

IOT Paralysis Patient Healthcare

Dr. Malatesh S H¹, Vishal Kumar², Veena Y H³, Vamshitha⁴, Sunil Kumar⁵

¹Prof & HOD, Dept of CSE, M S Engineering College

²B. tech, (CSE) MS Engineering College

^{3,4,5} Veena Y H, MS Engineering College

Abstract—we are designing a system using IoT (Internet of Things) for the healthcare of paralysis patients. Patients who are not able to speak or move due to paralysis can use this system to communicate their needs to their caretakers or doctors. The system involves sensor-based gloves worn by the patient. The flex sensors embedded in the glove detect the finger movements of the patient. These sensor values are sent to a microcontroller, which processes the data and uses wireless communication (such as Wi Fi or Bluetooth) to send the message to the caretaker. The project aims to improve the quality of life of paralysis patients by enabling non-verbal communication and providing real-time health monitoring. The system can be enhanced further by integrating heartbeat and temperature sensors, and potentially connecting to a mobile app or cloud server for remote access by doctors.

Index Terms—IoT, paralysis, flex sensors, I2C LCD, GSM communication, real-time monitoring.

I. INTRODUCTION

Patients suffering from severe forms of paralysis often struggle with basic communication, which significantly impacts their quality of life and increases their dependency on caregivers. The ultimate goal is to promote independence, safety, and improved care for paralysis patients through accessible and affordable technology. The lack of muscle function in the human body can result in paralysis. There are two varieties of Temporary and, in some situations, lifelong paralysis. It can result from various medical conditions such as strokes, spinal cord injuries, or neurodegenerative diseases. Although paralysis is not limited to any part of the human body, it is most commonly encountered in limbs. Partial or full paralysis can develop. Stroke is a prevalent component that causes either partial or total paralysis in the patient. The patient has partial control of the afflicted muscle when suffering from partial paralysis. In the

case of total paralysis, there is no control over the afflicted muscle tissue.

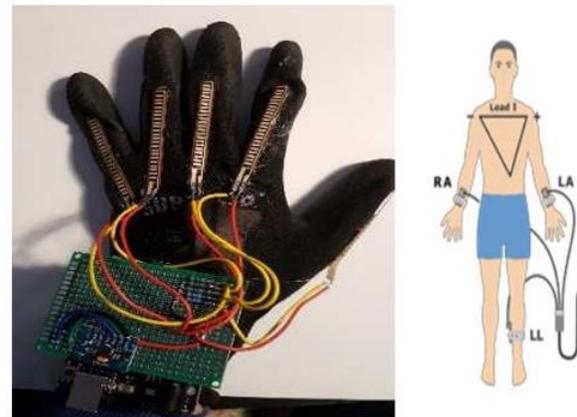


Fig. 1. Paralysis patient health monitoring device

As shown in Fig. 1, two devices that will be attached to the patient's body are depicted. The first is a flexible sensor. Through this, the patient can interact with the caregiver and request assistance if necessary, and the caregiver will receive a message in the event of an emergency.

The suggested system offers a reasonably priced communication option designed with paralyzed people in mind. This clever approach focuses on a glove that has an accelerometer built into it so that users may tilt their hands to send messages. The device can let paralyzed individuals communicate, which opens a bright new possibility for raising their standard of living.

II. PROPOSED SYSTEM METHODOLOGY

In this system, we will be using two different modes: This depicts all the interrelated components and their functionalities along with the integration of the modules working together to achieve the goal of making paralytic patients' lives easier.

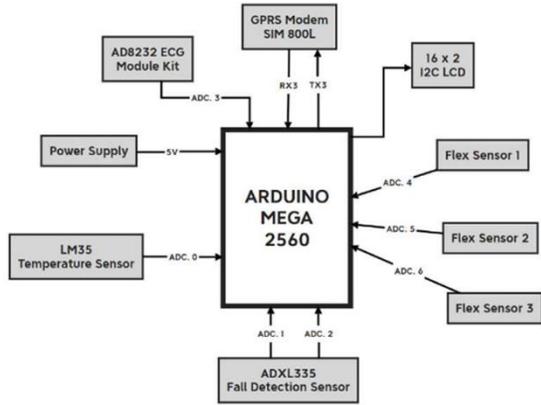


Fig. 2. Block diagram for automated paralysis patient healthcare and monitoring system

In Fig. 2, the Flex sensor, temperature sensor, ECG sensor, LCD, and fall detection sensor are connected to the Arduino ATmega2560. To keep track of patients' vital signs and movement sensors are used. The system works with a flex sensor to express the patient's condition through finger gestures. A "Help" signal is transmitted to the caregiver if the patient moves any portion of his body that can move.

A. Monitoring Mode The device will gather information from the patient's sensors and continuously track their vital signs and mobility.

B. Alert Mode When the system detects critical changes in the patient's health status, the alert mode will be activated. It may notify medical personnel, caregivers, or emergency services.

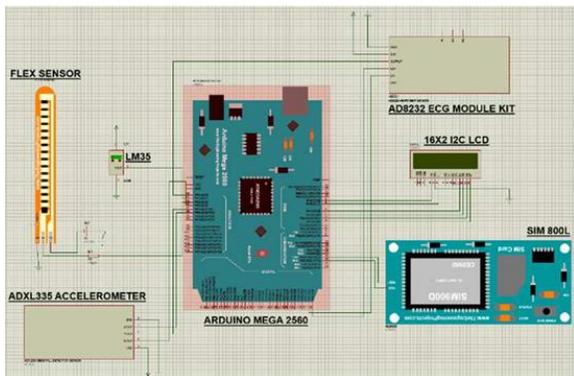


Fig. 3. Proposed system simulation in Proteus Design Suite Software

The Arduino Mega has a total of 70 pins where 54 digital input and output pins (0-53). 16 analog input pins are here (A0 to A15) and 14 Analog output pins (Pin 0 to 13). These pins allow it to interface with

various sensors, actuators, and other digital devices to create a wide range of projects and applications.

Components	Type	Range	Sensitivity	Time	Applications
Arduino Mega	Microcontroller	—	—	—	Wide range of electronic projects
Flex Sensor	Passive	0° to 180°	High	Fast	Wearable devices
Fall Detection Sensor	Digital	Detects falls	High	Fast	Wearable devices, smart home systems
ECG Sensor	Active	Complete cardiac cycle	High	Fast	Wearable health devices
Power Supply	—	Varies	—	—	Electronic system
Temperature Sensor	Passive/Active	Varies	High	fast	Weather monitoring

TABLE I. PARAMETERS SPECIFICATIONS OF THE SYSTEM

Arduino IDE emulates the Automated Paralysis Patient Health Care and Monitoring System. Flex sensor and temperature sensor values were accurate throughout the simulation as shown in Table I. Surges in acceleration simulated falls, triggering interruptions from the fall detection sensor. The ECG sensor properly displayed heart activity on the LCD and alerted the GPRS modem of crucial ECG occurrences. Arduino Mega with GPRS modem connectivity allowed caregivers and medical experts to receive real-time data.

III. HARDWARE TESTING & DEVELOPMENT

The automated paralysis patient health care system prototype was constructed after obtaining the desired simulation results. The evolution of circuits and sensors is covered in this section of the paper. A. Hardware Development of the system According to Fig. 5, the circuit is installed with all the necessary parts. The laptop was providing the power. To add logical code, an Arduino ATmega2560 was used.

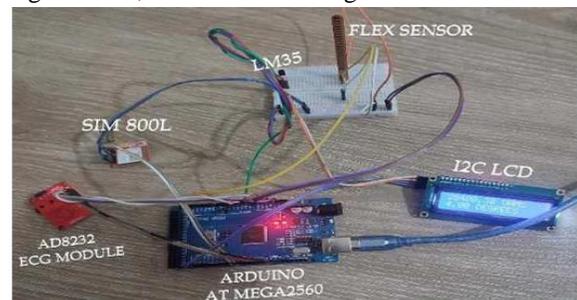


Fig. 5. Development prototype of the system

Circuit completion was followed by a code. On the LCD panel, temperature, BPM, fall detection, and hand gesture messages were displayed. A body-connected ECG, temperature, and flex sensor are needed. A hand or chest mount is best for the sensor. Sensor attachment activates the LCD's data display. B. Testing Arrangement of the System We aim to care for paraplegic individuals and monitor their vitals in real-time. Automating the procedure is the goal. We assigned many modules in our system to collect real-time data and notify the paralyzed patient's caregiver. The LM35 temperature sensor uses the linear voltage-temperature relationship. An analog voltage proportional to temperature in degrees Celsius is intended. Temperature raises the sensor's output voltage due to its internal construction [15]. Usually, a microcontroller measures this voltage to calculate temperature. The LM35 is used for temperature monitoring and control due to its simplicity and precision. The I2C LCD displays Celsius and Fahrenheit concurrently (Fig. 6).

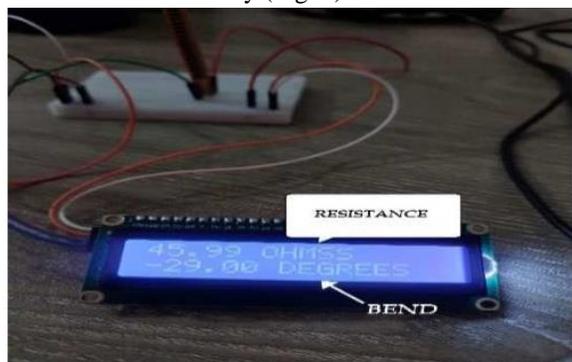


Fig. 6. Flex sensor output based on hand gesture.

The conversion factor from Fahrenheit to Celsius is:

$$C = 5/9(F-32) \tag{1}$$

Number 0-1023 from the ADC is converted into 0-5V using the following formula:

$$V_{out} = (\text{reading form ADC}) * (5/10240) \tag{2}$$

The volt-to-temperature conversion formula is

$$\text{Temperature}(\text{°C}) = V_{out} * 100 \tag{3}$$

Because the ADXL335 accelerometer uses acceleration, the capacitance theory changes. Tiny structures move when accelerated, changing capacitance between stationary plates. Analog voltage signals corresponding to acceleration along several axes are generated from this adjustment. Signal processing determines the device's orientation and acceleration in real-time applications.

IV. SYSTEM ARCHITECTURE AND METHODOLOGY

EMG Sensors: Measure muscle activity to assess the patient's motor function. IMU (Inertial Measurement Units): Monitor movement, posture, and orientation (accelerometers, gyroscopes).

The Control Module acts as the brain of the system, responsible for coordinating, processing, and responding to data from IoT devices.

The Communication Module is the nervous system of the architecture. It ensures data integrity, low-latency alerts, and reliable synchronization across the entire system. Buzzer: Provides local alert system. B. Working Method Sensors collect real-time data.

The User Interface (UI) module serves as the primary interaction point between patients, caregivers, and healthcare professionals. Central system handling: Data storage in a secure database.

Components	Functionality	Testing Method	Weightage (%)	Pass/Fail Criteria
Arduino ATmega 2560	Microcontroller and system control	Functional Testing	15	All system control functions work correctly.
LM35 Temperature Sensor	Temperature measurement	Calibration and Verification	10	Accurate temperature readings within an acceptable range.
ADXL335 Accelerometer	Movement and posture monitoring	Data Validation and Comparison	15	Accurate detection and recording of patient movements and posture changes.
Flex Sensor	Detection of joint movements	Range and Sensitivity Testing	10	Responsive readings based on the patient's joint movements.
AD8232 ECG Measurement Module Kit	Heart rate and ECG monitoring	Signal Validation and Comparison	20	Accurate heart rate monitoring and reliable ECG signal acquisition.
SIM800L GSM Module	Remote communication (SMS/Call)	Functional and Communication Testing	15	Reliable communication with healthcare personnel through SMS or calls.
16x2 LCD Display	Real-time data display	Display Verification	15	Proper and legible display of patient data on the LCD screen.

TABLE II. LAB TESTING DETAILS OF THE PROTOTYPE

Table II shows the detailed testing parameters with weightage and methods. The testing criteria for individual components are also described in table

V. SYSTEM DESIGN

The IoT-based paralysis patient healthcare system uses a smart glove with flex sensors to detect finger movements. These movements are processed by a microcontroller (like Arduino or ESP32), which maps them to specific messages (e.g., "I need help"). The system also includes heartbeat and temperature sensors for monitoring the patient's vitals.

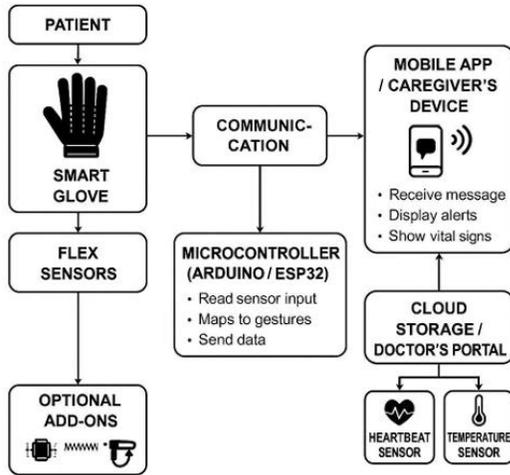


Fig 5: system architecture

All the data is transmitted wirelessly using Bluetooth or Wi-Fi to a mobile app or caregiver device, where alerts and health data are displayed. Optionally, data can be sent to the cloud for remote access by doctors or family.

VI. IMPLEMENTATION

The system was coded using the Arduino IDE. The system starts with wearable sensors such as EMG, IMU, and pressure sensors that collect data on the patient's muscle activity, movement, and posture. These sensors are connected to microcontrollers like ESP32 or Raspberry Pi, which act as edge devices to process and filter the data locally. The system is thoroughly tested and deployed across platforms, ensuring it delivers reliable, responsive, and user-friendly support to improve the quality of life and independence of paralysis patients.

VII. CLOUD AND DASHBOARD INTEGRATION

The system integrates with the ThinkSpeak IoT cloud platform, which provides a user-friendly interface for visualizing sensor data in real-time. The Arduino has the data of working for real time data. The transmitter an receiver helps to interact between two sensors to provide accurate data to doctors and caregivers. The IoT gecko has the logged in data to show the output for a data transmitted during and the hand gesture/movement of the patient. The dashboard has the data like name, contact, email. Etc. the main dashboard has the help!! Insight in it to provide the data whatever transmitted from the wearable sensors.

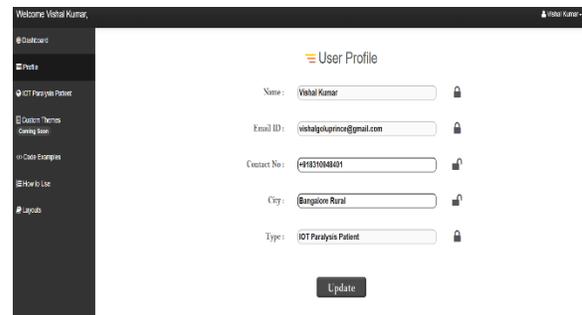


Fig 6: Login Page Dashboard

VIII. PERFORMANCE ANALYSIS OF THE SYSTEM

Automated paralysis patient healthcare system uses a real-time monitoring system to track patient's vital signs closely. It also detects any anomalies promptly. This approach reduces the risk of complications and ensures patients' needs. The caregiver can focus on the patient or any critical aspect using the system. As the system monitors the patient continuously, the caregiver can get a full health condition summary. Using a combination of the LM35 temperature sensor, ADXL335 accelerometer, flex sensor, AD8232 ECG module kit, SIM800L SIM module, Arduino Mega 2560, and an I2C LCD screen, we present a thorough performance analysis of the "Automated Paralysis Patient Healthcare and Monitoring System" in this section [21]. The evaluation tries to rate the system's precision, dependability, responsiveness, and usability while also taking its scalability and resilience into account. Several experiments were run using both simulated data and actual patient data to assess the system's performance. The hardware resources were

efficiently controlled by the system, ensuring smooth operation free from resource constraints. Multiple simulated patients were successfully monitored at once without performance being affected, proving the system's scalability. The serial port monitoring shown in Fig. 7 indicates the sensors were functional perfectly. The data will be sent to mobile phones by using the GSM module. Although the technology showed promise, there were issues with the SIM800L module's coverage in outlying locations with poor cellular reception.

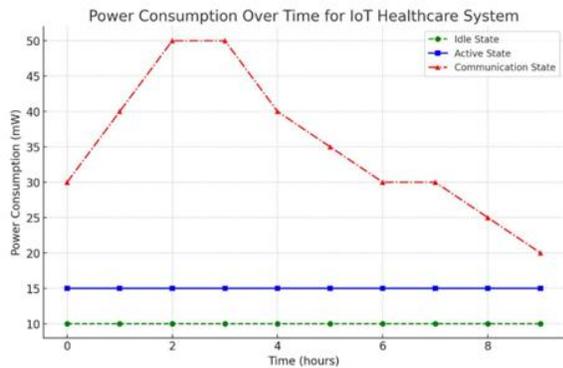


Fig. 7. Performance Evaluation Graph

The system was able to quickly identify emergencies thanks to its average response time of less than 3 seconds to crucial occurrences. Throughout the testing time, the system ran well with no data loss or interruptions. A simple user interface makes it simple to interact with the system, according to usability tests with healthcare practitioners.

IX RESULTS AND DISCUSSION

IoT in healthcare can offer a lot of potential for improving patient care, especially in managing chronic conditions like paralysis. WiFi Module is an integrated TCP/IP protocol stack with an independent SOC with that can give any microcontroller access to your WiFi network. Arduino IDE: Before you can start doing anything with the Arduino, you need to download and install the Arduino IDE (integrated development environment).

Fig 8- Wireless data transmission circuit: A wireless data transmission circuit enables the transfer of data between devices without physical connections, using radio waves, infrared, or other wireless technologies. These circuits are essential in communication systems

like Wi-Fi, Bluetooth, and RF (radio frequency) transmission.

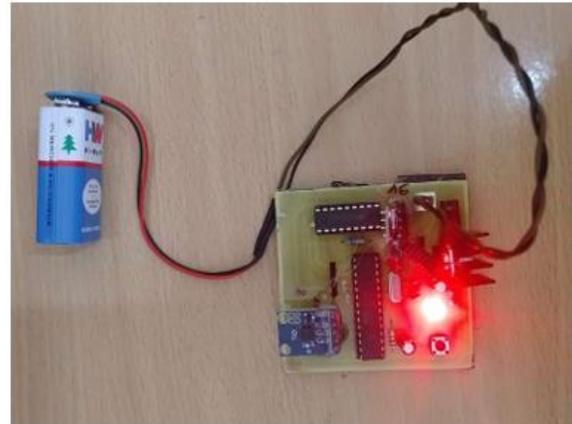


Fig 8: Wireless data transmission circuit

Fig 9- Microcontroller-based system: A microcontroller-based healthcare system for paralysis patients can provide essential monitoring, emergency alerts, and assistive communication. By integrating sensors, wireless communication, and automation, such a system can significantly improve patient care.



Fig 9: Display of IOT Paralysis Patient Care

Test Case: Test the alerting mechanism when abnormal data is detected (e.g., patient is immobile for too long).

Expected Result: An alert should be sent via email or app notification to the healthcare provider.

Test Case ID	Test Case Description	Expected Results	Actual Results	Status
1	Device Data Collection	Data should be transmitted and stored correctly	Data received and stored without errors	Pass
2	Real-Time Data Processing	Alerts triggered based on abnormal data	Alert triggered for low heart rate	Pass
3	Data Integrity	Data integrity maintained during transmission	No data loss or corruption during transfer	Fail
4	System Security	Unauthorized access blocked; data encrypted	Unauthorized access attempts blocked; data encrypted	Pass
5	Battery and Device Performance	Device performance and battery life meet specs	Device battery lasted 24 hours, performed well	Pass

Table III: Test Case Report

X. CONCLUSION

The integration of Internet of Things (IoT) technologies in healthcare, especially for individuals with paralysis, holds transformative potential. Through the continuous monitoring of vital signs, mobility aids, and smart home devices, IoT can significantly enhance the quality of care and independence for patients with paralysis. Key benefits include: Remote health monitoring that enables proactive interventions, reducing emergency hospital visits and improving patient outcomes. Smart mobility devices like IoT-enabled wheelchairs that provide greater autonomy and prevent common complications, such as pressure sores.

Real-time communication between patients and healthcare providers, ensuring timely responses to health changes and emergencies. Assistive technologies that promote independence, from smart homes to brain-computer interface systems. Predictive analytics to forecast and prevent health complications, allowing for more personalized and effective treatments. Despite the remarkable benefits, challenges related to privacy, security, and device interoperability remain.

XI. FUTURE SCOPE/ENHANCEMENT

Integration with AI for Predictive Care: The system can incorporate artificial intelligence to analyze patterns in patient requests and vitals.

Voice and Gesture Recognition: Advanced input mechanisms such as voice commands, eye-blink detection, or hand-gesture sensors can be integrated to provide more intuitive interaction methods for patients with varying levels of mobility.

Cloud-Based Medical Records: Expanding the system to sync with Electronic Health Records (EHRs) allows caregivers and medical professionals to access real-time patient data remotely and securely.

Wearable Integration: The system can be integrated with wearable devices (e.g., smartwatches or health bands) to continuously monitor vital signs and activity levels.

Real-Time Location Tracking: GPS modules can be incorporated to track patient location in case of emergencies or for monitoring patients within a facility.

Scalability for Hospital Use: The architecture can be scaled to support multiple patients in a healthcare facility, enabling centralized monitoring and alert management.

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