Enhanced patient care through seamless monitoring and data continuity

TECHNICAL DOCUMENTATION

PRESENTED TO:

5G Hackathon
GE Healthcare

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1. Problem Statement:

Emergency medical services (EMS) are essential in delivering prompt and life-saving assistance to people requiring urgent medical attention. Yet, the task of moving patients from the site of a crisis to a hospital poses many difficulties, especially in maintaining constant and precise observation of their essential signs. Outdated equipment and manual procedures are heavily relied upon in traditional patient monitoring during ambulance transportation, resulting in inefficiencies, care delivery delays, and potential harm to patient outcomes.

Manual monitoring procedures: Emergency Medical Services (EMS) staff frequently use manual techniques to track vital indicators, such as intermittent assessments using independent gadgets. This method takes up a lot of time and is susceptible to mistakes made by humans, as it involves shifting focus away from important duties.

Large Equipment: Traditional monitoring devices found in ambulances are typically cumbersome and take up space, making it difficult for personnel and patients to move freely.

Limited access to data: Recording vital signs manually during transportation can result in incomplete or incorrect records, hindering seamless care upon reaching the hospital. Healthcare providers may not have the essential information required for timely intervention and decision-making if real-time data transmission is not available.

Statistics that emphasise the difficulties:

1. As per a study in the Journal of Emergency Medicine, nearly **half** of adverse events during ambulance transport are due to insufficient monitoring and assessment of patients.
2. The American Heart Association states that delays in identifying and addressing heart issues while in ambulance transit are a major factor in pre-hospital death rates, with around **25%** of heart attack patients facing negative results because of delayed treatments.
3. A study by the National Association of EMS Physicians revealed that EMS providers consider manual monitoring procedures to be a primary source of distraction and stress while transporting patients, which may affect their capacity to deliver top-notch care.

2. Abstract:

In the field of emergency medical services (EMS), it is crucial to quickly and accurately monitor vital signs of patients while they are being transported in an ambulance. Nevertheless, current techniques frequently prove inadequate, depending on manual procedures and traditional tools that may hinder timely intervention and proper treatment. patient results. In order to tackle these obstacles, Body BudE is seen as an innovative answer, utilising IoT technology to automate monitoring and guarantee constant supervision of patient well-being.

At the heart of Body BudE lies a complex but compact patient monitoring system created to easily fit into ambulance settings, offering immediate information on vital signs like heart rate, blood oxygen saturation (SpO2), and body temperature. Through the use of the ESP32 microcontroller and the MAX30102 sensor, Body BudE provides unmatched precision and dependability in collecting data, giving healthcare providers extensive understanding of patient health during transportation.

One of the main advantages of Body BudE is its capacity to simplify the monitoring process, relieving EMS personnel from manual monitoring and enabling them to concentrate on delivering compassionate, life-saving care. Body BudE's compact and subtle design helps reduce disturbance in the ambulance setting, guaranteeing maximum comfort for patients and providers. Even when the ambulance is in motion or faces rash driving, the abstract design of the model stabilises the monitoring system.

In addition, Body BudE goes beyond standard monitoring systems by allowing smooth data transfer to the hospital's cloud server through the **ambulance's 5G WiFi router.** This new method allows healthcare providers to monitor in real-time, while also guaranteeing accessibility and integrity of patient data, improving continuity of care once the patient reaches the medical healthcare facility.

As emergency medical care changes, Body BudE leads in innovation by providing a solution that improves efficiency, accuracy, and timeliness of patient monitoring in ambulances. Body BudE has the potential to transform the quality of care in EMS operations, offering hope for better patient outcomes and influencing the future of emergency medical services on a global scale.

3. Solution:

1. Body BudE - IoT-based Patient Monitoring System for EMS
Aim: To automate and improve the monitoring of patient vital signs during ambulance transportation.
Key Components:
ESP32 Microcontroller: Acts as the central processing unit for data collection and transmission.
MAX30102 Sensor: Monitors heart rate and blood oxygen saturation (SpO2).
DS18B20 Temperature Sensor: Measures body temperature.
Thingspeak : Cloud platform used for storing and analysing the medical data.

2. Design and Implementation:
Integration into Ambulance Environment:
Compact design to seamlessly adjust with the ambulance setting.
Minimises disruptions, ensuring comfort for patients and EMS personnel and accurate and efficient monitoring.
Continuous monitoring of heart rate, SpO2, and body temperature.
High precision and reliability in data collection thanks to advanced sensor technology.

3. Automation and Efficiency:
Automates vital sign monitoring, allowing EMS personnel to focus on direct patient care.
Streamlines workflow, reducing the chances of human error in vital sign measurements.

4. Data Transmission and Integration:
Utilises the ambulance's 5G WiFi router to transmit data to hospital cloud servers thereby reducing the latency and leads to timely intervention.
Enables hospital staff to access patient data instantly, aiding in prompt medical decisions and preparations.
Ensures secure and uninterrupted access to patient data from pickup to hospital arrival.

5. Advantages of Body BudE:
Simplifies the vital sign monitoring process, lessening the burden on EMS personnel.
Provides precise and reliable data crucial for patient assessment and intervention.
Immediate data availability for hospital staff, enhancing preparedness and response times.
Non-intrusive design minimises disturbance during transport.

6. Future Implications:
This idea establishes a new benchmark for patient monitoring. Opening ways for creating more non intrusive medical tools, that will reduce human effort and thereby revolutionise the medical industry in terms of innovations. Advancements to the existing model can also be done by utilising more advanced and accurate medical grade sensors.

4. Mission

Body BudE is created with the noble goal of transforming the standard of emergency medical care provided during ambulance transportation. Our goal is to reduce human error, lighten the burden on EMS staff, and provide prompt medical assistance by automating vital signs monitoring and real-time data transmission. Body BudE is created to offer precise, ongoing monitoring of patient health data like heart rate, SpO2, and body temperature, leading to better patient results. Our objective is to develop an efficient, trustworthy system that allows EMS teams to concentrate on providing crucial care without the interruptions of manual monitoring. By incorporating cutting-edge IoT technology, Body BudE aims to improve the quality of care provided during emergency medical transportation, leading to life-saving results and increased efficiency in EMS services.

5. Vision

Body BudE's vision is to revolutionise emergency medical services by enhancing the safety, efficiency, and effectiveness of patient care during transportation. Our vision is for advanced IoT technology to be a crucial component of every emergency medical service in the future, allowing for precise, real-time monitoring of vital signs. This incorporation will make medical decisions quicker and more informed, resulting in improved patient outcomes and decreased mortality rates during ambulance transport. Body BudE strives to establish a new standard in emergency medical services, providing top-quality care to every patient in transit with the help of cutting-edge technology. Body BudE aims to improve emergency medical response by providing real-time monitoring worldwide, making high-quality care available in critical situations.

6. Unique Selling Proposition [USP]

1. The distinguishing factor of Body BudE lies in its incorporation of cutting-edge IoT technology, which includes the ESP32 microcontroller and MAX30102 sensor for accurate tracking of vital signs.

2. Additionally, it incorporates 5G technology for the purpose of data transfer that considerably reduces latency and loss of values, thereby making the overall process quick and reliable.

3. This automation minimises the need for manual monitoring, allowing EMS personnel to concentrate on critical care.

4. The device's compact and unobtrusive design ensures comfort for both patients and providers, while the cloud-based data storage ensures the integrity and accessibility of the collected information.

5. In addition to these functionalities Body BudE has the functionality to send alerts in cases where the vitals drop below minimum expected level, thus facilitating timely intervention and medical help.

6. With its scalable and adaptable system, Body BudE emerges as a revolutionary solution for EMS operations worldwide.

7. Biology Description

Body BudE is an innovative device designed to monitor essential physiological parameters that are crucial for evaluating a patient's health status during emergency situations. It focuses on monitoring key biological aspects, which include:

1. Heart Rate:
Measurement: Body BudE utilises the MAX30102 sensor, which employs photoplethysmography (PPG) to detect changes in blood volume within the microvascular bed of tissue. By emitting light and measuring its absorption by blood vessels, the sensor accurately determines the heart rate. The ideal resting heart rate of an individual is ranging from **60 to 100 beats per minute**.
Biological Significance: Heart rate serves as a critical indicator of cardiovascular health. It provides insights into the functioning of the heart and the overall circulatory system, enabling the detection of arrhythmias, tachycardia, bradycardia, and other cardiac conditions.

2. Blood Oxygen Saturation (SpO2):
Measurement: The MAX30102 sensor also measures SpO2 by utilising different wavelengths of light (red and infrared) to calculate the percentage of oxygen-saturated haemoglobin in the blood. These values are then utilised to calculate the percentage of oxygen in the blood. The ideal blood oxygen levels is between 95-100%.
Biological Significance: SpO2 levels indicate the efficiency of gas exchange in the lungs and the blood's capacity to carry oxygen. Low SpO2 levels can indicate respiratory or cardiac issues, hypoxemia, or other critical conditions that require immediate intervention.

3. Body Temperature:
Measurement: Body BudE incorporates the DS18B20 temperature sensor to continuously monitor the core body temperature.
Biological Significance: Body temperature serves as a fundamental vital sign that can provide insights into infections, inflammatory responses, and thermoregulation issues. Abnormal temperature readings can indicate the presence of fever, hypothermia, or other medical conditions.

8. Hardware Specifications

1. MAX30102 Sensor:
Type: Optical sensor
Functions: Measures heart rate and blood oxygen saturation (SpO2)
Technology:
Photoplethysmography (PPG): Utilises light-based technology to detect changes in blood volume within the microvascular tissue bed.
Dual LEDs: Utilises both red and infrared LEDs to measure the absorbance of pulsatile blood flow, enabling the calculation of SpO2 and heart rate.
Features:
Enhanced Sensitivity: Capable of detecting even subtle changes in blood flow and oxygen saturation.
Efficient Power Consumption: Ideal for continuous monitoring applications.
Integrated Ambient Light Cancellation: Minimises errors caused by interference from ambient light.
Applications: Continuous monitoring of heart rate and SpO2 in various settings, including ambulances.

2. DS18B20 Temperature Sensor:
Type: Digital temperature sensor
Functions: Measures core body temperature
Technology:
Thermistor or Thermocouple: Commonly used technologies for converting temperature changes into electrical signals.
Digital Sensors: Often employ semiconductor technology to provide precise digital temperature readings.
Features:
High Accuracy: Crucial for detecting small fluctuations in body temperature.
Rapid Response Time: Quickly adapts to changes in body temperature, providing real-time data.
Compact Design: Easily integrated into wearable devices without causing discomfort to the patient.
Applications: Continuous monitoring of body temperature in a variety of medical scenarios, including during patient transport in ambulances.

3. ESP32 Microcontroller:
Type: WiFi and Bluetooth-enabled microcontroller
Functions: Serves as the central processing unit for data collection, processing, and transmission
Technology:
Dual-core Processor: Ensures efficient handling of multiple streams of sensor data simultaneously.
Integrated WiFi and Bluetooth: Enables seamless wireless communication and data transfer.
Features:
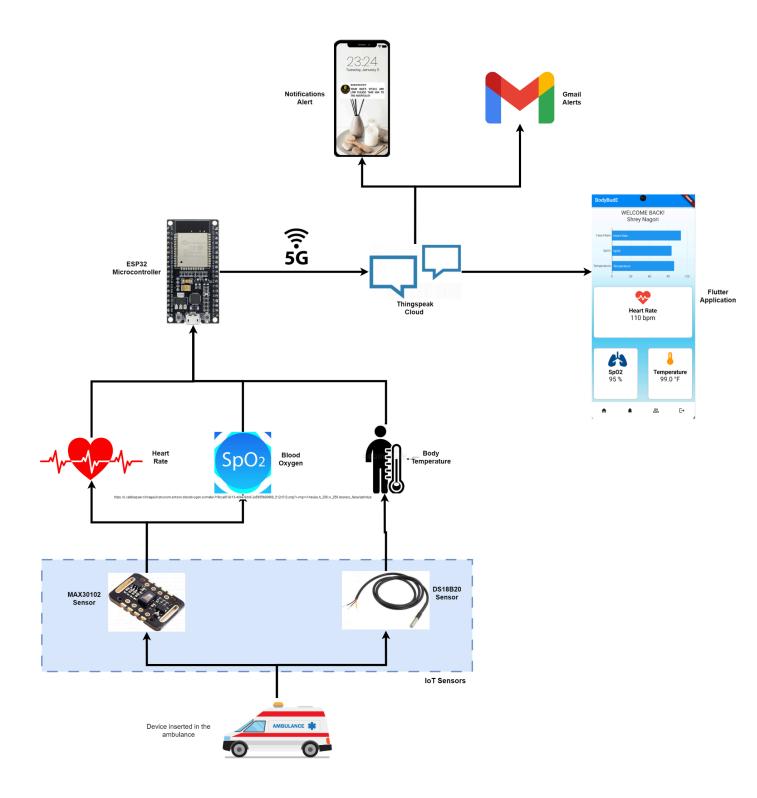High Performance: Capable of processing large volumes of data rapidly.
Low Power Consumption: Well-suited for battery-powered applications.
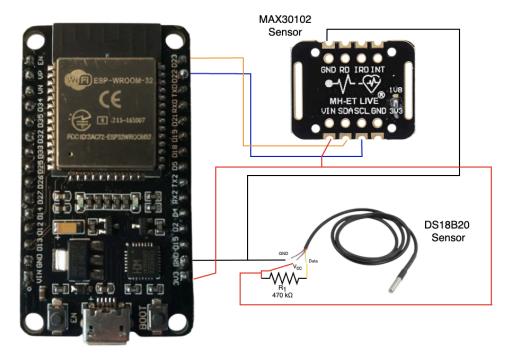Versatility: Supports a wide range of applications and functionalities.
Applications: Suitable for various data collection, processing, and transmission tasks, including those requiring WiFi and Bluetooth connectivity.

9. System Architecture:
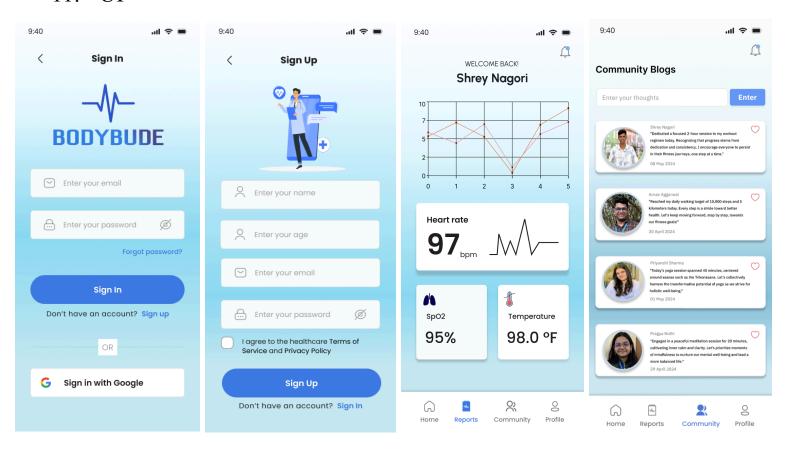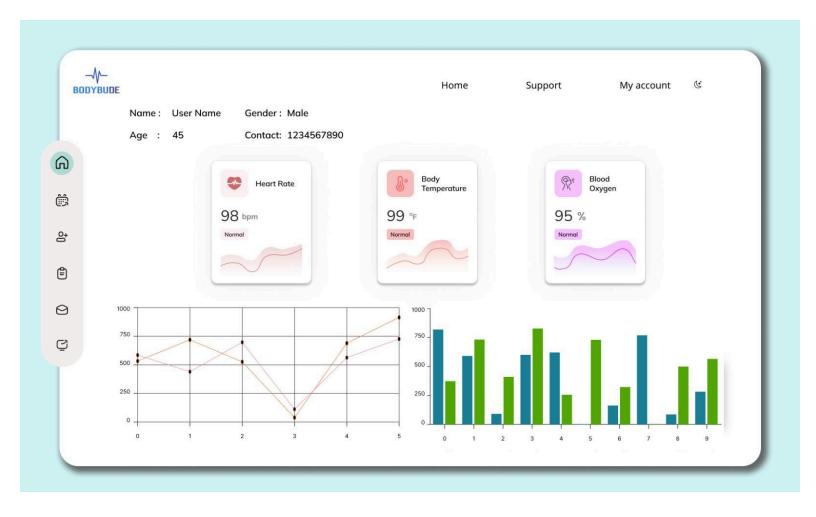
10. Circuit Diagram

ESP32 DevKit-V1

11. UI

BODYBUDE

Name :   User Name   Gender : Male

Age   :   45   Contact: 1234567890

Heart Rate

98 bpm

Normal

Body Temperature

99 °F

Normal

Blood Oxygen

95 %

Normal

12. Market Study

1. Market Overview:
Industry: Healthcare and Emergency Medical Services (EMS)
Focus: Patient monitoring systems based on IoT
Target Audience: EMS providers, hospitals, ambulance services, and healthcare facilities.

2. Market Drivers:
Increasing Demand for Advanced EMS Solutions: The focus on improving patient outcomes during pre-hospital care is driving the need for advanced monitoring technologies.
Technological Advancements: The growth in IoT, 5G connectivity, and sensor technology is enhancing the capabilities of monitoring devices like Body BudE.
Ageing Population: The higher prevalence of chronic conditions and medical emergencies in older adults is increasing the demand for efficient EMS services.
Regulatory Support: Governments and healthcare organisations are promoting the adoption of advanced EMS technologies for better patient care.

3. Market Size and Growth:
Global EMS Market : The market was valued at approximately $580 billion in 2023, and it is projected to have a compound annual growth rate (CAGR) of 7.2% from 2022 to 2028.
IoT Healthcare Market : The market is expected to grow from $72.5 billion in 2020 to $188.2 billion by 2026, driven by the integration of IoT in medical devices.
Indian EMS Market : India's EMS market of $20bn (2.3% of global market) is poised to expand at 32% CAGR over CY21–26E and outpace global/USA/China/Europe markets.

4. Competitive Landscape:
Key Players:
- Philips Healthcare
- GE Healthcare
- Medtronic
- Masimo Corporation.

5. SWOT Analysis:

Strengths:
- Advanced sensor technology and integration with IoT.
- Real-time data transfer and cloud storage capabilities.
- Ease of use and minimal disruption in ambulance settings.

Weaknesses:
- Initial setup and integration costs.
- Dependence on continuous connectivity for optimal performance.

Opportunities:
- Partnerships with hospitals and EMS providers.
- Leveraging AI for predictive analytics and advanced diagnostics.

Threats:
- Competition from established medical device companies.
- Regulatory challenges and compliance requirements.

6. Market Challenges:

Resistance to Adoption: Some EMS personnel may be resistant to adopting new methods and technologies, preferring to stick to traditional approaches.

7. Market Opportunities:

Expansion into Underserved Areas: By providing advanced monitoring capabilities, the device can help bridge the healthcare gap in rural and underserved regions, ensuring that patients receive the care they need.

8. Potential Market Size:
- Growing EMS Market: The global EMS market is expected to experience significant growth in the next decade, with a substantial portion of the market allocated to advanced monitoring equipment.
- Increasing Demand for IoT Healthcare: The IoT healthcare market is projected to witness substantial growth, driven by the increasing demand for connected and real-time monitoring solutions.

13. Go-to-Market[GTM] Strategy:

1. Market Research and Target Audience Identification
Analyse the present state of EMS technology and identify deficiencies in monitoring vital signs while transporting patients.
Assess the necessity of automated, instantaneous monitoring systems in ambulances.
Providers of emergency medical services (EMS) and hospitals that have ambulance services. Other organisations include government health departments, private ambulance companies, military medical units, and international relief organisations.

2. Regulatory Compliance:
Ensure adherence to relevant medical device regulations (e.g., Central Drugs Standard Control Organization (CDSCO) approval in India, FDA approval in the USA).
Obtain the necessary certifications for safety and effectiveness.
Prepare comprehensive documentation for regulatory submissions and quality assurance.

3. Pricing Strategy:
Conduct a competitive analysis to determine the best pricing strategy.
Consider a pricing model that reflects the value provided, such as a subscription-based model for the application to provide continuous support and updates.
Offer bundled pricing for multiple units or long-term contracts with EMS providers and hospitals.
Provide introductory discounts to early adopters.

4. Sales and Distribution Channels:
Create a specialised sales team to directly target EMS providers, hospitals, and government agencies.
Establish partnerships with medical device distributors and ambulance manufacturers to utilise their existing networks.
Build an e-commerce platform for smaller orders and individual buyers.

5. Marketing and Promotion:
Utilise social media, content marketing, and SEO strategies to enhance online visibility.
Develop a comprehensive website that showcases the product's features, benefits, and success stories.
Participate in EMS and medical device trade shows to showcase Body BudE to potential customers.
Conduct webinars and live demonstrations to educate potential customers about the advantages and functionality of Body BudE.
Utilise testimonials and case studies from early adopters to build credibility and trust.

6. Customer Support and Service:
Provide comprehensive training programs for EMS personnel to ensure proper usage and maintenance of Body BudE.
Offer 24/7 technical support and a dedicated customer service team to address any issues.
Implement a robust after-sales service plan, including regular software updates and hardware maintenance.

7. Feedback and Continuous Improvement:
Establish a system for collecting and analysing customer feedback to continuously enhance the product.
Regularly update the device based on user feedback and technological advancements to maintain a competitive edge.

14. Conclusion:

The incorporation of advanced IoT technology in Body BudE is a major development in improving patient monitoring during ambulance transport within emergency medical services. Body BudE guarantees constant and reliable monitoring of essential health indicators using the MAX30102 sensor for accurate heart rate and SpO2 measurements, along with the highly precise DS18B20 temperature sensor. The ESP32 microcontroller allows for efficient handling of data and instant wireless communication in real-time, ensuring minimal delay when connecting to hospital servers through the ambulance's 5G WiFi router. This continuous transfer of data allows healthcare providers to quickly retrieve important patient information, improving readiness and response times when patients arrive at the medical facility.

The manual workload on EMS personnel is decreased by Body BudE's automation and precision, enabling them to focus on critical care interventions. The small and inconspicuous design of the device reduces the amount of space it takes up and increases patient comfort, making it even more useful in hectic emergency situations. Body BudE simplifies the ambulance environment by removing large, unwieldy equipment, creating a more organised and less chaotic setting crucial for high-stress situations.

Body BudE also tackles the important problem of maintaining data consistency and precision. The receiving hospital's healthcare providers can access instant, complete, and current patient information through real-time data transmission, leading to quicker medical treatment decisions and administration. This live monitoring is especially important when patients' conditions can change quickly and become worse.

In summary, Body BudE sets a new standard for monitoring patients in ambulances by merging technological advancements with real-world use to improve patient results and transform emergency medical care worldwide. The extensive acceptance potential of Body BudE makes it a key solution in improving emergency medical services, changing the way patient care is provided during transportation and establishing a new benchmark for the future of emergency healthcare.