

Smart Wearable Health Monitoring System with IoT and Emergency Alert Mechanism

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Abstract- — Ensuring continuous health monitoring and child safety has become an important concern in modern society. Traditional monitoring methods do not provide real-time health updates or emergency alerts. To overcome these limitations, this project proposes the design and implementation of an IoT-enabled smart wearable device for continuous health monitoring and emergency notification. The proposed system combines health monitoring, location tracking, and emergency communication into a compact wearable device. The system continuously monitors vital parameters such as heart rate, pulse rate, oxygen level, and body temperature using the MAX30100 pulse oximeter sensor and LM35 temperature sensor. The collected data is processed by the ESP32 microcontroller and displayed on an OLED display for local monitoring. During abnormal conditions, the GSM SIM800L module sends emergency alerts, while the GPS module provides live location details to parents or guardians for quick response and tracking. The wearable device also supports two-way communication during emergencies. A 3.7V Lithium Polymer battery, Type-C charging module, and DC-DC voltage booster ensure stable and portable operation. The proposed system offers a reliable, low-cost, and real-time solution for child health monitoring and safety management, improving parental awareness and emergency response through IoT technology.

Keywords- IoT, Smart Wearable Device, ESP32, Health Monitoring, Child Safety, GSM, GPS, Emergency Notification..

I. INTRODUCTION

The rapid growth of Internet of Things (IoT) technology has significantly improved healthcare and safety monitoring systems. In recent years, ensuring continuous health monitoring and child safety has become a major concern due to increasing health emergencies, accidents, and security threats involving children. Traditional monitoring methods are unable to provide real-time health updates, live location tracking, and immediate emergency notifications, which may delay timely assistance during critical situations.

To overcome these limitations, this project proposes the design and implementation of an IoT-enabled smart wearable device for continuous health monitoring and emergency notification. The proposed system continuously monitors important health parameters such as heart rate, pulse rate, oxygen level, and body temperature using sensors like the MAX30100 pulse oximeter sensor and LM35 temperature sensor. The collected data is processed using the ESP32 microcontroller and displayed on an OLED display for local monitoring and analysis.

The system also integrates GSM SIM800L and GPS modules for emergency communication and real-time location tracking. Whenever abnormal conditions are detected, the device

automatically sends alert notifications and live location details to parents or guardians for immediate response. The wearable device provides a portable, reliable, and low-cost solution for improving child healthcare and safety using IoT technology.[1][2]

II. LITERATURE SURVEY

Several research studies have been carried out in the field of IoT-based healthcare and child safety systems to improve real-time monitoring and emergency response. Recent advancements in wearable technology and wireless communication have enabled the development of smart healthcare devices capable of continuously monitoring physiological parameters and transmitting data remotely. These systems mainly focus on improving safety, reducing emergency response time, and providing reliable health monitoring solutions.

A research work on IoT-based wearable health monitoring systems proposed the use of sensors such as heart rate and temperature sensors integrated with wireless communication modules to monitor patient health conditions continuously. The study highlighted that IoT technology enables real-time data transmission and remote health supervision, making healthcare systems more efficient and accessible. However, the system

lacked emergency communication and location tracking features required for child safety applications.

Another study focused on child safety tracking systems using GPS and GSM technology. The proposed system was designed to track children’s locations and send alert notifications to parents during emergencies. The research demonstrated that GPS and GSM modules provide effective real-time communication and location monitoring. However, the system mainly concentrated on tracking functionality and did not include continuous health monitoring features.

A further research work introduced a smart wearable device using ESP32 and IoT technology for monitoring body temperature and heart rate. The system used wireless communication to send health data to caregivers and provided early detection of abnormal conditions. Although the device improved healthcare monitoring, it did not support two-way communication and integrated safety mechanisms.

Based on the limitations identified in previous studies, the proposed project combines health monitoring, GPS tracking, GSM communication, emergency alert generation, and two-way communication into a single compact wearable device. Thus, the system provides an efficient and reliable solution for continuous child health monitoring and safety management using IoT technology.[3][4]

III. METHODOLOGY

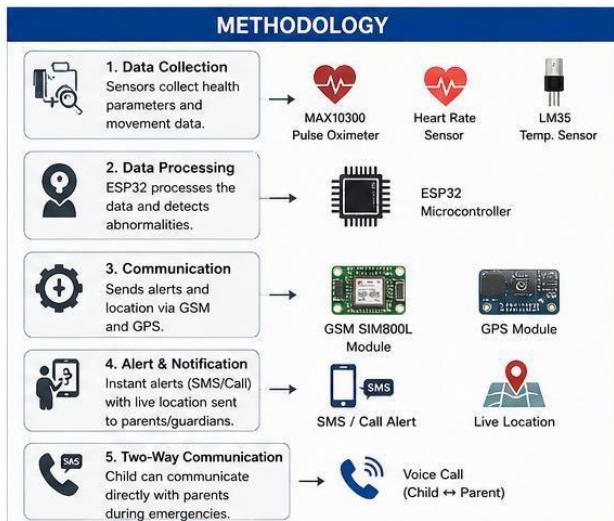


Fig 1: Methodology

The fig 1 illustrates the methodology of the IoT-enabled smart wearable device developed for continuous child health monitoring and emergency notification. The system is designed to monitor vital health parameters, detect abnormal conditions, and provide immediate alerts to parents or guardians through real-time communication technologies.

In the first stage, data collection is performed using multiple sensors integrated into the wearable device. The MAX30100 pulse oximeter and heart rate sensor continuously monitor the child’s pulse rate and oxygen level, while the LM35 temperature sensor measures body temperature in real time. These sensors collect accurate physiological data required for health monitoring and emergency detection.

In the second stage, the collected sensor data is processed by the ESP32 microcontroller, which acts as the central processing unit of the system. The ESP32 analyzes the received values and identifies abnormal conditions such as high temperature, irregular heart rate, or sudden health fluctuations. Due to its built-in wireless communication capability and low power consumption, ESP32 is highly suitable for wearable IoT applications.

The third stage involves communication and tracking using the GSM SIM800L module and GPS module. Whenever an abnormal condition is detected, the GSM module sends emergency SMS or call alerts to registered parents or guardians, while the GPS module provides the child’s live location details for quick assistance and tracking.

In the fourth stage, alert and notification mechanisms ensure rapid emergency response through instant communication. Finally, the system supports two-way communication, enabling direct voice interaction between the child and parents during emergencies. Thus, the proposed methodology ensures reliable health monitoring, real-time tracking, and improved child safety through IoT technology.[5][6]

III. WORKING METHODOLOGY

The fig 2 illustrates the working methodology of the IoT-enabled smart wearable health and safety device designed for continuous child monitoring and emergency notification. The system operates through a sequence of data collection, processing, communication, and alert generation to ensure real-time health monitoring and child protection.

In the first stage, the wearable device continuously collects physiological and movement-related data using integrated



sensors. The MAX30100 pulse oximeter and heart rate sensor monitor the child’s heart rate and oxygen level, while the LM35 temperature sensor measures body temperature. These sensors continuously transmit real-time data to the processing unit for analysis.

Fig 2: Working Methodology

In the second stage, the collected information is processed by the ESP32 microcontroller, which acts as the central controller of the system. The ESP32 analyzes the incoming sensor values and detects any abnormal conditions such as increased body temperature, irregular heart rate, or unusual movement patterns. The microcontroller ensures fast and accurate decision-making with low power consumption, making it suitable for wearable healthcare applications.

Once an abnormal condition is detected, the system enters the third stage, where the GSM SIM800L module and GPS module are activated. The GSM module sends emergency SMS or call alerts to registered parents or guardians, while the GPS module shares the child’s live location coordinates for immediate tracking and assistance.

In the fourth stage, parents receive alert notifications on their mobile phones along with real-time location details. Finally, the system enables two-way communication, allowing the child and parents to communicate directly during emergencies. Thus, the proposed working methodology provides a reliable, real-time, and efficient solution for child health monitoring, emergency response, and safety management using IoT technology.[7][8]

Global Observation



Fig 3: Global Observation

The fig 3 illustrates the growing global concern regarding child health monitoring and safety management. Across the world, millions of children face health emergencies, accidents, and security threats every year due to the absence of continuous monitoring systems. The image highlights that a large number of children suffer from preventable health issues, emphasizing the need for early detection and real-time medical observation. Delayed emergency response and lack of immediate communication are major challenges in ensuring child safety.

The figure also represents the increasing number of child abductions and missing child incidents reported globally. These situations demand advanced real-time tracking and alert mechanisms that can quickly notify parents or guardians during emergencies. Traditional safety methods are often insufficient because they cannot provide continuous monitoring or instant location updates.

Another important observation shown in the image is the rapid growth of IoT-based wearable healthcare technologies worldwide. Smart wearable devices integrated with sensors and wireless communication systems are becoming essential solutions for health monitoring and emergency notification applications. These devices can monitor body temperature, heart rate, and movement conditions continuously while sending alerts through GSM and GPS technologies during abnormal situations.

The global healthcare industry is increasingly adopting IoT-enabled wearable systems due to their reliability, portability, and real-time communication capabilities. The image further indicates the expanding market value of IoT healthcare technologies, showing their importance in future smart

healthcare systems. Therefore, the proposed IoT-enabled wearable device for continuous health monitoring and emergency notification provides an effective solution for improving child safety, parental awareness, and rapid emergency response in modern society.[9][10]

IV. BLOCK DIAGRAM

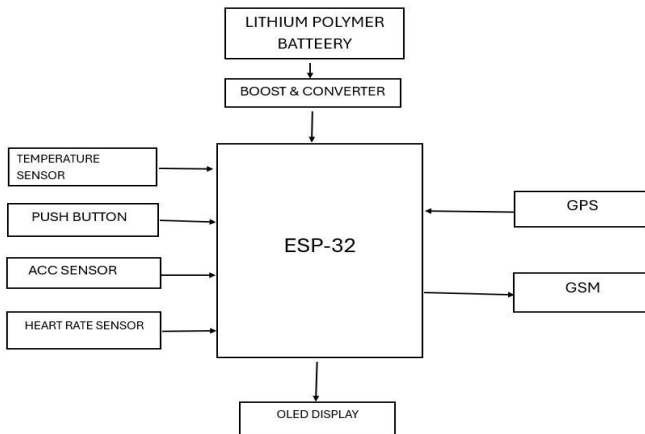


Fig 4: Block Diagram

The fig. 4 represents the overall functional structure of the IoT-based wearable health and safety system, highlighting the interactions among the sensing, processing, communication, and power modules. At the centre of the system is the ESP32 microcontroller, which serves as the main control unit responsible for data acquisition, processing, and decision-making.

The system is powered by a 3.7V lithium polymer battery, which supplies energy to all components. Since different modules require stable voltage levels, a boost and converter circuit is used to regulate and step up/down the voltage as needed, ensuring efficient and reliable operation.

On the input side, multiple sensors are connected to the ESP32. The temperature sensor continuously measures the body temperature of the user. The heart rate sensor monitors pulse rate in real time, providing critical health information. The accelerometer (ACC sensor) detects motion, enabling the system to identify activities such as walking, running, or sudden falls. Additionally, a push button is included as an emergency trigger, allowing the user to manually send alerts when needed.

For location tracking, a GPS module is interfaced with the ESP32 to obtain real-time geographical coordinates. This

information becomes essential during emergencies to track the user's location accurately.

Communication with external users is handled by the GSM module, which sends alert messages and location details to predefined contacts such as parents or guardians. This ensures immediate response in case of abnormal health conditions or emergencies.

The OLED display is connected as an output device to provide real-time visual feedback of health parameters like heart rate and temperature.

Overall, the block diagram illustrates a well-integrated system where sensors provide continuous input, the ESP32 processes the data, and communication modules ensure timely alerts, making the device effective for health monitoring and safety applications.

V. INDIAN STATISTICS

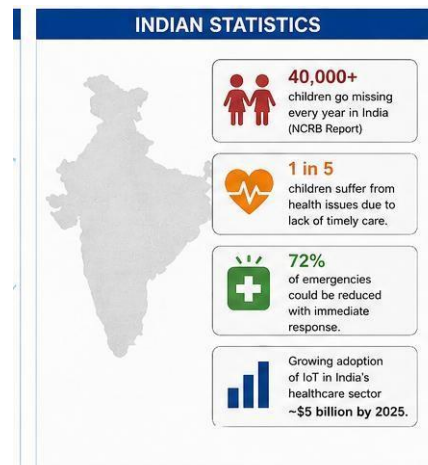


Fig 5: Indian Statics

The fig 5 represents the current scenario of child health and safety challenges in India and highlights the growing importance of IoT-enabled wearable healthcare systems. According to reports published by the National Crime Records Bureau (NCRB), more than 40,000 children go missing every year in India. This alarming statistic emphasizes the urgent need for advanced child safety technologies capable of providing real-time tracking and emergency communication. Traditional monitoring methods are often unable to ensure continuous supervision, especially in crowded public places and school environments.

The image also indicates that nearly 1 in 5 children suffer from health-related issues due to delayed or a lack of timely medical care. Many emergencies, such as sudden fever, abnormal heart rate, accidents, or unconscious conditions, require immediate attention. However, parents and guardians may not always be physically present to monitor the child's health continuously. Therefore, wearable IoT devices can play a significant role in early detection and rapid emergency response.

Another important observation highlighted in the figure is that approximately 72% of emergencies can be minimized or controlled through immediate alerts and timely action. This demonstrates the importance of real-time monitoring systems integrated with GSM communication and GPS tracking technologies. Instant notifications and live location sharing can help parents respond quickly during critical situations.

The figure further shows the rapid growth of IoT adoption in India's healthcare sector, which is expected to reach nearly \$5 billion by 2025. This growth reflects increasing awareness about smart healthcare technologies and remote monitoring systems. Hence, the proposed IoT-enabled wearable health and safety device provides an efficient, portable, and reliable solution for improving child protection, continuous health monitoring, and emergency notification systems in India.

VI. HARDWARE IMPLEMENTATION

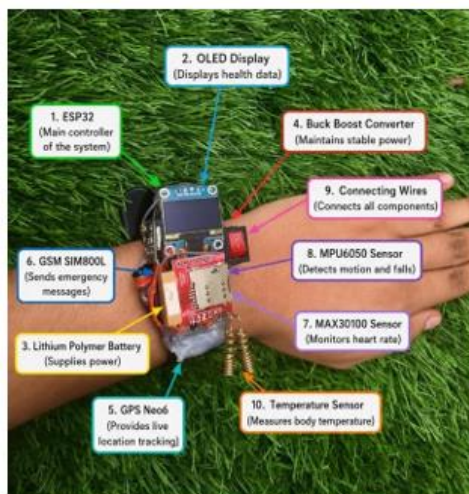


Fig 6: Hardware Implementation

The fig 6 of the Smart Wearable Health Monitoring System with IOT and Emergency Alert Mechanism shows the successful monitoring of important health parameters such as heart rate, body temperature, and oxygen level. The sensors

collect the patient's data continuously and display the values on the LCD screen in real time. Whenever the measured values exceed the normal range, the buzzer alert is activated to provide an emergency warning. This system helps in continuous health monitoring and allows doctors or family members to track the patient's condition remotely.

Hardware Output

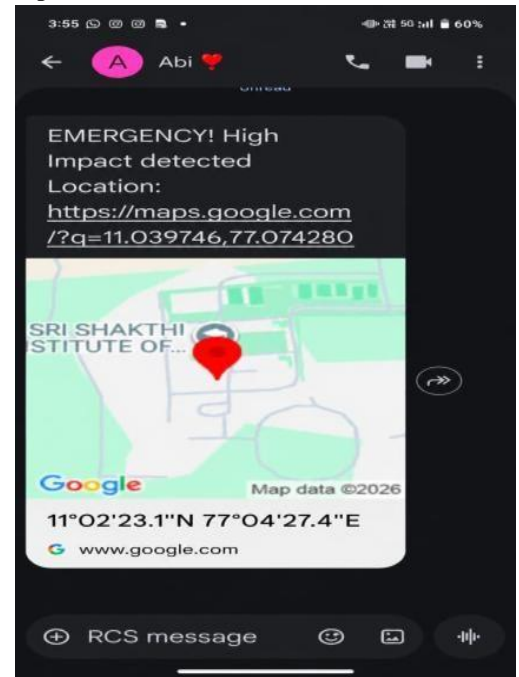


Fig 7: Hardware Output

The fig 7 illustrates the alert message generated Abnormal health condition detected. The message is automatically sent to the registered mobile number through the GSM module

Overall Result and Discussion

Table 1: Comparison table of observation and result

S.No	Parameter	Observation	Result Obtained	Discussion
1	Heart Rate Monitoring	The MAX30100 sensor continuously monitors the pulse rate	Accurate heart rate values are displayed	System successfully detected real-time pulse variations
2	Body Temperature Monitoring	The LM35 sensor measured body temperature continuously	Stable and reliable temperature readings obtained	Effective for detecting abnormal temperature conditions
3	ESP32 Data Processing	ESP32 processed sensor data efficiently	Fast response and abnormality detection achieved	Improved overall system performance and reliability
4	OLED Display Output	Health parameters displayed in real time	Clear display of temperature and heart rate values	Enabled easy local monitoring of the child's health status
5	GSM Communication	Emergency SMS/Call alerts transmitted successfully	Alerts received instantly by parents/guardians	Improved emergency response and communication efficiency
6	GPS Tracking	Live location coordinates generated accurately	Real-time child location tracking achieved	Enhanced child safety and monitoring capability
7	Emergency Notification System	Alerts are activated during abnormal conditions	Immediate notifications sent successfully	Reduced delay in emergency response
8	Two-Way Communication	Voice communication was established between the child and the parents	Successful emergency communication achieved	Increased parental interaction and child support
9	Power Supply Performance	Li-Po battery and DC-DC booster provided a stable supply	Continuous portable operation achieved	Suitable for wearable IoT applications
10	Overall System Performance	Integrated modules operated efficiently	Reliable health monitoring and safety system developed	The system provides a low-cost, portable, and real-time IoT solution

The table 1 shows the overall results and discussion of the proposed child health monitoring and safety system. The system successfully monitored heart rate and body temperature using sensors and displayed the data in real time through the OLED display. The ESP32 processed the data efficiently, while

the GSM and GPS modules provided emergency alerts and live location tracking. The emergency notification and two-way communication features improved child safety and parental support. Overall, the system worked accurately, reliably, and effectively.

VII. CONCLUSION

The proposed IoT-enabled smart wearable device for continuous health monitoring and emergency notification was successfully designed and implemented to improve child healthcare and safety management. The system effectively monitored important health parameters such as heart rate, pulse rate, oxygen level, and body temperature using the MAX30100 pulse oximeter sensor and LM35 temperature sensor. The collected data was processed efficiently using the ESP32 microcontroller and displayed in real time through the OLED display.

The integration of GSM SIM800L and GPS modules enabled instant emergency alerts and live location tracking during abnormal situations. The system successfully transmitted SMS/call notifications to parents or guardians, ensuring rapid response during emergencies. Additionally, the two-way communication feature improved interaction between the child and parents during critical situations.

Overall, the proposed wearable system provides a portable, reliable, low-cost, and real-time IoT-based solution for child health monitoring and safety applications. The project enhances parental awareness, improves emergency response efficiency, and contributes toward the development of smart healthcare and child protection systems using modern IoT technology.

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