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"Smart Med Ambulance: AIOT-Based Real Time Patient Monitoring and Emergency Response System"

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Abstract - In emergency medical situations, timely monitoring and rapid medical decision-making are critical for saving lives. This project presents a Smart Health Monitoring System for Ambulances, an IoT- and Machine Learning–based solution designed to continuously monitor a patient's vital signs during transit and transmit them to healthcare professionals in real time. The system integrates biomedical sensors to measure essential parameters such as heart rate, blood pressure, SpO_2, body temperature, and ECG signals. These sensors are interfaced with an ESP32 microcontroller, which collects, processes, and wirelessly transmits the data to a cloud-based platform using Wi-Fi connectivity.

A Machine Learning model analyzes the received data to assess the patient's health condition and classifies it into categories such as stable, moderate, or critical. This real-time analysis enables doctors at the hospital to monitor the patient remotely and prepare necessary medical interventions before the ambulance arrives. The automated system reduces the workload on paramedics, minimizes human error, and improves the accuracy of emergency diagnosis.

Overall, the proposed system enhances pre-hospital care by enabling continuous monitoring, early detection of critical conditions, and faster medical response. By combining IoT, cloud computing, and machine learning, this project contributes to the advancement of smart healthcare and improves patient survival rates during emergency transportation.

Key Words: Smart Health Monitoring, Ambulance System, Internet of Things (IoT), ESP32, Machine Learning, Biomedical Sensors, Real-Time Monitoring, Emergency Healthcare, Cloud Computing, Telemedicine

1.INTRODUCTION

The rapid advancement of healthcare technology has significantly improved the way medical services are delivered, particularly in emergency situations where every second is crucial. One of the most critical phases of emergency care occurs during patient transportation in ambulances. Continuous monitoring of vital health parameters during this period can play a vital role in early diagnosis and timely medical intervention. However, traditional ambulance systems largely rely on manual monitoring and lack real-time communication with hospitals, which may result in delayed treatment and reduced survival rates.

With the emergence of the Internet of Things (IoT) and Machine Learning (ML), healthcare systems have evolved toward smarter and more connected solutions. IoT enables the integration of biomedical sensors and communication devices to collect and transmit patient data in real time, while machine learning allows intelligent analysis of this data to detect abnormalities and predict critical conditions. These technologies together offer an effective solution to bridge the communication gap between ambulances and hospitals.

The Smart Health Monitoring System for Ambulances is designed to provide continuous, automated monitoring of a patient's vital parameters such as heart rate, blood pressure, oxygen saturation (SpO_2), body temperature, and ECG signals during transit. Using an ESP32 microcontroller with built-in wireless connectivity, the system collects sensor data and transmits it securely to a cloud-based platform. A machine learning model analyzes this data to classify the patient's health status and identify potential risks in real time.

By providing doctors with early access to patient health information, the system enables better preparedness and faster medical response upon arrival at the hospital. Additionally, the automated nature of the system reduces the workload on paramedics and minimizes human error. This project represents a significant step toward intelligent emergency healthcare systems, enhancing the quality of pre-hospital care and contributing to improved patient outcomes.

The rapid growth of urbanization and increasing number of road accidents and medical emergencies demand a faster and more efficient emergency healthcare system. Traditional ambulances often lack real-time patient monitoring and effective communication with hospitals, which can lead to delayed treatment and increased risk to patients during transit.

The Smart Med Ambulance is an advanced healthcare solution that integrates medical sensors, IoT technology,

cloud computing, and GPS tracking to continuously monitor a patient's vital signs in real time. By transmitting critical health data and location information to the hospital through a cloud-based dashboard, the system enables doctors to assess the patient's condition in advance and prepare appropriate treatment. This approach reduces response time, improves emergency decision-making, and significantly enhances patient safety and survival rates.

2. Body of Paper

The body of the paper consists of numbered sections that present the main findings. These sections should be organized to best present the material.

Problem Identification

Section 1 Emergency medical care during patient transportation faces several critical challenges that can negatively Most ambulances rely on basic medical equipment that requires manual operation and impact patient survival and treatment outcomes. One of the primary problems is the lack of continuous and real-time monitoring of patient vital signs in traditional ambulance systems. does not support live data sharing with hospitals.

Existing System

Section 2 The existing ambulance healthcare system mainly relies on manual monitoring of patient vitals using standalone medical devices. These devices do not support continuous data transmission to hospitals. Doctors receive patient information only after the ambulance arrives, causing delays in diagnosis and treatment preparation. Paramedics must manually observe and record readings, increasing workload and chances of human error.

Proposed System

Section 3 The proposed system introduces an IoT- and Machine Learning–based smart health monitoring solution for ambulances. It continuously monitors vital parameters such as heart rate, BP, SpO_2, temperature, and ECG using biomedical sensors. An ESP32 microcontroller collects and transmits data wirelessly to a cloud platform in real time.

System Requirements

Section 4 The system requires an ESP32 microcontroller with Wi-Fi connectivity, biomedical sensors (heart rate, BP, SpO_2, temperature, ECG), and a reliable power supply. Software requirements include Arduino IDE, cloud server, and machine learning model for data analysis. Internet connectivity is needed for real-time data transmission. A web or mobile dashboard is required for doctor access.

System Design

Section 5 The system is designed with sensors connected to the ESP32 as the central processing unit. Sensor data is collected, processed, and formatted within the microcontroller. The ESP32 transmits the data to a cloud server using Wi-Fi and HTTP/MQTT protocols. A machine learning model on the cloud analyzes the incoming data. The processed results are displayed on a doctor's dashboard, and alerts are generated in critical conditions.

Implementation

Section 6 The implementation involves integrating biomedical sensors with the ESP32 microcontroller. Sensor readings are programmed using embedded C in the Arduino IDE. The ESP32 connects to Wi-Fi and sends patient data to a cloud server in JSON format. A machine learning model processes the received data to evaluate patient condition. Real-time results are displayed on a web dashboard accessible to medical professionals.

Testing

Section 7 The system is tested by simulating different patient conditions using sensor inputs. Individual sensor accuracy is verified before full system integration. Data transmission is tested to ensure real-time updates on the cloud dashboard. Alert mechanisms are checked by generating abnormal vital values. Power stability and continuous operation are also tested in mobile conditions.

Results

The system successfully monitors and transmits patient vital parameters in real time. Doctors can remotely view patient health status before ambulance arrival. The machine learning model accurately classifies patient conditions and generates timely alerts. Manual workload on paramedics is reduced significantly. Overall, the system improves emergency response time and enhances pre-hospital patient care.

The Smart Med Ambulance project successfully provides real-time monitoring of vital health parameters such as ECG, SpO_2, blood pressure, and body temperature during patient transportation. All sensor data is continuously collected and transmitted to the cloud, allowing doctors to monitor the patient's condition remotely through a live dashboard before the ambulance reaches the hospital.

The system also enables instant emergency alerts through both automatic threshold detection and a manual emergency push button, ensuring timely communication with medical staff. Additionally, real-time GPS tracking helps hospitals prepare in advance and guides the ambulance through optimal routes.

Table -1: Sample Table format

Component	Description	Function
ESP32 Microcontroller	A low-power microcontroller with built-in Wi-Fi and Bluetooth capabilities	Acts as the main controller, collects sensor data, processes it, and transmits it to the cloud
Heart Rate & SpO_2 Sensor (MAX30102)	Optical sensor that measures pulse rate and oxygen saturation	Monitors heart rate and blood oxygen levels of the patient
Blood Pressure (BP) Sensor	The BP sensor monitors systolic and diastolic blood pressure levels.	Continuously measures **systolic** and **diastolic** blood pressure of the patient.
SpO_2 Sensor	The SpO_2 sensor, often integrated with the heart rate sensor, measures blood oxygen levels	Provides continuous oxygen level readings during patient transport.
DHT11 Temperature Sensor	The DHT11 sensor measures the body temperature of the patient.	Ensures patient condition is stable until reaching the hospital.
ECG Sensor	The ECG (Electrocardiogram) module records the electrical activity of the heart	Records the electrical signals generated by the heart
Power Supply Unit	A lithium-ion rechargeable battery or 12V DC source powers the system	A breadboard acts as a temporary power supply unit
Cloud & Dashboard Components	The system uses cloud storage and a web dashboard interface for transmitting and displaying the data to doctors.	Cloud and dashboard provide real-time storage, visualization, and remote monitoring of patient health data.
GPS Module	Determines real-time geographical location of the ambulance. Provides latitude and longitude coordinates	The GPS module provides real-time location tracking of the ambulance,
Push Botton	Send Immediate Alert Messege	Manually Trigger emergency Messege

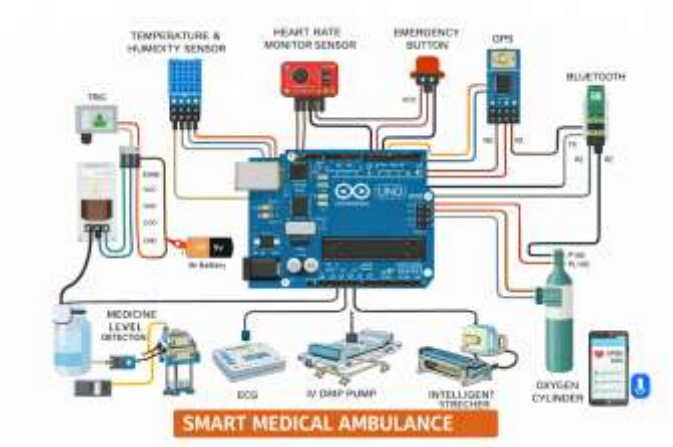

Fig -1: Circuit

Fig-2: ECG sensor

Fig-3: Aurdino

Fig-4: Heartrate sensor

3. CONCLUSION

In conclusion, the Smart Med Ambulance project presents a smart and efficient approach to emergency medical care by integrating vital health monitoring sensors such as ECG, SpO_2, blood pressure, and temperature with IoT technology. These sensors continuously track the patient's health condition during transportation and transmit real-time data to the cloud, allowing uninterrupted monitoring and early detection of critical situations.

The system also enhances emergency response through features like automatic alert generation, a manual emergency push button, and real-time GPS tracking. These functions ensure that hospitals receive timely notifications along with accurate location details, enabling medical teams to prepare necessary equipment, medications, and specialists before the ambulance arrives. This significantly reduces response time and improves coordination between ambulance staff and hospital personnel.

Overall, the Smart Med Ambulance project improves patient safety, reduces mortality risk, and increases the efficiency of emergency healthcare services. It demonstrates how the integration of smart technologies can modernize traditional ambulance systems and offers a scalable solution for future smart healthcare and intelligent emergency response systems.

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