

# IoT-Based Emergency SOS System for Post-Accident Assistance

Swarup Adsul\*, Omkar Salekar, Sahil Waghmare

## Abstract

*The increase in road accidents poses significant challenges for timely medical response, often leading to life-threatening delays. This project proposes an IoT-based accident wound detection system that utilizes a night vision camera mounted on either the interior or exterior of a vehicle. The system aims to detect injuries sustained by individuals during a collision and promptly alert emergency services. By employing a night vision camera, the system can operate effectively in low-light or nighttime conditions, ensuring round-the-clock functionality. When an accident occurs, the camera captures real-time images and videos of the vehicle's surroundings or interior. These images are analyzed by an onboard processing unit that references a wound dataset specifically curated for detecting human injuries. The dataset contains various wound types, including cuts, bruises, and severe trauma, enabling the system to identify and classify the severity of injuries accurately. This detection process leverages machine learning algorithms trained on the wound dataset, ensuring reliable wound recognition. Upon detecting an injury, the system automatically initiates an emergency protocol, which includes either calling or sending an SMS to nearby medical services, police, or predesignated emergency contacts. This automated alert system reduces the response time by providing critical information to emergency responders, including accident location and potential injury details. The proposed system offers a proactive approach to accident response, minimizing human intervention and enhancing post-accident care. This innovative solution addresses the urgent need for faster medical assistance, potentially saving lives by bridging the gap between accident occurrence and emergency response.*

**Keywords:** GSM, raspberry Pi, text to speech module, Crash detection sensor, night vision Camera module, GPS, CNN algorithm

## INTRODUCTION

Road accidents remain a significant cause of injury and fatality globally, with emergency response times often playing a critical role in determining outcomes for those involved. Rapid identification and assessment of injuries can make a life-saving difference, especially when accident victims are unable to

call for help themselves. To address this issue, we propose a novel IoT-based accident wound detection system that leverages night vision cameras and real-time alert mechanisms [1].

This project involves integrating a night vision camera, strategically placed on either the exterior or interior of a vehicle, to continuously monitor for signs of injury following an accident. This camera can detect both visible signs of trauma, such as blood or wounds, and sounds associated with distress or injury, helping to identify when immediate medical assistance is required. In the

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event of detecting an injury, the system will instantly contact emergency services via calls or text messages, providing essential location data and injury information, which can streamline rescue efforts and potentially reduce fatality rates.

At the heart of this system is a dataset comprising various images of human wounds, which is used to train the detection model. This dataset ensures that the camera can accurately differentiate between injuries and other harmless marks, thus minimizing false alarms and ensuring help is dispatched only when necessary.

## LITERATURE REVIEW

The field of accident detection has seen significant progress with IoT-based systems, which aim to improve emergency response times and reduce fatalities in vehicle accidents. Traditional methods, such as GPS-based tracking and impact sensors, are effective in identifying accident locations but lack the sophistication needed for real-time injury assessment [2]. Recent advancements have shown that integrating AI with IoT devices in vehicles can help bridge this gap, especially by detecting the presence and severity of injuries, which can lead to faster and more tailored medical responses.

One promising approach involves using night vision cameras and sound sensors to capture data from accident scenes even in low-light conditions. Night vision technology, traditionally used in security and wildlife monitoring, offers reliable visibility that can prove crucial in nighttime accidents [3]. When combined with sound detection, such as cries for help or other audible signs of distress, IoT systems gain the potential to accurately interpret the situation within the vehicle. This integration could enable the detection of injuries by identifying common visual and auditory markers associated with physical trauma.

Machine learning, specifically image recognition algorithms, plays a critical role in these systems. By training models on extensive datasets of wound images, AI can learn to identify different injury types, potentially distinguishing between minor and severe injuries. Techniques like deep learning have shown effectiveness in the medical field for analyzing various conditions, which can be applied to wound detection in accident scenarios. Such AI-enhanced systems would analyze visual and audio data from the accident scene in real-time, alerting emergency responders with information about potential injuries [4]. This approach is an advancement over conventional emergency notification systems, which provide limited information and typically lack any injury assessment capabilities.

Automated emergency response mechanisms powered by IoT have traditionally relied on GPS and impact data to contact emergency services. Integrating wound detection information into these systems could improve response times by providing responders with critical details about the victim's condition before they arrive on the scene. This approach not only enhances the speed of medical intervention but also allows responders to better prepare, potentially saving lives by addressing the victim's specific needs more quickly.

Implementing this kind of advanced IoT system comes with challenges. Achieving accurate and reliable wound detection requires training AI models on a broad and representative dataset to ensure the system can handle various injury types and skin tones. Additionally, the possibility of false positives from sound detection can complicate accurate diagnosis, requiring refined filtering algorithms to prevent misleading alerts. Another key consideration is maintaining privacy, as capturing sensitive images and sounds within vehicles poses ethical concerns. Furthermore, deploying and maintaining night vision and sound-sensing devices in vehicles can be costly, which may impact large-scale adoption [5].

In conclusion, combining night vision cameras and sound sensors with AI-powered IoT systems represents a transformative step in accident detection and response. By advancing beyond location

tracking to real-time injury assessment, this approach has the potential to reduce the time between accident occurrence and medical intervention, ultimately improving outcomes for accident victims. The technology offers a promising solution, though practical and ethical challenges must be addressed for its successful implementation.

## PROPOSED METHODOLOGY

### Problem Definition

Road accidents are a critical issue worldwide, leading to severe injuries or fatalities. A delay in medical assistance, particularly in isolated areas or during nighttime, can worsen outcomes. The proposed system aims to use IoT technology to detect possible human injuries after a car accident by analyzing sound cues (such as cries or distress sounds) and visual indicators (like visible wounds) captured through a night vision camera. The system will automatically alert emergency services with relevant information, expediting assistance and potentially saving lives [6].

### System Components:

- *Night Vision Camera*: The camera, mounted inside or outside the vehicle, captures clear images even in low-light conditions.
- *Microphone (for Sound Detection)*: Detects sounds indicative of human distress, such as cries or screams, which often accompany traumatic injuries.
- *Image Processing Unit*: Processes images to detect visual signs of wounds using a dataset of injury images for reference.
- *Sound Processing Unit*: Analyzes audio signals to identify sounds that indicate distress.
- *Communication Module*: Sends automated messages or calls to emergency contacts or services when an injury is detected.
- *Control Unit (Microcontroller/Processor)*: Manages the integration of various components, processing inputs from the camera and microphone, and triggering alerts [7].

### Dataset Preparation

- *Wound Image Dataset*: Develop or source a dataset with various images of human injuries, ensuring diversity in lighting, skin tones, and wound types to enhance accuracy.
- *Audio Dataset of Distress Sounds*: Curate a dataset of common sounds associated with human distress in accident scenarios to train the sound detection module effectively [8].

### Proposed Process Flow

- *Step 1: Sensor Activation*: The night vision camera and microphone activate based on car sensors (e.g., accelerometer) that detect a sudden impact, or can run continuously if resources allow.
- *Step 2: Image and Sound Data Collection*: The camera captures images of the vehicle's surroundings and interior (if mounted inside). The microphone captures audio signals, focusing on identifying distress sounds.
- *Step 3: Image Analysis for Wound Detection*: Images are analyzed using machine learning (ML) models trained on the wound dataset. Key characteristics of wounds, such as bloodstains, cuts, or abrasions, are identified by the model. The system calculates a confidence score for wound detection. If the score exceeds a threshold, the injury is considered detected.
- *Step 4: Sound Analysis for Distress Detection*: Sound data is analyzed for frequency patterns, pitch, and tone associated with human distress. The model assigns a confidence score based on the likelihood of the sound indicating an emergency.
- *Step 5: Decision-Making and Alert Generation*: The control unit assesses the confidence scores from both image and sound analysis. If either or both scores are above the defined thresholds, the system initiates an alert.

- *Step 6: Alert and Notification:* The communication module sends an automated message or call to emergency services, providing information such as location, time of the incident, and potential severity.  
An optional feature can include a real-time camera feed or snapshots of the scene for emergency responders.

### Technical Implementation

- *Machine Learning Models:* Convolutional Neural Networks (CNNs) for image processing and classification of wounds, and Recurrent Neural Networks (RNNs) or Convolutional RNNs for audio analysis.
- *Data Processing:* Preprocessing images to enhance wound visibility, and filtering noise in audio for clearer sound pattern recognition.
- *Threshold Calibration:* Experiment with confidence score thresholds to minimize false positives and ensure accurate emergency detection.
- *Hardware Selection:* Choose a microcontroller with enough computational power to handle image and sound processing efficiently, or use edge AI devices if on-board processing is required [9].

### Testing and Validation

- *Simulated Accident Scenarios:* Conduct controlled tests in various lighting conditions and different sound environments to validate system performance.
- *Model Evaluation:* Evaluate accuracy, precision, recall, and response time, fine-tuning thresholds as necessary.
- *Real-World Trials:* Pilot the system on a small scale to assess functionality and reliability in real accident scenarios.

### Deployment and Maintenance

Install the system in test vehicles, collect feedback, and refine it as needed. Periodically update the wound and audio datasets to enhance the model's accuracy and adjust system parameters based on field data [10]. This methodology outlines a structured approach to developing and implementing our accident wound detection system, ensuring a balance of accuracy, speed, and reliability (Figure 1).

## SYSTEM ARCHITECTURE

### Problem Definition

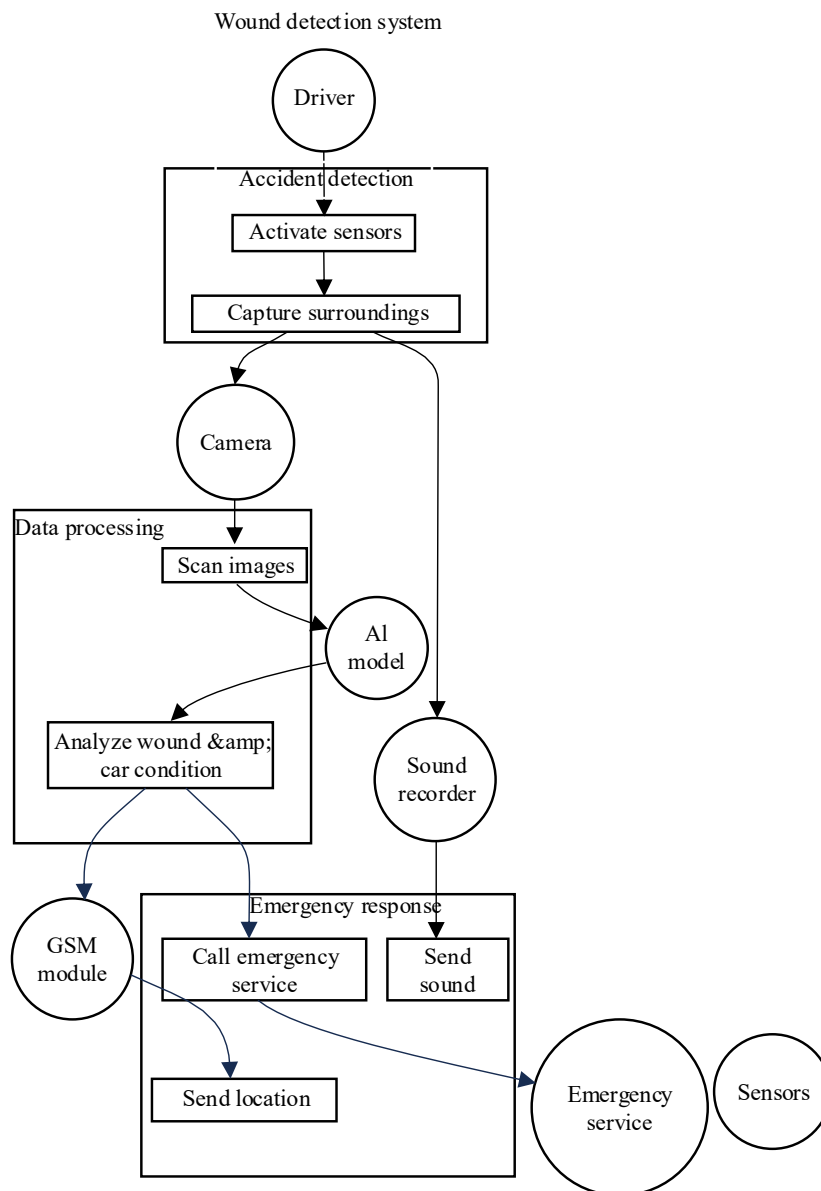
Road accidents are a leading cause of fatalities globally, often exacerbated by delays in emergency response. In cases where individuals are unable to seek help directly due to unconsciousness or severe injuries, an automatic wound detection and alert system could significantly improve response times and potentially save lives [7].

This project aims to develop an IoT-based system that detects accident wounds by analyzing sounds and visual cues, sending real-time alerts to emergency services. The system will use a night-vision camera and sound sensors to identify injuries, leveraging a wound-image dataset for accurate detection.

### System Architecture

#### Hardware Layer

- *Night Vision Camera (Interior/Exterior):* A camera with infrared capabilities will be mounted on either the vehicle's exterior or interior, capturing visuals even in low-light conditions. This camera will continuously monitor for signs of an accident, especially focusing on visible injuries.
- *Sound Sensor:* A high-sensitivity microphone will be installed to capture any loud, unusual sounds (e.g., crashes, screams) that indicate potential accidents. The sensor will help trigger the camera and activate further analysis.



**Figure 1.** UML Diagram.

- *Processing Unit (Microcontroller)*: A microcontroller, such as Raspberry Pi or Arduino with AI capabilities, will process data from the camera and sound sensor. It will analyze the input data to detect wounds or distress signals.
- *GPS Module*: Provides real-time location data, allowing emergency services to pinpoint the vehicle's location upon detecting an accident.
- *GSM Module or Internet Connectivity*: Enables sending automated messages or calls to emergency services, including details like GPS coordinates and incident type.

### Software Layer

- *Data Collection Module*: This module gathers data from the camera and sound sensor, processing images and sounds. It performs initial filtering to minimize false triggers, such as typical road noise or minor scratches.
- *Image Processing and Wound Detection Module*: Using machine learning models trained on a dataset of wound images, this module analyzes visual data from the night vision camera. It detects signs of human injuries based on blood patterns, bruising, and other wound characteristics.

- Machine learning algorithms like CNNs (Convolutional Neural Networks) are used for high accuracy in image classification [5].
- *Sound Analysis Module*: Uses audio data to identify abnormal sounds indicating a crash or human distress. This module can be powered by a sound classification model, distinguishing accident-related noises from normal sounds.
- *Emergency Notification Module*: Once the system detects an injury, this module automatically sends an alert to emergency contacts and services. The message includes the GPS location, type of injury detected, and any relevant image or sound data.

#### **Data Flow and Communication Layer**

- *Sensor to Processing Unit Communication*: Data from the night vision camera and sound sensor flows to the micro-controller for real-time analysis.
- *Processing Unit to Cloud Storage (Optional)*: If the system stores data for post-incident analysis or insurance purposes, it will communicate with cloud storage, using encryption to maintain data privacy.
- *Notification to Emergency Services*: Once an accident is detected, the processing unit communicates with the GSM module to trigger a call or send an SMS to emergency services, including GPS coordinates.

#### **Machine Learning and Model Training Layer**

- *Wound Image Dataset Preparation*: A dataset of wound images will be used for training the wound detection model. This dataset will include various types of wounds, categorized based on severity and appearance [3].
- *Model Training and Deployment*: Train the model on local or cloud-based ML platforms. The trained model will then be deployed to the microcontroller, enabling on-device detection.
- *Continuous Learning*: Integrate new data from detected incidents to improve the model over time, reducing false positives and enhancing detection accuracy.

#### **Working Flow**

- *Incident Detection*: Upon sensing an unusual sound or capturing distress signals through the camera, the system initiates the detection process.
- *Analysis*: Visual and audio data are processed to confirm the presence of injuries, applying trained ML models to classify detected patterns as human wounds.
- *Alert*: If injuries are confirmed, the system triggers the GSM module to send an automated alert message or call, providing location and incident details to emergency services.
- *Continuous Monitoring*: The system returns to standby mode, awaiting further incidents.

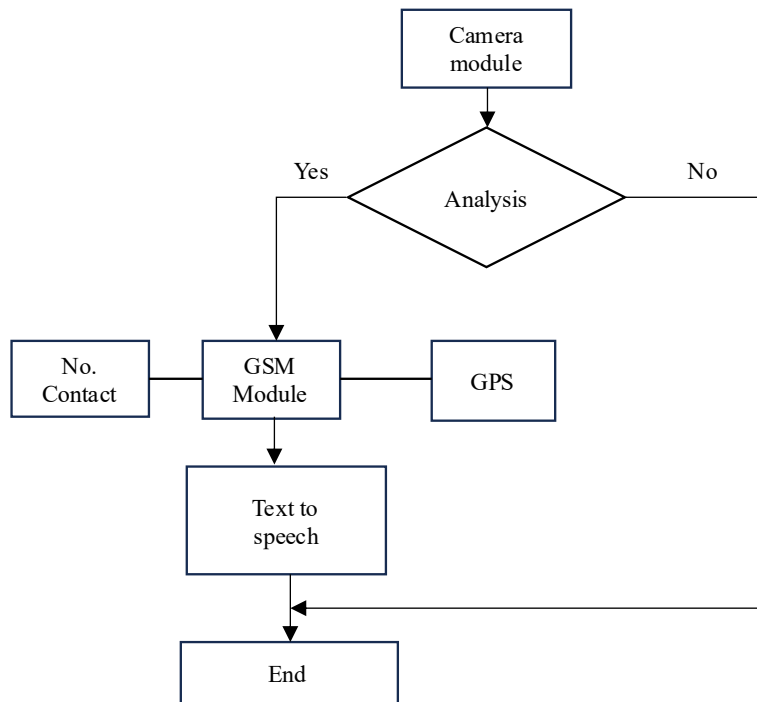
#### **Challenges and Solutions**

- *False Alarms*: Apply noise-filtering algorithms to minimize false alerts from typical traffic sounds.
- *Data Privacy*: Ensure that any collected data is encrypted, protecting personal information.
- *Power Efficiency*: Implement low-power modes and optimize data processing to ensure the system does not drain vehicle battery.

#### **Benefits**

- *Rapid emergency response can reduce fatalities*: Improved accuracy in injury detection using machine learning.
- Enhanced road safety and peace of mind for drivers and passengers.

This architecture provides a comprehensive, modular approach to accident wound detection using IoT and machine learning, ensuring timely and effective emergency response (Figure 2).



**Figure 2.** System architecture.

## CHALLENGES AND FUTURE DIRECTIONS

### Problem Statement

The growing incidence of road accidents globally underscores the need for advanced accident response solutions, especially in detecting and addressing serious injuries as early as possible. Traditional emergency response relies on bystanders or witnesses to report an incident, which can lead to delays in critical care [4]. An IoT-based accident wound detection system using a night vision camera can address these limitations by proactively identifying potential injuries based on visual indicators (such as bleeding) and auditory cues (like distress sounds). This system aims to notify emergency services immediately, reducing response times and improving chances of survival.

### Challenges

#### *Data Accuracy and Interpretation*

- *Challenge:* Accurate detection of wounds and distress sounds in various lighting and environmental conditions is difficult. False positives (non-injured persons triggering an alert) and false negatives (missing actual injuries) can be a risk.
- *Solution:* The system should employ advanced machine learning models trained on extensive datasets of human injury visuals and distress sounds to improve detection accuracy.

#### *Environmental Interference and Noise Detection*

- *Challenge:* Detecting distress sounds can be challenging when there is background noise, such as engine sounds, traffic, or other passengers. Distinguishing actual distress sounds from ambient sounds is complex.
- *Solution:* Utilizing noise cancellation techniques and machine learning algorithms capable of isolating specific frequencies associated with distress sounds can improve detection rates. This may also require ongoing dataset updates to adapt to new sounds and noises.

#### *Night Vision Camera and Sensor Integration:*

- *Challenge:* Installing a night vision camera that can reliably capture wound images in low light and varying weather conditions (rain, fog, etc.) is technically complex.

- *Solution:* High-quality infrared sensors or low-light cameras combined with image enhancement software can help. Proper camera positioning (exterior or interior) and lens protection from environmental elements are also crucial [8].

### **Communication Reliability**

- *Challenge:* Ensuring reliable and rapid communication with emergency services, particularly in remote or low-signal areas, is essential for real-time response.
- *Solution:* Implementing a hybrid communication system that combines cellular, satellite, and possibly vehicle-to-vehicle (V2V) communication methods can enhance connectivity in various settings. Emergency message compression algorithms can also help with transmission speed.

### **Privacy and Data Security**

- *Challenge:* As the system collects sensitive data (injury images and sounds), there is a risk of data misuse or unauthorized access, raising privacy concerns.
- *Solution:* Employing encryption, secure data storage, and adherence to privacy regulations (such as GDPR) can mitigate these risks. Ensuring that data is stored locally on the vehicle until needed for emergency purposes may reduce potential breaches [11].

### **Power and Resource Efficiency**

- *Challenge:* The constant operation of a camera, sound detection, and communication system could drain vehicle resources, especially in electric cars.
- *Solution:* Developing an energy-efficient system, possibly powered by the vehicle's battery management system or utilizing intermittent activation (only during detected impact) could help. Implementing standby modes and energy-saving algorithms will be essential.

### **Future Directions**

1. *AI-Driven Injury Severity Assessment:* Developing algorithms capable of not just detecting injuries but also assessing their severity could prioritize more serious cases for emergency responders. This would likely require sophisticated machine learning models and collaboration with medical experts to identify and categorize injury types.
2. *Integration with Autonomous Vehicles:* As autonomous vehicles become more common, incorporating wound detection into these systems can improve safety features. Future iterations could use shared data across vehicles in an accident, offering a holistic view for emergency responders.
3. *Predictive Analytics and Accident Prevention:* Moving beyond reaction, future versions could incorporate predictive analytics to foresee potential accident risks based on driving behavior, weather conditions, and traffic data, providing alerts to drivers before an accident occurs.
4. *Expansion to Other Emergency Situations:* While initially designed for road accidents, this technology could be adapted for other emergency scenarios, like detecting injuries in workplace accidents or natural disasters [9].
5. *Cloud-Based Data Aggregation for Real Time Analysis:* Centralized data aggregation in the cloud could allow for real-time monitoring, predictive analytics, and sharing of crucial information with emergency services, leading to insights into accident trends and response optimization. This would necessitate a secure, scalable cloud infrastructure to manage data from multiple vehicles.

These directions open avenues for improving accident response systems and ultimately contribute to enhancing road safety worldwide.

## **CONCLUSION**

In overall, a major advancement in emergency response technology is the suggested Internet of Things-based accident wound detection system. Rapid and automatic injury diagnosis during vehicle

accidents is made possible by the system's integration of night vision cameras, sound sensors, and machine learning algorithms trained on wound datasets. Immediate notifications to emergency services are made possible by this real-time detection, which reduces crucial reaction times and may even save lives. Although there are still ethical and technical issues to be resolved, such as safeguarding data privacy, reducing false positives, and enhancing energy efficiency, the system sets the stage for future breakthroughs in automated injury assessment and emergency communication as well as smarter, more responsive vehicle safety measures.

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