

Automated Paralysis Patient Health Care & Monitoring System

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Abstract— The majority of paralysis sufferers have difficulty communicating as well as moving certain body parts. An automated paralysis patient healthcare system can be incredibly valuable to these individuals. It's a computerized healthcare system. By moving any part of their body that can move, a disabled person can utilize this technology to display a message on an LCD panel. This strategy is also useful when the patient is left alone, and no one is available to provide care. A GPRS modem (SIM) is used to send an SMS, allowing whoever is caring for the patient to monitor the patient's condition from a distance. The system functions by understanding the user's tilt direction and monitoring real-time vitals. The device is used to demonstrate how it works by holding the thing in the fingers of the moving hand. The user only needs to tilt the device at a specific angle to send a message. This approach was designed to safeguard the safety and health of paralysis patients by giving immediate assistance.

Keywords— *IoT, paralysis, flex sensors, I2C LCD, GSM communication, real-time monitoring.*

I. INTRODUCTION

The innovative healthcare automation solution that this research project introduces is carefully crafted to meet the unique requirements of patients with paralysis and those with impaired motor control. The first system uses an advanced Internet of Things (IoT) methodology, combining hand motion control, a variety of sensors, and circuitry based on microcontrollers [1]. Patients are empowered by this connection since it allows them to remotely monitor their health and operate equipment. It shows that communication, remote health monitoring, and appliance control may be executed successfully even though network architecture isn't specified with enough precision [2].

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. 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 [3]. Some frequent signs of paralysis are spam, loss of sensation in the arms and legs, a decline in muscle function, a decrease in motor function, and the inability to speak. Some types of paralysis allow the patient to live a normal life, while others entail serious consequences. The need for crutches, wheelchairs, and full-time nursing may increase dramatically [4].

The IoT-based technique is groundbreaking and suggests future applications where healthcare automation can be

extended to aid not only paralyzed patients but also the elderly and temporarily impaired people [5]. 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 ECG is the second figure from the left. The BPM of the patients will be measured. It will continuously provide reliable data, allowing the caregiver to have a detailed picture of the patient's current state [6].

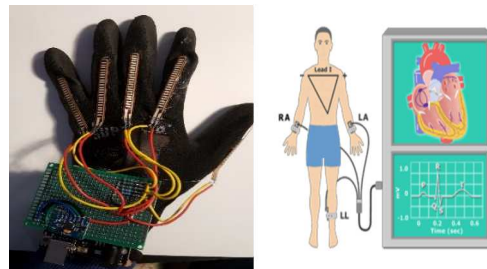


Fig. 1. Paralysis patient health monitoring devices (Flex sensor and ECG)

The paper's presentation establishes the foundation for future improvements and the growth of these systems into more extensive uses in healthcare. The main takeaway is that there is a lot of potential for improving healthcare through the integration of IoT technology, and this research lays the groundwork for future developments [7]. The system is made up of a few simple sensors that connect to the human body and machine immediately. The SIM module and LCD monitor patient and caregiver interactions as well as patient health. Proteus software was used for circuit simulations for sensors and instruments. The system will incorporate an accelerometer to detect gestures. The microcontroller receives the accelerometer data, processes it, and outputs targeted messages on an LCD screen. A message and a siren can also be broadcast as alerts. A graphical LCD will display a graph of health parameter changes over time.

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 [8]. The lack of precise findings, in-depth analysis, or suggestions for future research in this work encourages more investigation and highlights the system's potential as a comprehensive healthcare solution. Even in the absence of specific algorithm details, its clever design—which consists of a transmitter module, a reception unit, and a computer interface highlights its intelligence.

II. PROPOSED SYSTEM METHODOLOGY

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.

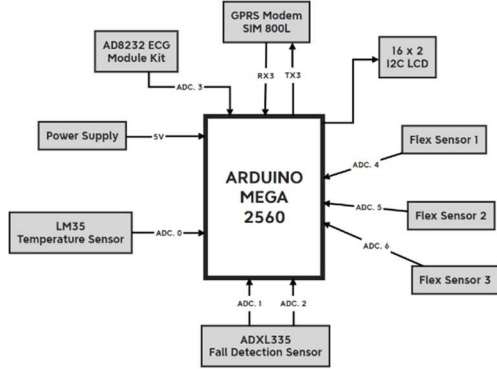


Fig. 2. Block diagram for automated paralysis patient healthcare and monitoring system

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 [9]. The patient's body temperature is measured via the LM35 temperature sensor. If the body temperature drops, the system will notify the caregiver. When the patient moves towards the ground, a fall detection sensor is activated. In all these cases, the SIM module can send a message to the patient's caregiver. On the LCD, the output of the patient's needs is also shown.

To enable patient management of appliances and remote health monitoring, the paper provides an IoT-based strategy for a paralysis patient healthcare system (Fig. 3). It focuses on the integration of microcontroller-based circuitry, hand motion control, and sensors [10].

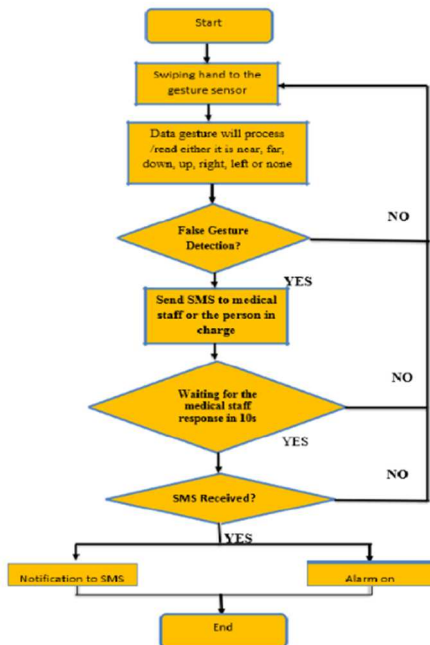


Fig. 3. Flow chart of the proposed system

In this system, we will be using two different modes:

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.

The proposed method utilizes an ECG sensor to measure the heart rate and continuously monitor other vital data of patients like body temperature and fall detection. It also uses a glove equipped with flex sensors on four fingers to communicate through finger movement. The flex sensors are used to deliver emergency messages to their caretaker. The system is also equipped with a fall detection sensor to detect the tilt directions of a paralytic person's body. The overall approach or methodology used in the project is to design a healthcare system for paralyzed and mute individuals. It involves using a gesture-based communication system and a vision-based approach for interpreting sign language [11].

III. PROPOSED SYSTEM DESIGN & SIMULATION

For patients with paralysis, the "Automated Paralysis Patient Health Care and Monitoring System" is intended to offer real-time monitoring options and healthcare services. Now to develop the prototype of remote sensing we need a GPRS SIM module. By using an LED display, a patient's condition will be observed directly. Along with this, we need the Flex sensor, temperature sensor, fall detection sensor, ECG sensor, Arduino Mega, and power supply for simulations where the microcontroller is Arduino Mega.

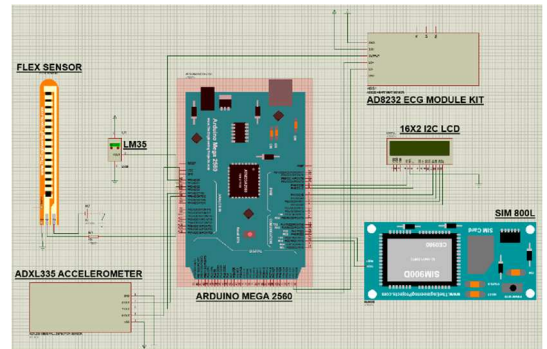


Fig. 4. Proposed system simulation in Proteus Design Suite Software

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 [12]. The Flex sensor, temperature sensor, and ECG sensor can relate to any of the analog input pins (A0 to A15), and the Fall detection sensor can be connected to any of the digital input pins (D0 to D53). In our simulation as shown in Fig. 4, we connect the Flex sensor, temperature sensor, and ECG sensor to any of the analog input pins on the Arduino Mega. We also connect the Fall detection sensor to any of the digital input pins on the Arduino Mega. The power supply is connected to a USB port in the Arduino Mega and the LED display is connected to any digital pin [13].

TABLE I. PARAMETERS SPECIFICATIONS OF THE SYSTEM

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,

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 [14]. Arduino Mega with GPRS modem connectivity allowed caregivers and medical experts to receive real-time data.

IV. 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.

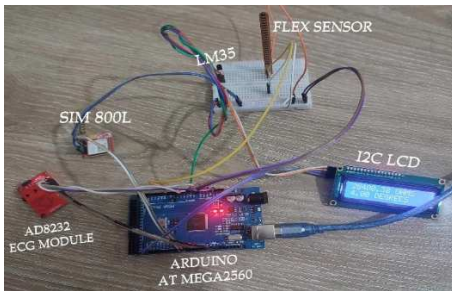


Fig. 5. Development prototype of the system

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).

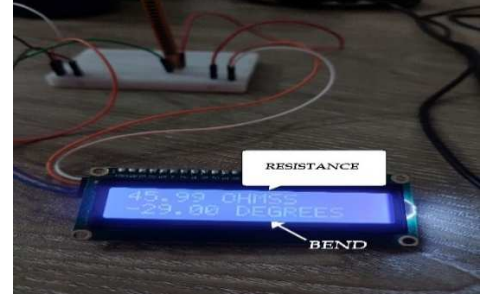


Fig. 6. Flex sensor output based on hand gesture.

The conversion factor from Fahrenheit to Celsius is:

$$C = 5/9(F-32) \quad (1)$$

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

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

The volt-to-temperature conversion formula is

$$Temperature(^{\circ}C) = V_{out} * 100 \quad (3)$$

Because the ADXL335 accelerometer uses acceleration, the capacitance theory changes. Tiny structures move when accelerated, changing capacitance between stationary plates [16]. 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.

AD8232 ECG module kit records heart electrical activity. Body electrodes detect tiny voltage changes caused by cardiac contractions. The module digitalizes, amplifies, and filters these signals. The data is sent to a computer or microcontroller. The software analyzes the data and builds an electrocardiogram (ECG) graph after detecting cardiac rhythm anomalies [17]. This allows heart monitoring and diagnostics, aiding medical evaluation.

The principle of resistance changes in response to bending governs how a flex sensor functions. It has a flexible substrate made of conductive substances. The resistance changes as the sensor bends because the spacing between the conducting components shifts. The degree of bending directly correlates with this change in resistance. The position or degree of bending of the sensor can be calculated by measuring the resistance, often using a microcontroller. This property makes the sensor ideal for robotics, gaming, and medical equipment [18].

It is a GSM/GPRS communication device, the SIM800L module. To send and receive data, mostly text messages and calls, it connects to cellular networks. It interacts by sending AT commands through a microcontroller and connecting to a network using a SIM card. It employs protocols to create communication channels with mobile towers and runs on GSM frequencies [19]. It is advantageous for IoT, remote monitoring, and communication applications since it enables remote data transfer, communication, and tracking.

TABLE II. LAB TESTING DETAILS OF THE PROTOTYPE

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 shows the detailed testing parameters with weightage and methods. The testing criteria for individual components are also described in table [20].

V. 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 [22].

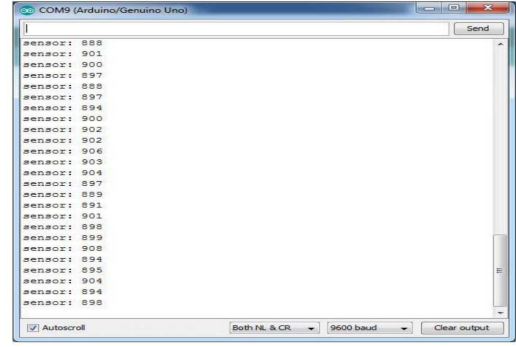


Fig. 7. The serial port monitoring indicates the sensor data.

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.



Fig. 8. ECG reading is based on electrical impulse.

The system's various functionalities, including temperature monitoring, patient position tracking with an accelerometer, muscle activity measurement with a flex sensor, ECG monitoring with an AD8232 module, and emergency communication with a SIM800L module, were tested using various scenarios that were simulated [23]. Fig. 8 shows the result after attaching the sensors to the body. With an accuracy of $\pm 0.5^\circ\text{C}$, the LM35 temperature sensor ensures accurate temperature readings (Fig. 9). Within ± 2 degrees of variation, the ADXL335 accelerometer demonstrated precise patient position tracking. The flex sensor offered accurate measures of muscle activity [24].

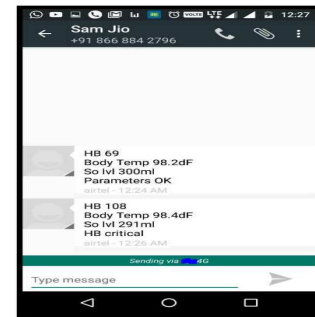


Fig. 9. The message to cell phones from the developed prototype.

Performance analysis confirms the "Automated Paralysis Patient Healthcare and Monitoring System's" reliability. Accurate sensor measurements, fast response time, user-

friendly interface, scalability, and resource efficiency make the system promising for paralytic patient monitoring [25].

VI. CONCLUSION

The Automated Dialysis Patient Healthcare System is a novel approach to meeting the demands of paraplegic patients. Through the integration of remote monitoring, the system aims to improve patient care. The proposed solution lacks a module that can be added to this project to act as an automated injection pusher. The caregiver may have to leave the patient at times. This module will automatically inject the patient (i.e., with insulin) at a predefined time. Although our system has several limitations, it has the ability to further research and treatment programs by integrating an improved injection pusher mechanism. Future potential will be stimulated, such as wider integration of healthcare infrastructure and improved AI algorithms. The method is both cost-effective and simple to use. Even from afar, the caregiver may simply monitor the health of the patients. The goal is achieved by providing a low-cost means of releasing paralyzed people, which improves their quality of life. The Automated Paralysis Patient Healthcare System has the potential to transform patient care while also leading to new medical technology breakthroughs.

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