GSM BASED PARALYSIS PATIENT HEALTH MONITORING SYSTEM

Report for Project Part-II (EC881)
Group No.12

B. Tech in Electronics and Communication Engineering

B. P. Poddar Institute of Management & Technology

under

Maulana Abul Kalam Azad University of Technology

Under the supervision of

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CERTIFICATE

This is to certify that the project work, entitled "GSM BASED PARALYSIS PATIENT HEALTH MONITORING SYSTEM**" submitted by** Subhajit Ghosh, Suroj Mete, Uddipan Mete & Sandipan Saha **has/have been prepared according to the regulation of the degree B. Tech in Electronics & Communication Engineering of the Maulana Abul Kalam Azad University of Technology, West Bengal. The candidate(s) has/have partially fulfilled the requirements for the submission of the project work.**

---------------------------------------	**---------------------------------**
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ACKNOWLEDGEMENTS

It is a great pleasure for me/us to express my/our earnest and great appreciation to Dr.Susmita Biswas, my project guide. I/We am/are very much grateful to him/her for his/her kind guidance, encouragement, valuable suggestions, innovative ideas, and supervision throughout this project work, without which the completion of the project work would have been difficult one.

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I/We would like to express my/our gratitude to the library staff and laboratory staff for providing me/us with a congenial working environment.

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B. Tech in Electronics & Comm. Engg.
Department of Electronics & Comm. Engg.
B.P.Poddar Institute of Management & Technology

Table of Content

Section	Pg. No.

DEPARTMENTAL MISSION & VISION:

Departmental Mission: -

Imparting innovative educational program through laboratory and project based teaching-learning process for meeting the growing challenges of industry and research. Providing an inspiring and conducive learning environment to prepare skilled and competent engineers and entrepreneurs for sustainable development of the society. Creating a knowledge center of advanced technologies committed to societal growth using environment-friendly technologies.

Departmental Vision: -

To emerge as a premier department for studies in Electronics and Communication Engineering.

Program Educational Objectives (PEOs): -

Graduates of Electronics and Communication Engineering will be able to use latest tools and techniques to analyze, design and develop novel systems and products to solve real life problems. Graduates of Electronics and Communication Engineering will have strong domain knowledge, skills and attitude toward employment in core and allied industries, higher studies and research or will become successful entrepreneurs. Graduates of Electronics and Communication will exhibit ethical values, professionalism, leadership, communication and management skills, team work and multi-disciplinary approach to adapt current trends in technology through life-long learning.

Program Outcomes (POs)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

1. Students will acquire knowledge in Advance Communication Engineering, Signal and Image Processing, Embedded and VLSI System Design.
2. Students will qualify in various competitive examinations for successful employment, higher studies and research.

TITLE:

GSM BASED PARALYSIS PATIENT HEALTH MONITORING SYSTEM

OBJECTIVE:

The objectives of a GSM-based Paralysis Patient Health Monitoring System are:

- **Real-time Data Transmission:** Enable continuous monitoring of vital signs (such as heart rate, blood pressure, body temperature and body movement) and send this data to healthcare providers via GSM technology.
- **Emergency Alerts:** Automatically alert caregivers or medical professionals in case of critical health changes or emergencies, ensuring timely intervention.
- **Remote Accessibility:** Allow family members and healthcare providers to access patient health information remotely, facilitating better communication and decision-making.
- **Patient Comfort:** Minimize the need for frequent hospital visits by providing at-home monitoring, improving the overall comfort and quality of life for patients.
- **Data Logging and Analysis:** Collect and store health data over time for trend analysis, enabling personalized healthcare adjustments and better management of the patient's condition.

PO & PSO MAPPING:

PO1	PO2	PO3	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
3	2	1	2	3	2	2	3	3	3	2	1	2

JUSTIFICATIONS OF MAPPING

PO/PSO MAPPED	LEVEL OF MAPPING	JUSTIFICATION
PO1	3	The system applies GSM technology, biomedical sensors, and wireless communication for real-time health monitoring and alert generation,

		demonstrating engineering principles in healthcare applications.
PO2	2	It analyzes patient health parameters such as heart rate and temperature, allowing early detection of health anomalies and ensuring patient safety.
PO3	1	The system is designed for efficient energy usage and optimized communication, contributing to societal health benefits through timely medical intervention.
PO4	2	Health data is continuously analyzed using research methodologies to enhance patient monitoring and develop strategies for emergency response.
PO5	3	The selection of GSM modules, sensors, and microcontrollers is crucial for building a reliable health monitoring system for paralysis patients.
PO6	2	The system supports sustainable medical care by promoting efficient resource use (e.g., minimal power consumption) and improving patient quality of life.
PO7	2	The project addresses healthcare needs, minimizing hospital visits and enabling at home monitoring, reducing the overall strain on healthcare resources.

PO8	3	Ethical considerations are integrated into the design to ensure patient data privacy and system reliability, following responsible IoT practices.
PO9	3	The project development involves collaboration between healthcare professionals, engineers, and technologists, emphasizing multidisciplinary teamwork.
PO10	3	The project requires clear communication, including documentation and presenting system benefits to stakeholders.
PO11	3	Project management skills are applied to balance cost, time, and quality while ensuring a functional prototype is delivered on time.
PO12	2	The project team must stay updated with advancements in biomedical sensors and wireless communication for continuous system improvement.
PSO1	1	The project strengthens technical proficiency in IoT and embedded system integration, developing a functional health monitoring solution.
PSO2	2	The project sets a foundation for future research and innovations in patient health monitoring, contributing to the medical IoT domain.

ABSTRACT

The GSM-Based Paralysis Patient Health Monitoring System is an innovative solution aimed at enhancing patient care by enabling continuous, real-time monitoring of vital health parameters for individuals affected by paralysis. Patients with limited mobility often face challenges in communicating discomfort or medical distress, making automated health surveillance systems critically important. This project integrates biomedical sensing, embedded system control, and wireless communication technologies to provide a robust and responsive healthcare support system. [3]

At the core of the system is the Arduino Mega 2560 microcontroller, which serves as the primary processing unit. It collects, processes, and analyzes data from multiple sensors: the LM35 temperature sensor, which measures the patient's body temperature; the ECG sensor, which monitors the electrical activity of the heart and provides heart rate information; and the flex sensor, which detects any minor limb movement and helps assess the patient's motor activity. These readings are displayed on a 16x2 LCD screen, providing real-time visual feedback to caregivers in the vicinity.[1]

For remote health monitoring, the system employs the SIM900 GSM/GPRS module, which transmits SMS alerts containing vital information to preconfigured mobile numbers. In critical situations—such as abnormal temperature, irregular heartbeat, or lack of movement—the system automatically sends an emergency message to notify caregivers or medical personnel. The system can be further enhanced by integrating GPS capabilities, allowing the transmission of the patient's exact location, which is particularly useful in outdoor or rural settings where immediate access may be limited. [2]

The overall design emphasizes portability, low power consumption, and user-friendliness, making it ideal for use in both home-based care and clinical environments. This project not only increases the safety and well-being of paralysis patients but also reduces the burden on healthcare providers by enabling automated, intelligent health tracking and faster response times during emergencies.

Activity chart (Give What you have done so far in table format):

Odd Semester:

Timeline	Activity			
September 2024	Extensive study on IoT Arduino mega 2560, SIM 900 GSM GPRS, flux sensor, etc.			
October 2024		Establishing the work flow (flow chart) & Making of the design of the project		
November 2024			Model making (Hardware part)	
December 2024				Prepare project report

Even Semester:

Timeline	Activity					
January 2025	Developing the Software part (writing code, uploading code, etc.)					
February 2025		Fixing the run time issues of the Project				
March			Finalize the Project			
20-31 March				Add some Additional functionalities		
April 2025					Launch of the final project	
May 2025						Prepare final project report and presentation

Chapter 1
Introduction

1.1 Context

Paralysis is a neurological condition that results in the loss of muscle function in one or more parts of the body. Patients suffering from paralysis often face significant challenges related to mobility, self-care, and communication. They are usually dependent on caregivers for assistance in daily activities and health monitoring. A major concern in the management of such patients is the inability to detect sudden medical emergencies, such as abnormal body temperature, irregular heartbeat, or loss of consciousness, especially when the patient is alone or unable to speak. [2]

Traditional healthcare models rely heavily on periodic monitoring and human supervision, which may not always be feasible, especially in rural or resource-limited environments. These models are inadequate for providing continuous, real-time health updates. As a result, there is a critical need for a system that can automatically monitor the patient's health conditions and notify caregivers instantly in case of any abnormalities.

1.2 Motivation for the Project

The motivation behind this project arises from the growing need for accessible, real-time health monitoring solutions tailored for patients with severe physical limitations. Paralysis patients often find it difficult or impossible to alert caregivers during emergencies due to limited movement and speech disabilities. In such cases, delays in medical intervention can lead to serious health complications or even death.

This project aims to bridge the communication and care gap by offering a system that not only monitors key health indicators continuously but also communicates this information to caregivers remotely. Technologies like GSM communication and GPS tracking enable rapid response, ensuring that patients receive timely help. The use of affordable and readily available components makes the system practical for implementation in both urban and rural healthcare settings.[5]

1.3 Aim

The primary objective of this project is to design and develop a real-time health monitoring system specifically for paralysis patients. The system aims to continuously observe critical physiological parameters such as:

- Body temperature
- Heart rate
- Limb movement

Using these data, the system can detect irregularities and immediately alert caregivers through SMS notifications. Additionally, in emergency conditions, the system sends the patient's exact location using GPS data, enabling prompt medical assistance. The system enhances patient safety, autonomy, and caregiver awareness.

1.4 Scope of the Project

The scope of this project includes the design, development, and implementation of an embedded health monitoring system capable of:

- Measuring and displaying body temperature using an LM35 sensor
- Monitoring heart rate using an ECG sensor
- Detecting limb movement using a flex sensor
- Displaying real-time data on a 16x2 LCD screen
- Sending SMS alerts to caregivers in case of abnormal health readings
- Transmitting GPS location in emergency situations using the GSM module

This system is focused on non-invasive monitoring and communication. It does **not** include advanced diagnostic features, medical-grade ECG analysis, or long-term health data storage. However, it is an effective solution for continuous home-based monitoring and early emergency detection.

1.5 Technology Used

This project utilizes a combination of hardware components and communication modules to achieve its objectives:

- **Arduino mega 2560 microcontroller:**

Fig 1: Arduino mega 2560 microcontroller

The Arduino mega 2560 microcontroller is central to the GSM-Based Paralysis Patient Health Monitoring System, providing a powerful platform for sensor integration and communication. With a 16 MHz clock speed, 256 KB of flash memory, and 54 digital I/O pins, it efficiently processes data from various sensors, including flex sensor, temperature and ECG monitors. Its support for communication protocols like UART enables seamless connectivity with the GSM-GPRS SIM900 module for remote alerts and the APR33A3 voice module for patient communication. Its low power consumption makes it suitable for battery-operated applications, ensuring timely intervention and improved care for paralysis patients.[2]

- **GSM-GPRS SIM900 module:**

Fig 2: GSM-GPRS SIM900 module

The GSM-GPRS SIM900 module is a key component of the GSM-Based Paralysis Patient Health Monitoring System, providing essential communication capabilities. This module enables real-time data transmission over mobile networks, allowing the system to send health updates and emergency alerts directly to caregivers via SMS. With support for both GSM and GPRS, the SIM900 facilitates reliable communication even in remote areas. Its compact design and ease of integration with the Arduino mega 2560 microcontroller make it an ideal choice for this project, ensuring that critical health information and patient location are transmitted promptly in emergencies, thereby enhancing patient safety and care.[4]

- **Flex Senor:**

Fig 3: Flex Sensor

The flex sensor used in the GSM-Based Paralysis Patient Health Monitoring System plays a crucial role in detecting limb movement, providing valuable insights into the patient's physical activity. This analog sensor responds to bending or flexing, generating a change in resistance that is proportional to the degree of flexion. By integrating the flex sensor with the Arduino mega 2560 microcontroller, the system can monitor the patient's ability to move their limbs, offering real-time data that helps assess their physical condition. This information is vital for caregivers, enabling them to understand the patient's mobility status and respond appropriately to any changes, thereby enhancing overall patient care and support.

- **LM35 Temperature sensor:**

Fig 4: LM35 Temperature sensor

The LM35 temperature sensor is a key component of the GSM-Based Paralysis Patient Health Monitoring System, providing accurate real-time temperature readings. It outputs a voltage that is directly proportional to the Celsius temperature, making it easy to integrate with the Arduino mega 2560 microcontroller. With its wide temperature range, high accuracy, and low power consumption, the LM35 is ideal for monitoring body temperature. This timely data helps caregivers detect potential health issues, enhancing patient safety and overall care.[3]

- **ECG Sensor:**

Fig 5: ECG Sensor

This sensor captures electrical signals from the heart, converting them into a readable format that can be processed by the Arduino mega 2560 microcontroller. With its ability to provide real-time heart rate data, the ECG sensor enables caregivers to assess the patient's cardiovascular health and respond quickly to any anomalies. Its compact design and ease of integration make it a vital tool in the monitoring system, ensuring that critical heart health information is readily available, thereby enhancing patient safety and care.

- **16 x 2 LCD:**

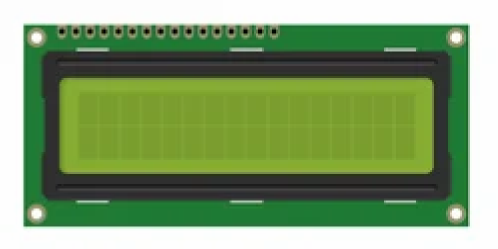

Fig 6: 16 x 2 LCD

This 16 x 2 LCD can show up to 16 characters per line and has two lines, allowing caregivers to easily read real-time data such as temperature, heart rate, and limb movement. Its straightforward design and compatibility with the Arduino mega 2560 microcontroller enable seamless integration into the system. The LCD enhances usability by providing immediate visual feedback, ensuring that caregivers can quickly assess the patient's condition without needing to access remote data, thus improving response times in critical situations.

Chapter 2
Theory

2.1 Introduction to Health Monitoring Systems

Health monitoring systems are essential in today's medical field, especially for patients who require constant observation. These systems are designed to continuously track vital physiological parameters such as heart rate, temperature, and movement, thereby allowing caregivers to respond promptly in case of emergencies. For patients with paralysis or limited mobility, regular clinical visits or manual monitoring is often impractical. In such scenarios, automated health monitoring systems offer a practical and efficient solution. By integrating biomedical sensors with microcontrollers and communication modules, real-time monitoring becomes feasible even in remote or home-care environments.

2.2 Embedded Systems in Medical Applications

Embedded systems are specialized computing systems designed to perform dedicated functions within larger mechanical or electrical systems. They are composed of hardware and software and are optimized for specific control functions. In the field of healthcare, embedded systems have revolutionized patient care by enabling portable, reliable, and real-time monitoring devices. These systems operate with low power and provide accurate outputs, which is essential in health-critical applications. In this project, the embedded system consists of the Arduino Mega 2560 microcontroller integrated with biomedical sensors and communication modules to provide an effective health monitoring solution for paralysis patients.[1]

2.3 Sensors Used in the Project

LM35 Temperature Sensor

The LM35 is a precision temperature sensor whose output voltage is linearly proportional to the Celsius temperature. It offers an advantage over linear temperature sensors calibrated in Kelvin, as no external calibration is required. The sensor provides accurate body temperature readings, which are crucial for identifying signs of fever, infection, or other medical conditions. It is easily interfaced with the Arduino Mega 2560 through analog input pins.

ECG Sensor

The ECG (Electrocardiogram) sensor is used to monitor the electrical activity of the heart. It detects the heartbeats and provides a voltage signal that can be analyzed to measure heart rate. Abnormalities in the ECG signal can indicate various heart conditions, and early detection can prevent serious health issues. The ECG sensor sends real-time data to the microcontroller for processing and display.

Flex Sensor

The flex sensor detects bending or movement of the patient's limbs. It changes its resistance based on the amount of flex or movement. When a paralyzed patient attempts to move a limb, the flex sensor can detect this small motion, making it useful for monitoring physical activity and rehabilitation progress. It is particularly helpful in evaluating whether the patient has regained any motor control or requires assistance.

2.4 Arduino Mega 2560 Microcontroller

The Arduino Mega 2560 is the core processing unit of the system. It is a microcontroller board based on the ATmega2560, with 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. It gathers data from the sensors, processes it, and determines when to trigger alerts or send messages. It is responsible for controlling the LCD display, interfacing with the GSM module, and managing sensor inputs, making it ideal for real-time applications such as health monitoring systems.

2.5 GSM Technology

GSM (Global System for Mobile Communications) technology is widely used for mobile communication and data transmission. In this project, the SIM900 GSM module enables the system to communicate over mobile networks. It sends SMS alerts containing health data and emergency messages to predefined mobile numbers. This feature is crucial when the patient is alone or when immediate medical attention is required. GSM ensures the system remains connected even in remote or rural areas where Wi-Fi or Ethernet might not be available.

2.6 Real-Time Monitoring Concept

Real-time monitoring involves the continuous collection, processing, and display of health parameters as they occur. This ensures that any abnormality in the patient’s condition can be identified and addressed immediately. For paralysis patients who may not be able to express discomfort or call for help, real-time monitoring is critical. It reduces the response time of caregivers and increases the chances of early medical intervention, which can be lifesaving.

2.7 Block Diagram (Conceptual Description)

Although the physical block diagram is typically provided as a figure, its conceptual structure includes the following:

- **Input Devices:** LM35 Temperature Sensor, ECG Sensor, Flex Sensor
- **Processing Unit:** Arduino Mega 2560
- **Output Devices:** 16x2 LCD Display, GSM Module for SMS alerts
- **Communication Module:** GSM SIM900
- **Power Supply:** Battery/Adapter for powering the system

Each sensor sends data to the Arduino, which processes the information. Based on pre-defined thresholds, the Arduino may display values on the LCD and trigger alerts via SMS.

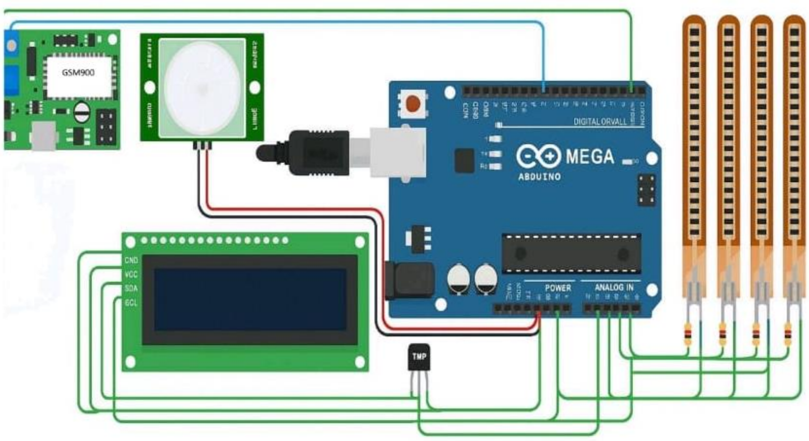

Fig 6: Circuit Diagram

2.8 Working Principle

The GSM-Based Paralysis Patient Health Monitoring System operates by continuously monitoring critical health parameters of a paralysis patient using various sensors connected to the Arduino Mega 2560 microcontroller. Here is the step-by-step working principle of the system:

1. **Data-Acquisition:**

   The system collects physiological data from the patient using the following sensors:

   - The **LM35 temperature sensor** measures the patient's body temperature and converts it into an analog voltage signal proportional to the temperature in Celsius.
   - The **ECG sensor** detects the electrical activity of the heart, providing real-time heart rate data.
   - The **flex sensor** monitors limb movement by detecting bending or flexion, indicating the patient's mobility status.

2. **Signal-Processing:**

   These analog signals from the sensors are fed into the analog input pins of the Arduino Mega 2560 microcontroller. The microcontroller processes the raw sensor data by converting analog signals to digital values and applying calibration or threshold checks to identify any abnormal conditions.

3. **Local-Display:**

   Processed data such as temperature, heart rate, and limb movement status are displayed on the 16x2 LCD screen for immediate visual monitoring by nearby caregivers.

4. **Alert-Generation-and-Communication:**

   If the microcontroller detects any abnormal health parameters—such as high temperature, irregular heart rate, or no limb movement—it triggers an alert condition. The Arduino then uses the GSM-GPRS SIM900 module to send SMS messages containing the patient's current health data and status to pre-registered mobile numbers of caregivers or healthcare providers.

5. **Emergency-Support:**

   This real-time SMS alert system ensures that caregivers are notified promptly, even if they are not physically present, enabling quick medical intervention. The system can continuously monitor the patient and send updates at regular intervals, providing ongoing supervision.

Overall, the system's integration of sensors, microcontroller processing, local display, and GSM communication enables continuous, real-time health monitoring and timely emergency response, significantly improving the care and safety of paralysis patients. [2]

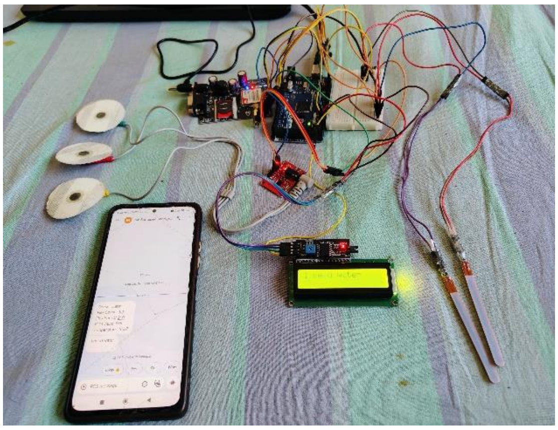

Fig 7: Before Final Hardware Implementation on gloves

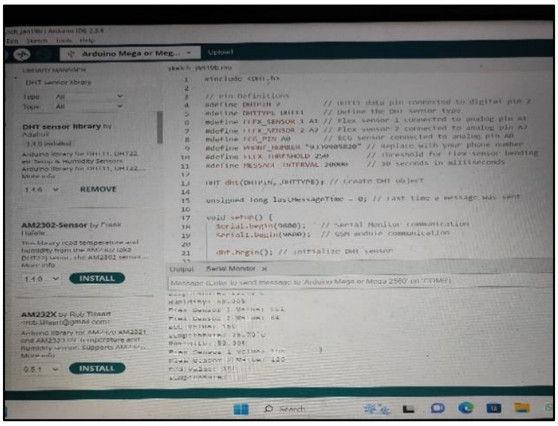

Fig 8: Before Final Software Implementation

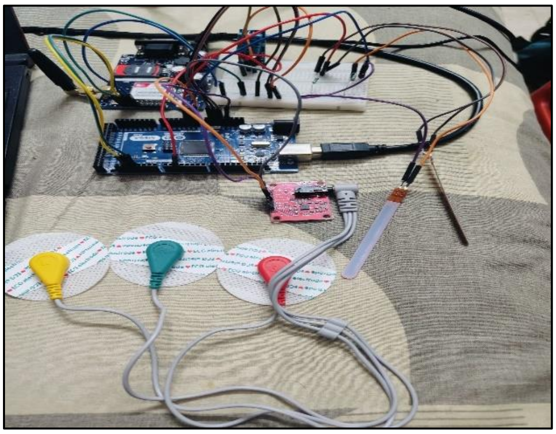

Fig 9: Before Final Hardware Implementation-2 on gloves

Chapter 3
Proposed System

3.1 Introduction to the Proposed System

The proposed system is a microcontroller-based health monitoring solution tailored for paralysis patients, who often suffer from limited mobility and communication barriers. This system addresses the need for continuous health tracking and rapid alert mechanisms by integrating biomedical sensors, real-time data display, and mobile communication technologies. It not only monitors vital parameters such as body temperature, heart activity, and limb movement but also provides emergency alerts via SMS, enabling remote caregivers to act quickly. The system is compact, portable, energy-efficient, and capable of operating in both urban and rural settings where constant medical supervision may not be available.[4]

3.2 System Architecture

The system architecture is modular and consists of the following layers:

- **Sensing Layer:** Comprises three primary sensors:
  - LM35 Temperature Sensor — measures the patient's body temperature.
  - ECG Sensor — captures heart signals and helps in real-time heart rate monitoring.
  - Flex Sensor — detects motion or bending of limbs, indicating physical activity or immobility.
- **Processing Layer:**
  - The Arduino Mega 2560 acts as the central processing unit. It receives analog inputs from the sensors, converts them into digital data, and performs logic-based analysis to determine the patient's health status.
- **Output/Display Layer:**
  - 16x2 LCD Display shows live sensor values like temperature, heart rate, and flex readings.
  - GSM-GPRS SIM900 Module is used for wireless communication to transmit health data and alert messages to caregivers through SMS.

This architecture ensures seamless data flow from sensing to alerting, providing both local and remote visibility into the patient's health condition.

3.3 System Design and Operation

The design of the system focuses on simplicity, reliability, and low-power operation, suitable for bedside or wearable health monitoring. The operation workflow is as follows:

1. **Sensor Data Collection:**
    - The LM35 continuously measures body temperature and outputs voltage in direct proportion to the temperature.
    - The ECG sensor picks up electrical signals from the heart to calculate heart rate.
    - The flex sensor detects bending of limbs, with its resistance varying based on the degree of movement.
2. **Microcontroller Processing:**
    - The Arduino Mega 2560 reads the analog signals from each sensor and converts them into digital values using its built-in ADC (Analog to Digital Converter).
    - Thresholds for safe ranges (e.g., normal body temperature and heart rate) are programmed into the Arduino. If any value deviates significantly, it is considered an emergency.
3. **Real-Time Display:**
    - The processed data is immediately displayed on a 16x2 LCD, providing continuous real-time feedback to any caregiver nearby.
4. **Communication and Alerts:**
    - If an abnormality is detected, the Arduino sends a signal to the SIM900 GSM module.
    - The module then sends an SMS message to pre-set mobile numbers with the health data and an alert notification.
    - This ensures that even remote caregivers can be informed immediately without delay.

3.4 Advantages of the Proposed System

- **Continuous Monitoring:** Tracks critical health parameters 24/7, reducing the risk of unnoticed deterioration.
- **Remote Notification:** Ensures caregivers receive alerts instantly, regardless of their physical location.
- **Customizable Thresholds:** Alert limits can be configured based on the individual patient’s health profile.

- **Low Cost and Scalable:** Uses low-cost sensors and open-source hardware, making it suitable for large-scale implementation.
- **Battery Operated:** Can run on portable power sources, suitable for home use or during transport.
- **Easy Integration:** Compatible with additional modules such as GPS or Wi-Fi (if needed in future versions).

3.5 Use Case Scenario

Imagine a paralysis patient resting at home, without direct supervision. The system remains active, recording vital signs. If the patient develops a fever or shows irregular heart activity, the system automatically sends an SMS alert to the caregiver's phone. The caregiver can then take appropriate action, whether it's making a call, visiting the patient, or calling emergency services. This kind of early warning can prevent complications and even save lives.

3.6 Limitations of the Proposed System

While effective, the proposed system has certain limitations:

- It cannot monitor complex parameters like blood pressure or oxygen saturation without additional sensors.
- It does not include speech or motion-controlled commands for communication (voice modules or IoT features were not implemented).
- It requires mobile network coverage to function reliably. [5]

Chapter 4
Mathematical formulation

Mathematical formulation in this project involves converting sensor data into meaningful physical quantities and analyzing the data to trigger alerts under predefined conditions. Each sensor used in the system has its own operating principle, which involves basic mathematical expressions. The following are the formulations and logic used in processing sensor outputs.

4.1 Temperature Calculation (LM35 Sensor)

The LM35 temperature sensor outputs a voltage that is linearly proportional to the temperature in Celsius.

- Output voltage: $V_{out} = 10\ mV/{\circ}C$
- Analog-to-digital conversion on Arduino Mega 2560:

$$V_{analog} = \frac{\text{ADC value} \times 5.0}{1023} \text{ volts}$$

- Temperature in Celsius:

$$T(^{\circ}C) = V_{analog} \times 100$$

4.2 ECG Sensor (Heart Rate Calculation)

The ECG sensor provides analog output signals that represent heart electrical activity. The system detects R-peaks (the prominent upward spikes in ECG waveforms) to calculate beats per minute (BPM).

- Time interval between two R-peaks: t seconds
- Heart rate (BPM):

$$HR = \frac{60}{t}$$

4.3 Flex Sensor (Limb Movement Detection)

The flex sensor changes its resistance based on the degree of bending.

- As flexion increases, resistance RRR increases.
- Arduino reads voltage through a voltage divider:

$$V_{flex} = \left(\frac{\text{R Flex}}{\text{R Flex} + \text{R Fixed}}\right) \text{ x } V_{in}$$

- Change in voltage (compared to base voltage) indicates limb movement.

4.4 Alert Condition Logic

Based on the processed values, the Arduino Mega decides whether to send an alert.

Let:

- T = measured temperature
- HR = measured heart rate
- M = movement detected (1 = yes, 0 = no)

Define thresholds:

- $T_{max} = 38^0$ C (fever)
- $HR_{min}=60$, $HR_{max}=100$
- Movement timeout = 30 minutes (example)

Alert Rule:

IF $T > T_{max}$ OR $HR < HR_{min}$ OR $HR > HR_{max}$ OR $M = 0 \Rightarrow$ Send SMS Alert

Chapter 5
Results & Discussions

5.1 Results

The implemented GSM-Based Paralysis Patient Health Monitoring System was tested successfully under different physiological and environmental conditions. The system was observed to effectively monitor vital parameters including body temperature, heart rate, and limb movement, and send SMS alerts when any abnormal values were detected.
During testing, the following results were obtained:

Additional results include:

- **LCD Display:** Successfully showed real-time temperature, heart rate, and movement status.
- **SMS Delivery:** Alerts were reliably sent within 5–10 seconds under good signal strength. In weak areas, messages were delayed but not lost.
- **Sensor Stability:** Sensors remained stable under continuous operation for several hours.
- **Power Consumption:** Low enough to allow operation through standard 5V DC supply or portable power banks.

Image of the Project:

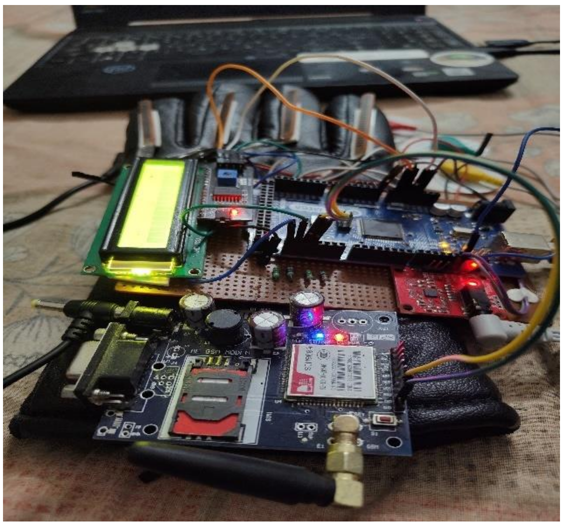

Fig 10: Final Hardware Implementation on gloves

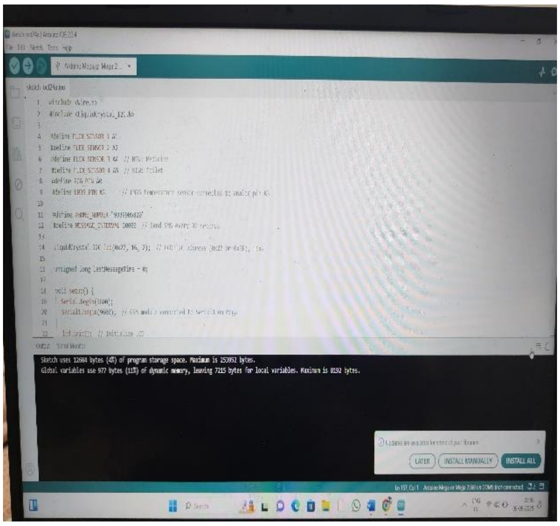

Fig 11: Software implementation for final implementation

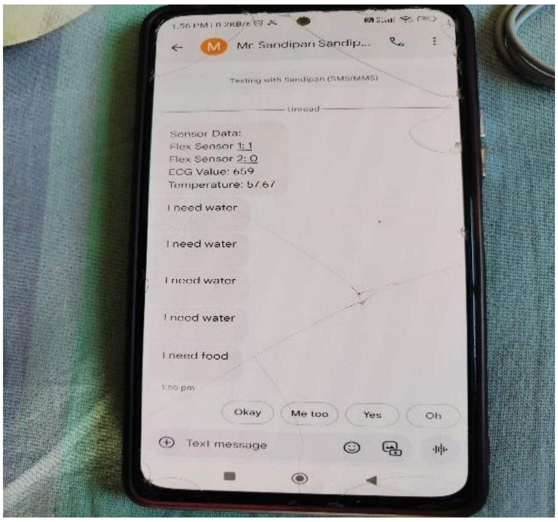

Fig 12: Final Output via message alert

5.2 Discussion

The proposed health monitoring system provides a low-cost, real-time solution to monitor paralysis patients who may have limited mobility and communication ability. The integration of sensors and GSM communication achieved the primary goal of providing timely alerts to caregivers.

Key Advantages Observed:

- **Continuous-Monitoring:**
  The system enables real-time tracking of body temperature, heart rate, and limb movement without the need for manual checks.

- **Prompt-Alerts:**
  Whenever any abnormal reading is detected, an SMS is sent to a pre-registered caregiver's mobile number. This ensures rapid response in emergencies.
- **Cost-Effective-Design:**
  All components used are low-cost and readily available. The use of Arduino Mega 2560 allows easy interfacing of multiple sensors and modules, reducing the need for additional processing hardware.
- **Ease-of-Use:**
  The 16x2 LCD display provides immediate visual feedback for local monitoring, making the system user-friendly for caregivers without technical knowledge.

Challenges Faced:

- **Sensor-Noise-&-Calibration:**
  ECG sensors were sensitive to external electrical noise and required proper placement for accurate readings. Similarly, the flex sensor needed calibration to avoid false alerts due to slight vibrations or accidental bends.
- **GSM-Network-Dependency:**
  The alert system relies heavily on the availability and strength of the GSM signal. In areas with poor coverage, there was noticeable delay in SMS delivery.
- **Limited-Parameter-Range:**
  The current system monitors only three parameters. For more comprehensive health analysis, additional sensors (such as SpO_2, respiration rate, or blood pressure) could be integrated.
- **No-Data-Logging:**
  The system does not currently store historical data, which limits long-term health analysis. Future improvements could include SD card storage or cloud connectivity for data history.

5.3 Use Case Analysis

This system was designed to meet the real-world needs of patients who may be homebound or living in rural areas where immediate medical support is not always available. The test results show that the system:

- Is reliable for single-patient monitoring.
- Functions well in both indoor and semi-outdoor conditions.

- Can be operated by non-technical caregivers due to its simplicity.
- Enhances patient safety by reducing dependency on constant physical supervision.

5.4 Summary

In conclusion, the developed GSM-Based Paralysis Patient Health Monitoring System achieves its intended objectives with high reliability and performance. It provides an essential tool for improving patient care, especially for individuals who are unable to communicate or move independently. Despite some limitations such as reliance on GSM network availability and lack of historical data storage, the system proves to be an effective prototype for remote health monitoring. Future improvements can further enhance its capabilities, making it suitable for wider deployment in real-life healthcare applications.

Future plan

The current implementation of the GSM-Based Paralysis Patient Health Monitoring System has proven effective in basic health monitoring and emergency alert generation for paralysis patients. However, there are several enhancements and upgrades that can be incorporated in the future to improve the system's functionality, reliability, and usability:

1. Integration of Additional Health Parameters

In the future, more advanced biomedical sensors can be integrated to monitor additional vital signs such as:

- Oxygen saturation (SpO_2)
- Blood pressure
- Respiratory rate
- Blood glucose levels

This will provide a more comprehensive health assessment of the patient.

2. Data Logging and Cloud Storage

Currently, the system displays real-time data and sends alerts, but it does not store past data. In future versions:

- A cloud-based server can be used to log health data over time.
- Data can be analyzed for long-term trends and shared with doctors remotely.
- Mobile apps or web dashboards can be developed for live monitoring and record-keeping.

3. Use of IoT and Wi-Fi Modules

To enhance connectivity and reduce reliance on GSM signal strength:

- Wi-Fi modules (e.g., ESP8266 or ESP32) can be added for internet-based communication.
- MQTT or HTTP protocols can be used for efficient data transfer to cloud servers or health apps.

4. Wearable Design

The future design can be miniaturized and converted into a wearable device or integrated into a smart belt or wristband that the patient can wear comfortably at all times.

5. Machine Learning for Predictive Alerts

With enough historical data, machine learning algorithms can be implemented to:

- Detect abnormal patterns before a crisis occurs.
- Predict possible health deterioration based on trends.
- Customize alerts based on patient history.

6. Emergency Call Feature

Along with SMS alerts, future systems can include:

- Automatic voice calls to emergency contacts.
- Integration with ambulance or nearby hospital networks for immediate help.

7. Mobile Application Development

A dedicated Android/iOS app can be developed for caregivers to:

- Monitor live health data.
- Set custom thresholds for alerts.
- Track patient history and receive notifications.

8. Battery and Power Optimization

Power efficiency will be improved for long-term, portable use:

- Use of rechargeable Li-ion batteries.
- Solar panels or wireless charging options.
- System sleep modes when not active to conserve energy.

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TITLE:
GSM BASED PARALYSIS PATIENT HEALTH MONITORING SYSTEM

OBJECTIVE:
The objectives of a GSM-based Paralysis Patient Health Monitoring System are:

- Real-time Data Transmission: Enable continuous monitoring of vital signs (such as heart rate, blood pressure, body temperature and body movement) and send this data to healthcare providers via GSM technology.
- Emergency Alerts: Automatically alert caregivers or medical professionals in case of critical health changes or emergencies, ensuring timely intervention.
- Remote Accessibility: Allow family members and healthcare providers to access patient health information remotely, facilitating better communication and decision-making.
- Patient Comfort: Minimize the need for frequent hospital visits by providing at-home monitoring, improving the overall comfort and quality of life for patients.
- Data Logging and Analysis: Collect and store health data over time for trend analysis, enabling personalized healthcare adjustments and better management of the patient's condition.

ABSTRACT:
The GSM-Based Paralysis Patient Health Monitoring System is designed to provide real-time health monitoring and emergency alert mechanisms for patients suffering from paralysis. The system employs a combination of sensors and communication modules to track critical health parameters, ensuring timely intervention in case of abnormalities. The project utilizes an Arduino mega 2560 microcontroller to integrate and process data from various sensors, including a LM35 Temperature sensor for measuring temperature and humidity, an ECG sensor for monitoring heart rate, and a flex sensor to detect limb movement. These parameters are displayed on a 16x2 LCD display for local monitoring. For remote communication, the system uses a GSM-GPRS SIM900 module, which sends real-time health data and the patient's location to caregivers or healthcare providers via SMS. In emergency situations, such as a sudden change in vital signs, the system triggers an alert and provides the patient's exact location using the GPS feature.

1.1 Context
Paralysis is a neurological condition that results in the loss of muscle function in one or more parts of the body. Patients suffering from paralysis often face significant challenges related to mobility, self-care, and communication. They are usually dependent on caregivers for assistance in daily activities and health monitoring. A major concern in the management of such patients is the inability to detect sudden medical emergencies, such as abnormal body temperature, irregular heartbeat, or loss of consciousness, especially when the patient is alone or unable to speak.
Traditional healthcare models rely heavily on periodic monitoring and human supervision, which may not

always be feasible, especially in rural or resource-limited environments. These models are inadequate for providing continuous, real-time health updates. As a result, there is a critical need for a system that can automatically monitor the patient's health conditions and notify caregivers instantly in case of any abnormalities.

1.2 Motivation for the Project

The motivation behind this project arises from the growing need for accessible, real-time health monitoring solutions tailored for patients with severe physical limitations. Paralysis patients often find it difficult or impossible to alert caregivers during emergencies due to limited movement and speech disabilities. In such cases, delays in medical intervention can lead to serious health complications or even death.

This project aims to bridge the communication and care gap by offering a system that not only monitors key health indicators continuously but also communicates this information to caregivers remotely. Technologies like GSM communication and GPS tracking enable rapid response, ensuring that patients receive timely help. The use of affordable and readily available components makes the system practical for implementation in both urban and rural healthcare settings.

1.3 Aim

The primary objective of this project is to design and develop a real-time health monitoring system specifically for paralysis patients. The system aims to continuously observe critical physiological parameters such as:

- Body temperature
- Heart rate
- Limb movement

Using these data, the system can detect irregularities and immediately alert caregivers through SMS notifications. Additionally, in emergency conditions, the system sends the patient's exact location using GPS data, enabling prompt medical assistance. The system enhances patient safety, autonomy, and caregiver awareness.

1.4 Scope of the Project

The scope of this project includes the design, development, and implementation of an embedded health monitoring system capable of:

- Measuring and displaying body temperature using an LM35 sensor
- Monitoring heart rate using an ECG sensor
- Detecting limb movement using a flex sensor
- Displaying real-time data on a 16x2 LCD screen
- Sending SMS alerts to caregivers in case of abnormal health readings
- Transmitting GPS location in emergency situations using the GSM module

This system is focused on non-invasive monitoring and communication. It does not include advanced diagnostic features, medical-grade ECG analysis, or long-term health data storage. However, it is an effective solution for continuous home-based monitoring and early emergency detection.

Chapter 2

Theory

2.1 Introduction to Health Monitoring Systems

Health monitoring systems are essential in today's medical field, especially for patients who require constant observation. These systems are designed to continuously track vital physiological parameters such as heart rate, temperature, and movement, thereby allowing caregivers to respond promptly in case of emergencies. For patients with paralysis or limited mobility, regular clinical visits or manual monitoring is often impractical. In such scenarios, automated health monitoring systems offer a practical and efficient solution. By integrating biomedical sensors with microcontrollers and communication modules, real-time monitoring becomes feasible even in remote or home-care environments.

2.2 Embedded Systems in Medical Applications

Embedded systems are specialized computing systems designed to perform dedicated functions within larger mechanical or electrical systems. They are composed of hardware and software and are optimized for specific control functions. In the field of healthcare, embedded systems have revolutionized patient care by enabling portable, reliable, and real-time monitoring devices. These systems operate with low power and provide accurate outputs, which is essential in health-critical applications. In this project, the embedded system consists of the Arduino Mega 2560 microcontroller integrated with biomedical sensors and communication modules to provide an effective health monitoring solution for paralysis patients.

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