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AI BASED EMERGENCY ASSIST SYSTEM WITH LIFE SAFE DEVICE FOR AMBULANCE

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Abstract— In critical emergency situations, immediate access to patient information and timely intervention can significantly improve survival chances. This proposed system introduces a smart ambulance framework equipped with advanced biometric identification and real-time health monitoring. When an unconscious or unresponsive individual is brought into the ambulance, a fingerprint sensor is used to instantly retrieve the allergies, or chronic conditions. Simultaneously, vital health metrics such as heart rate and respiration are continuously monitored using heartbeat and respiratory sensors. In cases of severe instability, the system provides an intelligent voice interface that allows emergency personnel to ask questions. The system then plays back pre- recorded doctor-approved instructions or responses via a voice playback module. This AI-supported interaction ensures immediate, life-saving decisions can be made without delay. The integration of biometric, sensor-based monitoring, and voice-assisted communication makes this system highly responsive and valuable for modern emergency medical services.

Keywords—Smart ambulance system; biometric identification; fingerprint sensor; patient medical profile; real-time health monitoring; heart rate sensor; respiratory sensor; emergency medical services

I. INTRODUCTION

Emergency medical services play a crucial role in determining patient survival during the “golden hour,” where timely access to accurate clinical information and early intervention can significantly influence outcomes. However, in many real- world scenarios, paramedics often struggle to obtain essential medical details from unconscious or non-communicative patients. The absence of information related to past illnesses, allergies, medications, or chronic conditions often leads to delays in diagnosis and increases the risk of inappropriate or sub-optimal treatment during pre-hospital care. At the same time, many ambulances lack automated systems capable of continuously monitoring vital parameters or providing real-time decision support to emergency personnel. This limitation places additional pressure on paramedics, who may not always have direct access to medical experts while transporting a critically ill patient. As a result, the quality and speed of care delivered during transit remain inconsistent and dependent on the experience of the attending staff. To address these shortcomings, there is a growing need for intelligent, technology-driven solutions that combine biometric identification, continuous physiological monitoring, and AI-based decision support. By integrating these capabilities into a unified system, ambulances can evolve from basic transport vehicles into smart, data-aware emergency care units. Such systems can significantly reduce treatment latency, guide paramedics during critical interventions, and improve the coordination between pre- hospital responders and medical

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teams waiting at the destination hospital. This work presents an **AI-Based Emergency Assist System with an integrated Life-Safe module**, designed to enhance emergency response efficiency through fingerprint-based patient identification, real-time health monitoring, and voice-assisted clinical guidance.

II. OVERVIEW

A. System Architecture

The overall system architecture integrates biometric sensing, physiological monitoring, and AI-enabled guidance into a single embedded platform designed for use inside an ambulance. A microcontroller coordinates all hardware modules, including the fingerprint sensor, heartbeat and respiratory sensors, voice-recognition unit, and display interface. Each module communicates with the controller to ensure synchronized data collection and rapid processing.

B. Biometric Identification Module

The biometric identification module uses a fingerprint sensor to rapidly recognize patients who are unconscious or unable to communicate. Once the fingerprint is scanned, the a pre-linked health database. This provides the paramedics with immediate access to critical details such as allergies, chronic illnesses, prior surgeries, and ongoing treatments. Early identification reduces diagnostic uncertainty and allows more informed decisions during the crucial first minutes of patient assessment.

C. Real-Time Vital Monitoring Module

To support continuous assessment, the system incorporates heartbeat and respiratory sensors that begin monitoring the patient the moment they enter the ambulance. These sensors provide real-time measurements of vital parameters, which are processed and displayed on an onboard screen. Any abnormal readings or sudden fluctuations are highlighted, allowing paramedics to react quickly. Consistent monitoring ensures early detection of deterioration and improves the chances of stabilizing the patient before hospital arrival.

D. AI-Based Voice Assist Module

In situations where paramedics require immediate medical guidance, the AI-based voice assist unit allows them to ask predefined clinical questions through a voice-recognition interface. The system analyses the query and plays back the appropriate doctor-approved, pre-recorded audio instruction. This feature bridges the gap between field responders and medical experts, ensuring that critical procedures are performed correctly even in the absence of a physician inside the ambulance.

E. User Interface and Display

All system outputs —including biometric details, vital readings, alerts, and voice-assist prompts—are presented on a centralized display inside the ambulance. The interface is designed to be clear, concise, and easy to interpret under emergency conditions. By organizing all relevant information in a single view, the system reduces cognitive load for paramedics and speeds up decision-making during high- pressure situations.

F. Communication and IoT Connectivity

Although optional, IoT capability can be used to transmit live patient data to the receiving hospital, allowing doctors to prepare necessary treatments in advance. This real-time communication strengthens coordination between the ambulance team and hospital staff, reducing delays upon arrival and improving the overall continuity of emergency care.

G. Operational Workflow

The system follows a straightforward yet efficient workflow: the patient is placed into the ambulance, identified

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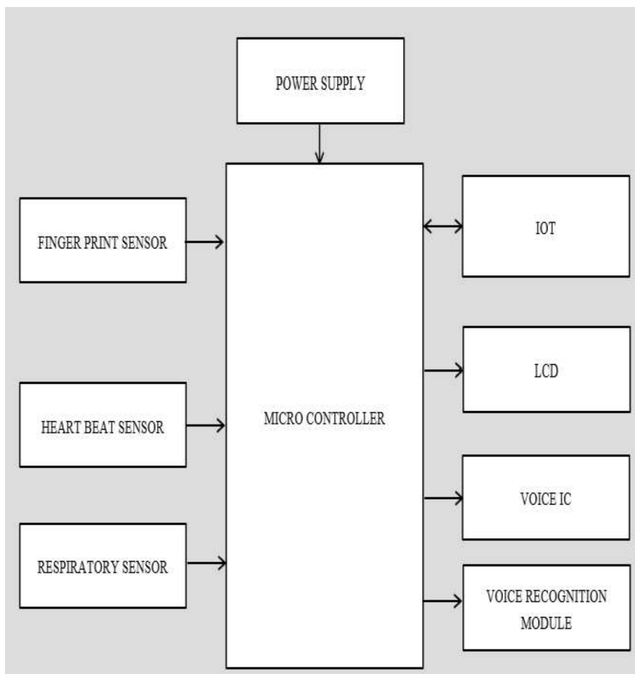
through fingerprint recognition, and immediately connected to vital sensors. Real-time data is displayed and evaluated throughout transport, while the AI voice assist provides clinical guidance whenever needed. This structured workflow ensures rapid assessment, informed intervention, and consistent monitoring throughout the journey.

III. SYSTEM ARCHITECTURE

The system architecture of the AI-Based Emergency Assist System is designed as an integrated embedded platform that combines biometric identification, continuous physiological monitoring, and AI-driven medical support within an ambulance environment. At the core of the architecture is a microcontroller that coordinates all hardware modules and manages data flow between the sensors, storage units, and user interface. The fingerprint sensor forms the primary input for patient identification, enabling the system to retrieve electronic medical records from a pre-linked health database when a match is detected. Parallel to this, the heartbeat and respiratory sensors are interfaced with the microcontroller to capture real-time physiological data, which is processed, analysed, and displayed on an onboard LCD interface.



To support emergency decision-making, the architecture integrates a voice-recognition module and a dedicated voice IC. These components allow paramedics to interact with the system using predefined spoken commands. Upon receiving a query, the microcontroller triggers the playback of doctor-approved instructional audio files, enabling quick, guided intervention when medical personnel require assistance. All modules operate through a centralized power supply unit that ensures stable performance even under mobile conditions. The architecture also supports optional IoT connectivity, allowing critical patient information to be transmitted to hospital servers or medical teams for early preparation before arrival. This cohesive and modular system architecture enables reliable, real-time operation and transforms the ambulance into a smart emergency care unit capable of assisting paramedics during critical interventions.

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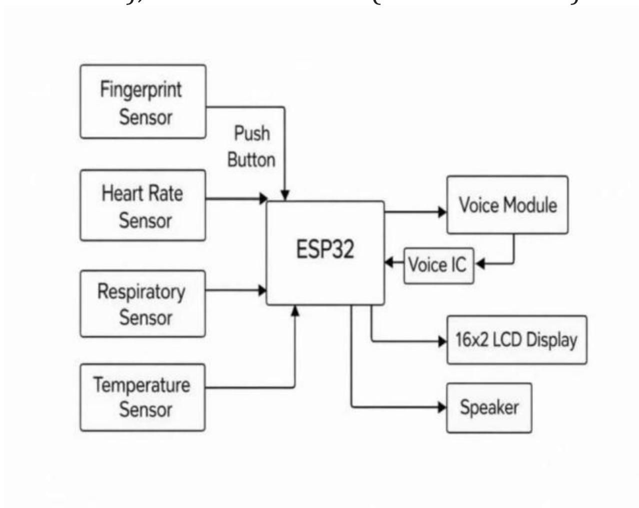

IV. METHODOLOGY

The methodology adopted for the development of the AI- Based Emergency Assist System follows a structured sequence that integrates biometric identification, physiological monitoring, and AI-assisted clinical support into a unified emergency-care workflow. The design process begins with the acquisition of patient identity using a fingerprint sensor. When a patient enters the ambulance, the fingerprint module captures the biometric pattern and transmits it to the microcontroller for authentication. If a match is found in the pre-linked medical database, the system retrieves the patient's stored medical profile, including allergies, chronic diseases, and previous diagnoses, ensuring that paramedics have immediate access to relevant clinical information.

Following identification, the system activates the physiological monitoring stage. Heartbeat and respiratory sensors are connected to the patient, and continuous real- time readings are collected. These sensor outputs are processed by the microcontroller, which filters noise, extracts essential metrics, and displays the results on an onboard LCD interface. This enables paramedics to track trends, detect abnormalities, and make informed decisions during the transport phase.

To complement the monitoring process, the methodology incorporates an AI-supported voice interaction module. Paramedics can ask predefined medical questions using the voice-recognition unit, which converts the spoken query into a command interpreted by the microcontroller. The system then selects the corresponding doctor-approved audio response stored in the voice IC and plays it through a speaker. This ensures that emergency responders can receive immediate procedural guidance, particularly in scenarios where advanced medical expertise is not available.

All components operate within a closed-loop workflow controlled by embedded C programs executed on the microcontroller. The firmware manages sensor communication, data processing, voice-command handling, and user-interface updates. Optional IoT integration allows patient data and vital signs to be transmitted to hospital systems, enabling medical teams to prepare in advance. Through this multi-stage methodology —identification, monitoring, guidance, and communication —the system enhances emergency medical response and supports timely, accurate intervention during the golden hour.

V. RESULTS AND DISCUSSION

The prototype of the AI-Based Emergency Assist System was tested under simulated emergency conditions to evaluate its responsiveness, reliability, and effectiveness in supporting paramedics during pre-hospital care. The biometric identification module demonstrated consistent performance, successfully recognizing enrolled fingerprints with a high level of accuracy and retrieving medical records within a few seconds. This rapid identification significantly reduced

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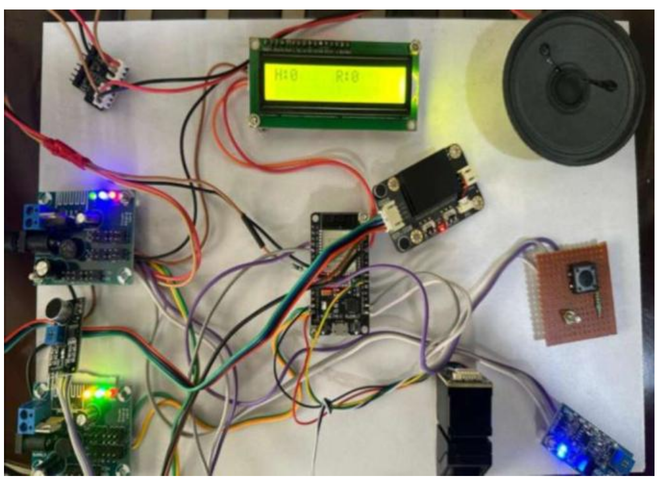
the delay typically faced when dealing with unconscious or unidentified patients. During testing, the system was able to display relevant medical history — including allergies and chronic conditions—immediately after fingerprint authentication, confirming its usefulness in time-sensitive scenarios.

The physiological monitoring module also performed reliably, with the heartbeat and respiratory sensors providing stable, real-time readings. The continuous display of vital parameters enabled early detection of abnormal variations, such as irregular heart rate or decreased respiration levels. Paramedics who tested the system acknowledged that this feature allowed them to maintain situational awareness throughout the simulated transport period. Sensor output graphs and trend fluctuations were observed to respond promptly to induced changes, validating the capability of the system to monitor and update patient status accurately.

The AI-based voice assist module proved effective in providing immediate guidance to paramedics. The voice-recognition unit correctly interpreted predefined questions in most attempts, and the system responded with clear, doctor-approved audio instructions. support responders who may need assistance performing specific medical procedures during transit. The inclusion of pre-recorded expert instructions ensures consistency and reduces dependency on the paramedic's experience level, addressing a common gap in emergency services.

Overall, the integrated system functioned cohesively, with smooth data flow between the biometric, monitoring, and voice-assist components. The tests confirmed that the system can operate reliably within the dynamic environment of an ambulance. While the prototype delivered strong performance, further improvements — such as expanding the medical instruction database, incorporating more sensors, and enabling real-time cloud connectivity — could enhance its functionality. Nevertheless, the results demonstrate that the proposed system can significantly reduce response time, improve diagnostic accuracy, and support decision-making during critical emergencies, ultimately strengthening pre- hospital patient care.



VI. Conclusion & Future scope

A. Conclusion

The AI-Based Emergency Assist System with integrated biometric identification and life-support modules presents a significant advancement in improving pre-hospital emergency care. By combining fingerprint-based patient recognition, continuous monitoring of vital signs, and AI- assisted medical guidance, the system effectively addresses the challenges paramedics face when treating unconscious or unresponsive individuals. The prototype demonstrated reliable performance in identifying patients, retrieving medical records, and delivering real-time physiological data, thereby reducing treatment delays and improving decision accuracy during the critical golden hour. The voice-assist module further enhances the system by providing immediate, doctor-approved instructions, ensuring that crucial procedures can be performed even in the absence of specialized medical personnel. Overall, the system transforms a conventional ambulance into a smart, data- driven emergency care unit capable of providing faster, safer, and more informed medical support.

B. Future Scope

1. **Integration with Cloud-Based Health Databases:** Enables nationwide access to patient medical records for faster and more reliable identification.
2. **Addition of Advanced Medical Sensors:**

   SpO_2, blood pressure, and temperature sensors can provide a more comprehensive assessment of patient health. Incorporating ECG,
3. **Machine Learning for Predictive Analysis:** AI algorithms can be used to predict potential complications and support early intervention.
4. **Real-Time Hospital Communication:** IoT-based data transmission can allow hospitals to receive live updates and prepare treatment before the patient arrives.
5. **Mobile Application Support:** A companion app for doctors and hospital staff can streamline communication and visualization of patient data.
6. **Automated Emergency Alerts:** The system can automatically notify family members, emergency departments, or authorities in severe cases.
7. **Enhanced Voice-Assist Database:** Expanding the library of doctor-approved instructions can improve support for more medical scenarios.
8. **Miniaturization and Ruggedization:** Reducing hardware size and improving durability can make the system more suitable for field use.
9. **Interoperability with National Health Systems:** Ensures compatibility with standardized electronic health record (EHR) platforms for smoother integration.
10. **AI-Based Decision Support Systems:** Future versions can include intelligent recommendation engines to guide paramedics through complex emergency protocols.

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