A power supply is an important part of any electronic thing. It helps make sures that the voltage is stable and that the power supply provides the amount of current so that electronic systems can work safely and do what they are supposed to do. The power supply takes the energy that comes from the wall outlet and changes it into the kind of energy that the electronic systems need. It also sends power to all the parts of the system and keeps them safe from problems, like getting too much power or having a short circuit. If you have a power supply then your electronic devices will work properly and they will last a long time. A power supply is what makes sure that electronic devices work well and keep on working for a time.

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Fig 11. Power supply

V. METHODOLOGY

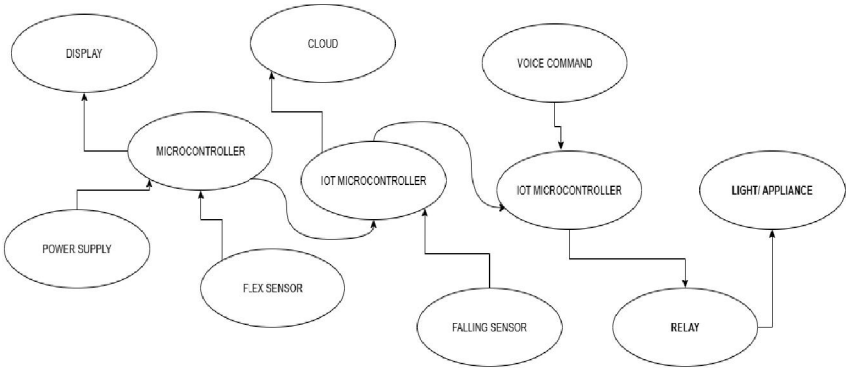

Fig 12. Activity Diagram

The development of the Assistive Smart Glove system has several steps, including hardware, sensors, software, and IoT communication. First, the glove is designed to have multiple flex sensors that are connected to the fingers, allowing the glove to detect the bending of the fingers, resulting in a signal that corresponds to the angle of the bending motion. This signal is then processed by a microcontroller, where the signal is changed from analog to digital.

The microcontroller then processes the information received from the sensors through a set of algorithms that recognize the gesture made by the user, where the gesture corresponds to a message or command that the system has been set to send. Once the gesture is recognized, the message appears on the user interface.

For the fall detection, the system uses an accelerometer sensor that detects the orientation of the hand, where a sudden change in the acceleration of the hand, beyond a certain value, is a sign of a fall, where the system sends a message for emergency response. The communication module of the IoT is connected to the internet through a Wi-Fi network. This enables the system to send notifications to the caregivers and receive commands to control the home appliances.

The system is integrated with a mobile app to enable the caregivers to monitor the status of the user remotely. The methodology ensures efficient integration of hardware and software components to provide reliable performance and user-friendly operation.

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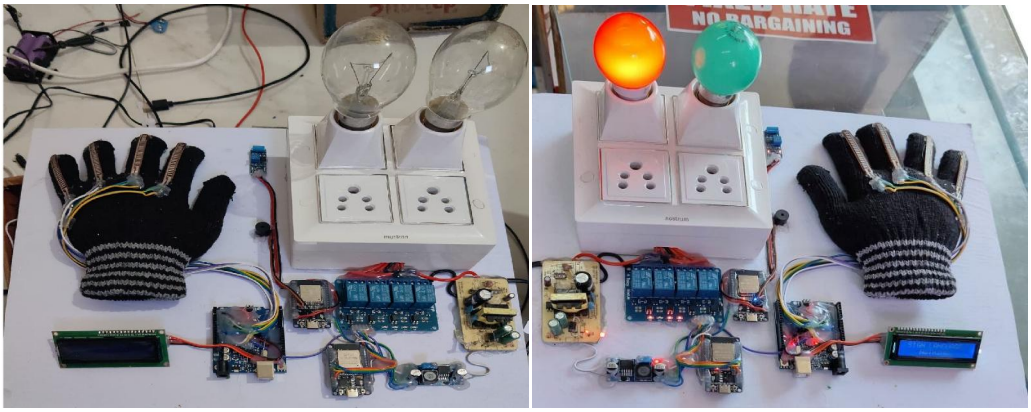
VI. RESULTS AND DISCUSSION



The Assistive Smart Glove system was. Tested in many different situations to see how well it works. The gesture recognition system did a job of detecting finger movements and turning them into messages with high accuracy.

The fall detection part was tested by making the hand move and dropping it. The Assistive Smart Glove system detected these things. Sent emergency notifications in just a few seconds.

The Assistive Smart Glove system also worked with the internet to control things at home. Users could tell the Assistive Smart Glove system what to do with their voice or by moving their hands. The Assistive Smart Glove system, the mobile application and the internet all worked well together.

The results show that the Assistive Smart Glove system can really help people who are paralyzed. It helps them talk to others stay safe and control things around them.

VII. ADVANTAGES

The proposed system offers several advantages including:

The Assistive Smart Glove system has good things about it including:

It lets people talk to others by moving their hands

It can detect if someone has fallen and send for help

It works with the internet to control things at home

It helps people who are paralyzed be more independent

It means caregivers do not have to do much

The Assistive Smart Glove system is small. Can be worn on the hand

It does not cost much to make

It makes people safer and happier

VIII. CONCLUSION

The Assistive Smart Glove system is a way to help people who are paralyzed. It combines things like detecting hand movements detecting falls and controlling things at home into one device that can be worn on the hand. This helps solve problems that people with disabilities face.

The Assistive Smart Glove system helps people talk to others stay safe and be more independent. It is affordable, easy to use and works well. This makes it a great tool to help people.

The Assistive Smart Glove system shows how wearable internet technologies can change the lives of people with disabilities. It can help make healthcare better for everyone.

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IX. ACKNOWLEDGMENT

We are very happy to present our paper on the Assistive Smart Glove system for people who're paralyzed and need help controlling things at home. We want to thank our teacher Prof. Dr. A.D. Gawande, from the Department of Electronics and Telecommunication Engineering at Sipna College of Engineering and Technology. He gave us all the help and guidance we needed. We are thankful, for his support and suggestions which were very helpful.

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