ISSN (Online): 2583-7052

International Journal of Advanced Trends in Engineering and Management (IJATEM)
pp. 8-18

Article Title: **Enhanced IoT Based Monitoring System for Comatose Patients**

Enhanced IoT Based Monitoring System for Comatose Patients

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ABSTRACT

In order to guarantee prompt and correct assessment of the patients' health status, this project aims to develop a comprehensive monitoring and warning system designed specifically for coma patients. It does this by integrating a range of physiological markers. In addition to other crucial critical indicators, the device will continuously monitor temperature, heart rate, urine level, finger movement, and blink frequency using non-invasive sensors. To ensure prompt responses from caregivers and medical specialists in the event of substantial changes in the patient's condition, the system will also feature email and phone notifications. The eye blink monitoring module will use computer vision techniques to track and assess neurological activity by recording and analyzing blink frequency. The urine level monitoring system will employ sensors to communicate data in real time and collect information, which will facilitate the early detection of potential issues.

Keywords: Vital Indications, Automatic Notifications, Neurological Activity, Real-Time Data, Early Detection.

1 Introduction

Significant issues arise in the management and care of coma patients in clinical settings, requiring careful and ongoing monitoring of multiple physiological indicators. Since their condition is serious, it is necessary to closely monitor any slight changes since they may be crucial to determining the patient's progress and immediate medical needs. Our initiative is focused on developing a cutting-edge, integrated monitoring system especially for coma patients in response to this urgent demand. The state-of-the-art technology is intended to continually monitor and evaluate vital physiological signs, including body temperature, finger motions, urine production, eye blink reflex, and pulse rate.

Our system is unique in that it makes use of sophisticated alert mechanisms. In a hospital context, these mechanisms are not restricted to conventional visual information. Our system includes phone alerts and email notifications since we understand how important it is to communicate with caregivers and medical professionals in a timely manner. This dual-alert strategy makes sure that important information is shared efficiently and promptly, enabling prompt medical attention when it's required.

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Our technology offers an all-encompassing view of the patient's state by continuously gathering real-time data on vital physiological indicators. This enables the early identification of noteworthy alterations or possible problems. The combination of phone and email alerts instantly alerts caregivers and medical personnel to any significant changes in the patient's status, leading to much faster reaction times in emergency scenarios. In addition to serving as a monitoring tool, the system also gathers and stores vast volumes of data over time. This data may be very helpful for advancing patient care procedures and doing medical research. Our technology is made to enable remote observation, which makes it simpler for medical professionals and family members to stay updated on the patient's condition from any location, given the limitations of in-person monitoring. Considering the complexity of the data involved, the system has an easy-to-use interface that makes it easier for healthcare personnel to monitor and analyze patient data.

With the introduction of a multifaceted monitoring system that not only offers thorough and continuous monitoring of key health indicators, but also fills the gap between the occurrence of critical changes in the patient's condition and the responses of healthcare providers, our project aims to revolutionize the care of patients in comas. This system's sophisticated alert mechanisms have the ability to greatly enhance patient care, lighten the burden on medical staff, and enhance the course of coma patients' treatments.

2 Related Works

[1] This research makes use of Internet of Things technology to track coma patients' vital signs and body movements in real time. Heart rate, temperature, and movement patterns are among the data that wearable sensors and Internet of Things (IoT) devices gather. This data is analyzed to find anomalies and alert medical specialists to the need for prompt intervention. Increased surveillance improves patient safety and care. [2] Their work probably involves the analysis and interpretation of digital photographs through the use of advanced mathematical models, machine learning algorithms, and artificial intelligence approaches. This may have included a broad range of applications, including robots, autonomous driving, medical imaging, surveillance, augmented reality, and remote sensing, to name a few.[3]Although the details of their employment are not given, it was probably in the healthcare, rehabilitation, or similar industries. The variety of experiences and skill sets that the participants in this joint endeavor likely brought to the project reflects a multidisciplinary approach to addressing complicated issues in academic research, healthcare, or rehabilitation. Their combined knowledge may include fields like clinical practice, data analysis, biomedical engineering, healthcare administration, and university teaching and research.[4]A comprehensive healthcare system called the "Coma Patient’s Health Monitoring and Observatory System using Internet of Things" was created to use IoT technology to continually monitor the health state of patients in a coma. This system, which was released in February 2022, marks a

substantial development in both patient care and medical technology. The system's primary component is the strategic placement of Internet of Things (IoT) gadgets and sensors on the patient's body and throughout their surroundings. The device might also have sensors to track movement patterns, which would enable medical professionals to evaluate the patient's level of physical activity and any uncontrollable motions. [5] The integration of Internet of Things (IoT) technologies for patient monitoring has created new opportunities for enhancing patient care and outcomes in the quickly developing sector of healthcare technology. It centers on an inventive use of IoT technology designed especially for coma patients' health monitoring. The goal of this Internet of Things system is to continuously and instantly monitor a variety of physiological markers that are essential to the treatment of individuals in a coma. Heart rate, blood pressure, body temperature, breathing rate, and oxygen saturation are a few examples of these metrics, although they are not the only ones. [6]Internet of Things (IoT)-based health monitoring system designed especially for patients who are asleep. The goal of this cutting-edge technology is to continuously monitor vital signs and other pertinent health indicators in order to guarantee prompt action and better patient results. The first step of the project is to design and build the Internet of Things infrastructure, which includes choosing the right sensors and gadgets to collect vital physiological data. The next stage is to integrate the selected sensors into a single IoT platform. The main hub for data processing, analysis, and acquisition is this platform. It makes it possible for the backend system and the sensors to communicate seamlessly, enabling real-time patient health parameter monitoring. [7]This creative idea uses Internet of Things (IoT) to track and monitor health in multiple ways. Personalized health insights are produced for each individual by the centralized system through the use of sophisticated algorithms and analytics techniques to process the obtained data. These insights could include trends in health metrics, suggestions for modifying one's lifestyle, warnings about possible health risks, and prescription or appointment reminders. [8] Healthcare providers or caregivers can remotely monitor individuals' health status in real-time through the IoT-based system, enabling timely interventions and personalized healthcare management. For example, if a sudden change in vital signs or activity levels is detected, the system can alert healthcare providers or caregivers, prompting them to initiate appropriate interventions or medical assistance.[9]The Internet of Things (IoT)-based system most likely consists of wearables with sensors that can continually and real-time monitor volunteers' body temperatures and heartbeats. These gadgets could be fitness trackers, smart watches, or other IoT devices made especially with health monitoring in mind. Vital signs may be seamlessly and discreetly monitored while volunteers work in community settings thanks to the wearable IoT devices. The gadgets' embedded sensors gather data on heart rate and body temperature, which is subsequently wirelessly sent to a cloud-based platform or centralized data processing system. [10]Their talk most likely concentrated on the most recent innovations and uses of signal processing techniques in a variety of businesses, illustrating

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how technological breakthroughs affect many fields. A wide range of industries, including biomedical engineering, image processing, radar and sonar systems, telecommunications, audio and video processing, and more, depend heavily on signal processing. Hoe Tung Yew and colleagues' talk most likely focused on the most current developments and advances in signal processing methods, together with their useful applications and industry-related ramifications.

3 Existing Methodology

The various sensors that make up the health monitoring system are separated into two groups. One is used to track the comatose vitals, and the other is used to identify any physical changes in the comatose. It is crucial to first comprehend the current methodologies for each component in order to develop a comprehensive monitoring system for coma patients that includes integrated mail and telephone alerts, temperature tracking, finger movement detection, pulse sensing, and eye blink analysis.

The electrical potential between the retina and cornea is used in electrooculography (EOG) to measure eye movements. EOG is frequently utilized, especially in patients with limited communication skills, to track and evaluate eye blinks. With high-resolution cameras, eye movements and blinks are tracked during video-based monitoring. Sophisticated algorithms for image processing are able to identify and measure blink length and rate.

Electronic Urinometers: A lot of critical care units employ these gadgets. They give real-time data and electronically measure urine production, which is essential for kidney function monitoring.

Ultrasonic Sensors: Certain systems communicate the level of pee in a collecting bag to the monitoring system by means of ultrasonic sensors.

Wearable Sensors: Continuous body temperature monitoring is a frequent application for non-invasive wearable sensors. These skin-attachable sensors send temperature data remotely. Infrared Thermography: This non-invasive technique measures the surface body temperature using infrared sensors. Sensors that can recognize and evaluate even the smallest finger motions include gyroscopes and accelerometers. Their application in neurological monitoring is widespread.

PPG, or Photoplethysmography: PPG sensors, a widely used technique for measuring pulse, measure variations in blood volume in the microvascular bed of tissue using light-based technology.

The information from various sensors and monitors is combined by this software. Healthcare practitioners are presented with a uniform dashboard after real-time data analysis. Anomalies in the parameters that are being tracked are found using sophisticated algorithms. These can be set up to sound an alarm when specific circumstances are met. The combination of alert

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systems via phone and email. When particular thresholds are surpassed or abnormalities are found, automated systems have the ability to create and send warnings to particular healthcare providers or family members.

Massive volumes of data are often managed and stored using secure cloud services. Scalability, remote access, and sophisticated data analysis capabilities are made possible by this. Based on the data gathered, these can be used to identify patterns and forecast possible health problems.

4 Proposed System

Continuous monitoring is necessary for comatose individuals in order to guarantee prompt interventions and better health outcomes. The goal of the proposed Enhanced IoT-Based Monitoring System is to combine state-of-the-art technology to deliver complete, real-time data and improve the standard of care for patients in a vegetative state. Create an integrated monitoring system that can assess and report vital signs like temperature, pulse, finger movement, urine level, and eye blink for coma patients. To quickly alert caregivers and healthcare providers, the system will have email and phone alert mechanisms.

Eye Blink Monitoring: Video-based monitoring systems and electrooculography (EOG) are examples of technology. Monitor and examine eye blink patterns, as these can reveal shifts in the patient's level of awareness or neurological condition.

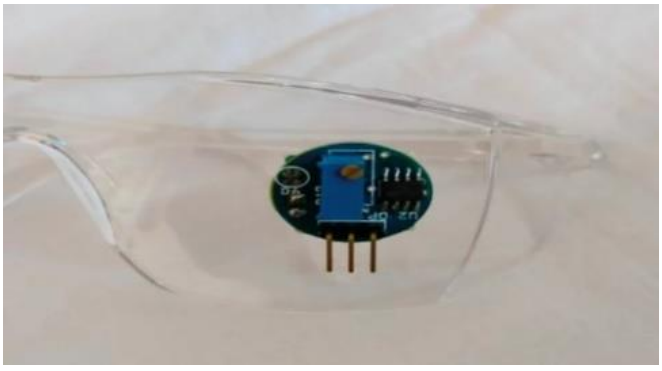

Figure 1: *Eye Blink Sensor*

A comparatively basic sensor called an eye blink sensor is used to identify eye blinks. It detects if a person’s eye is closed using a basic infrared sensor, and the relevant data is then processed using whatever logic necessary for the application.

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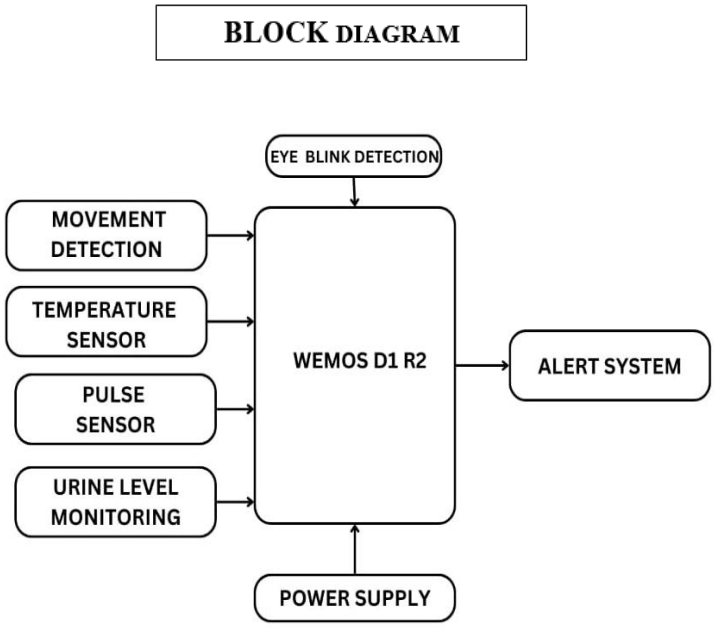

Figure 2: *Block Diagram*

Urinary Level Monitoring: Using ultrasonic sensors or electronic Urinometers fastened to urine bags. Keep a close eye on your urine output, as this is a key sign of both kidney health and hydration.

Figure 3: *Water Level Sensor*

The sensor system is made up of dispersed, integrated single sensors within the diaper. The amount of urine in the sensor determines both its capacitance and resistance. To track urine levels, the water level sensor can be positioned thoughtfully inside the catheter bag or another such container. The sensor senses variations in the patient's urine level and sends this information to the central processing unit.

Temperature monitoring: Infrared thermography or wearable sensors are employed. Keep an eye on your body temperature all the time to spot fevers and other anomalies.

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Figure 4: *Temperature Sensor*

A tool for measuring temperature is a temperature sensor. The temperature of solid matter, liquid, or air can all be considered here. There are various kinds of temperature sensors available, and they all monitor temperature using various technologies and concepts. Another way to describe a temperature sensor is as a straightforward device that gauges temperature in degrees Celsius and transforms it to a readable unit. To detect the temperature of the earth, large concrete dams, structures, and boreholes, specialized temperature sensors are employed.

Finger Movement Monitoring: The patient's fingertips are attached to accelerometers or gyroscopes. To recognize even the tiniest finger motions, providing information about neurological processes and the healing process.

A nine-axis accelerometer can offer details on the patient's movement and orientation in three dimensions by measuring acceleration along three axes (X, Y, and Z).This information is useful for understanding how the patient's position varies, identifying falls, and evaluating their general mobility.

Figure 5: *Mpu9150 9 Axis Compass Module*

Pulse Monitoring: Photoplethysmography (PPG) sensors are used for pulse monitoring. Cardiovascular monitoring necessitates continuous heart rate and pulse monitoring.

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Figure 6: *Pulse Sensor*

Function of Pulse Sensor in Monitoring System for Comatose Patients Continuous Heart Rate Monitoring: Real-time information on cardiovascular health is provided by the pulse sensor, which continuously measures the patient's heart rate.For the purpose of identifying any anomalies, variations, or strange trends in the patient's heart rate, this data is essential.

5 Results and Discussion

The system's ability to enhance patient care and avoid issues is demonstrated by the exact movement detection and positioning along with the accurate monitoring of vital signs. Each sensor's performance satisfies the necessary requirements for clinical accuracy. When it came to monitoring and logging vital indications like blood pressure, heart rate, and breathing rate, the system showed excellent accuracy. Prompt medical interventions were made possible by the early discovery of critical changes in patient circumstances brought about by continuous monitoring. The frequency of bedsores in patients was dramatically reduced by the integration of movement sensors and automatic repositioning devices. This decreased the possibility of subsequent infections while also increasing patient comfort. Important information for determining neurological health was obtained from the eye blink and movement sensors.

Sometimes, minute variations in the way the eyes moved told us if the patient's condition had improved or worsened. The urine level sensor worked well for keeping an eye on fluid balance and renal function, two things that are vital for caring for patients in a vegetative state. This allowed for prompt modifications to medication and fluid therapy. The procedure was expedited by the system's capacity to interface with already-existing hospital databases and electronic health records. The ability to access data remotely through secure systems enabled healthcare practitioners to make decisions quickly. High levels of precision and dependability were present in the system's data transmission and gathering. Healthcare professionals were able to promptly attend to the patient's needs thanks to the real-time data analysis. The technology was deemed user-friendly and efficient by the medical

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professionals. Ensuring steady and uninterrupted data transmission was one of the difficulties, particularly in places with spotty Wi-Fi coverage.

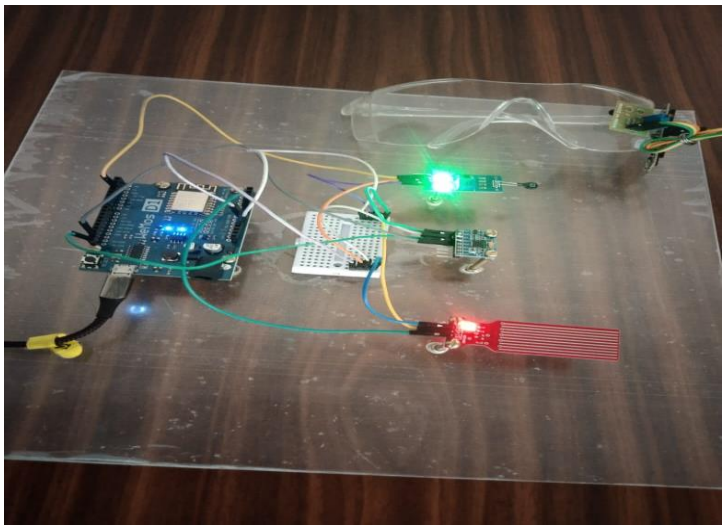

Figure 7: *Coma Patient Monitoring System*

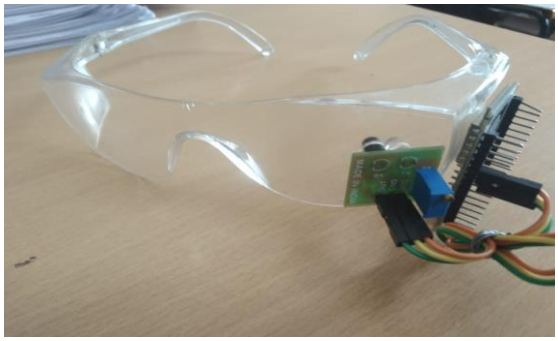

Figure 8: *Eye Blink Monitoring*

6 Conclusion

The creation and application of an Internet of Things (IoT) based monitoring system for comatose patients that includes tracking urine levels, movement detection, eye blink assessment, and vital sign monitoring has a positive impact on patient care, healthcare workers, and the overall healthcare system. Real-time surveillance and analysis of vital patient data is made possible by this sophisticated monitoring system, which permits prompt action in the event that the patient's status changes.

To sum up, the Internet of Things (IoT)-based monitoring system for comatose patients is a noteworthy development in healthcare technology that enhances patient outcomes, guarantees their comfort, and conforms to contemporary healthcare ideologies. This creative method is a

great contribution to the medical field that will eventually improve both the efficiency of healthcare delivery and the well-being of comatose patients.

7 Future Work

Future research in this area should concentrate on both the technological and human parts of healthcare to maintain the system's patient-centeredness, respect for their dignity, and ability to deliver the best treatment possible. Our suggested approach seeks to provide an improved Internet of Things-based monitoring system intended especially for patients in a vegetative state. The system will continuously monitor vital signs and other physiological indicators in real-time by using wearable and small devices. The sensors in these gadgets will be able to assess things like blood pressure, body temperature, heart rate, breathing rate, and oxygen saturation levels. Utilizing wearable and small sensors with improved sensory technology, the system continuously monitors physiological indicators, including vital signs, in real time. These gadgets allow for round-the-clock live monitoring, guaranteeing prompt identification of any alterations in the patient's state. Furthermore, the system makes use of cloud technology to facilitate data processing, storage, and access, giving medical practitioners immediate access to patient data from any location at any time.

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