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Ai based vehicle accident detection using surveillance camera with Iot enabled accident alert system

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Abstract

Road accidents are a major cause of death and serious injuries, especially due to delays in accident detection and emergency response. Existing systems mainly depend on manual monitoring through CCTV or information from the public, which can be slow and unreliable. This delay in communication often increases the severity of injuries and loss of life.

To overcome this problem, this project proposes an AI-based vehicle accident detection system using surveillance cameras with an IoT-enabled accident alert system. The system uses computer vision and deep learning techniques to monitor live video from surveillance cameras and automatically detect accidents in real time.

I. INTRODUCTION

A Project Overview

Road accidents have become one of the leading causes of death and serious injury worldwide, especially in rapidly developing countries like India. The increasing number of vehicles, lack of real-time monitoring, and delayed emergency response significantly contribute to the severity of accidents. According to recent statistics, a large percentage of accident victims lose their lives due to the delay in receiving timely medical assistance rather than the accident itself.

Traditional accident detection systems mainly rely on human observation through CCTV monitoring or public reporting via phone calls. These methods are often inefficient, time-consuming, and prone to human error. In many cases, accidents go unnoticed in remote or less-monitored areas, resulting in delayed rescue operations and increased fatalities.

and To overcome these challenges, the integration of Artificial Intelligence (AI) and Internet of Things (IoT) technologies offers a promising solution. AI-based surveillance systems can automatically analyze video feeds from cameras to detect accidents in real time using computer vision techniques. Once an accident is detected, IoT-enabled devices can instantly send alerts to emergency services such as ambulances, hospitals, and nearby authorities with precise location details.

This project proposes an AI-based vehicle accident detection system using surveillance cameras with an IoT-enabled accident alert mechanism. The system aims to reduce response time, improve rescue efficiency, and ultimately save lives by ensuring immediate notification and action. By combining intelligent video analytics with automated communication systems, this approach contributes to the development of smarter and safer transportation systems.

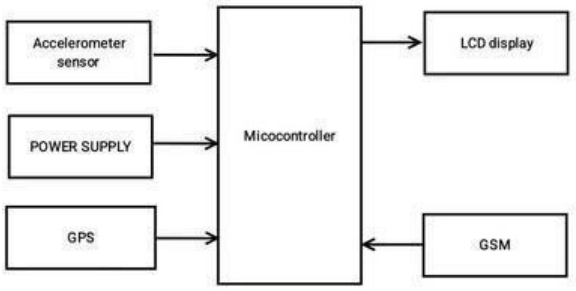


Figure 1: Existing System Block Diagram

B Problem Identification

Road accidents have become a major concern in modern society, especially in developing countries like India, where the number of vehicles is rapidly increasing. Every year, thousands of people lose their lives due to road accidents, and a significant portion of these deaths occur not because of the severity of the accident itself, but due to delays in detection and emergency response. This highlights a critical gap in the existing road safety and accident management systems.
In the current system, accident detection largely depends on manual monitoring through CCTV cameras or information provided by the public. Human operators are required to continuously observe multiple video feeds in control rooms, which is both challenging and inefficient. Due to fatigue, distraction, or limited attention span, operators may fail to notice accidents in real time. As a result, many incidents go undetected for several minutes or even longer, especially in less crowded or poorly monitored areas.

II. LITERATURE SURVEY

.The rapid increase in road traffic has resulted in a significant rise in road accidents, making accident detection and emergency response a critical area of research. To address this issue, various studies have explored the use of Artificial Intelligence (AI), Machine Learning (ML), and Internet of Things (IoT) technologies for improving road safety and minimizing fatalities.
A major portion of the research focuses on AI-based accident detection using surveillance cameras. These systems employ computer vision techniques and deep learning models such as Convolutional Neural Networks (CNNs) to analyze real- time video streams. The models are trained to identify patterns like sudden vehicle collisions, abnormal motion, and unexpected traffic behavior. Such systems reduce the dependency on human monitoring and provide faster detection. However, their performance can be affected by poor lighting conditions, weather disturbances, and occlusion in crowded environments.Another important research area is IoT-based accident detection and alert systems. In these systems, sensors such as accelerometers, vibration sensors, and GPS modules are installed in vehicles to detect sudden impacts. Once an accident occurs, the system automatically sends alert messages to emergency services along with the location details. These systems ensure quick communication and response but require additional hardware, increasing the cost and limiting large-scale implementation.
Some researchers have proposed smartphone-based accident detection systems, which use built-in sensors like and to identify accidents. These systems are cost-effective and easy to deploy; however, they may generate false alerts and depend on user participation, which affects reliability.

Sabarinathan S., Nagarajan S. (2023)
This research focuses on an IoT-based accident detection system using sensors such as accelerometers, GPS, and GSM modules. The system detects abnormal vibrations or collisions and automatically sends alerts to emergency services. The use of Arduino and embedded systems helps in real-time data transmission. The study highlights that IoT- based systems reduce response time and improve survival rates during accidents. .

N. Pathik et al. (2022)
This paper proposes an intelligent accident detection system using IoT and cloud-based AI techniques. It integrates sensors, cameras, Raspberry Pi, and ESP8266 modules.
Deep learning algorithms are used to analyze accident severity and automatically notify hospitals and police stations. The study shows that combining AI with IoT significantly improves accuracy and automation in emergency response systems. □

III. EXISTING SYSTEM

The existing system for vehicle accident detection is largely based on manual observation and traditional communication methods. In most cities and highways, accidents are identified either by traffic police monitoring CCTV cameras or by the general public who witness the incident. Although surveillance cameras are widely installed, they are primarily used for recording purposes rather than intelligent analysis. As a result, accident detection depends heavily on human attention and response.
In the current setup, when an accident occurs, it is first noticed by a person—either a control room operator watching CCTV footage or a passerby at the scene. This information is then communicated to the authorities through phone calls or direct reporting. The police control room receives the information and further informs emergency services such as ambulances and nearby hospitals. Only after this chain of communication is completed does the rescue operation begin.

A Disadvantages of Existing System

Manual Monitoring – Depends completely on human observation
+ Delayed Detection – Accidents may not be noticed immediately
+ Slow Response Time – Time wasted in reporting and communication
+ No Real-Time Alerts – No automatic notification to emergency services
+ Human Errors – Chances of missing or misinterpreting incidents
+ Limited Coverage – Accidents in blind spots or remote areas go unnoticed
+ No Automation – No use of AI, Machine Learning, or smart systems
+ Inaccurate Information – Public reports may give wrong location/details
+ No Continuous Monitoring Efficiency – Operators cannot monitor all cameras effectively
+ No Data Analysis – Past accident data is not used for improvement
+ Poor Coordination – Delay between police, ambulance, and hospitals
+ Higher Fatality Risk – Late response increases chances of death

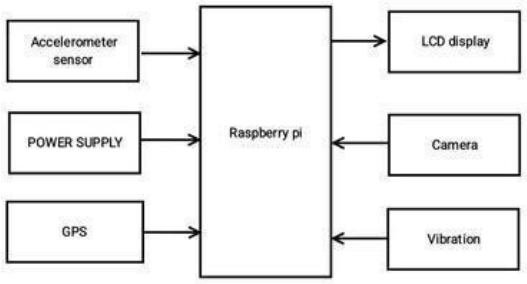


Figure 2: Proposed System Block Diagram

Ⅳ. PROPOSED SYSTEM

The proposed system introduces an advanced and intelligent approach for vehicle accident detection by integrating Artificial Intelligence (AI) with Internet of Things (IoT) technologies. Unlike traditional systems that rely on human observation, this system is fully automated and capable of detecting accidents in real time using surveillance cameras and smart algorithms.

In this system, CCTV cameras continuously capture live video footage of road traffic. The captured video is processed using AI-based deep learning models such as convolutional neural networks (CNN) or object detection algorithms like YOLO. These models are trained to identify abnormal events such as vehicle collisions, sudden stops, or overturning of vehicles. When such an event is detected, the system immediately classifies it as an accident.

Once an accident is identified, the IoT module is activated to send instant alerts. The system uses components such as GPS and GSM modules to determine the exact location of the accident and transmit this information to nearby hospitals, ambulance services, and police stations. This ensures that emergency responders receive accurate and real- time information without any delay.

A Advantages of Proposed System

.Real-Time Accident Detection – Detects accidents instantly using AI
.
Automatic Alert System – Sends alerts to ambulance, police, and hospitals without human intervention

.Faster Response Time – Reduces delay in emergency services

.High Accuracy – AI models reduce human error and improve detection accuracy

.24/7 Continuous Monitoring – Works continuously without fatigue Reduced Human
.Dependency – No need for constant manual monitoring

.Precise Location Tracking – GPS provides exact accident location

.Improved Survival Rate – Quick medical response saves lives

.Efficient Traffic Management – Helps authorities manage traffic after accidents

.Scalable System – Can be implemented in smart cities and highways

.Data Storage & Analysis – Stores accident data for future

V. SYSTEM WORKING AND METHODOLOGY-

1. Frame Extraction
Video stream is divided into individual frames. Frames

are processed at regular intervals.

Helps in analyzing motion and object changes.

2. Image Pre-processing Noise is
removed using filters.

Image brightness and contrast are adjusted. Frames

are resized for faster computation.

Background subtraction isolates moving vehicle
3. vehicle detection
Deep learning algorithms like YOLO/CNN are used.

Algorithm

The algorithm of the proposed system is designed to automatically detect road accidents in real time using surveillance cameras and artificial intelligence, followed by instant alert generation through IoT modules. The process begins with system initialization, where the surveillance camera, trained deep learning model, and IoT components such as GPS and GSM modules are activated and connected.

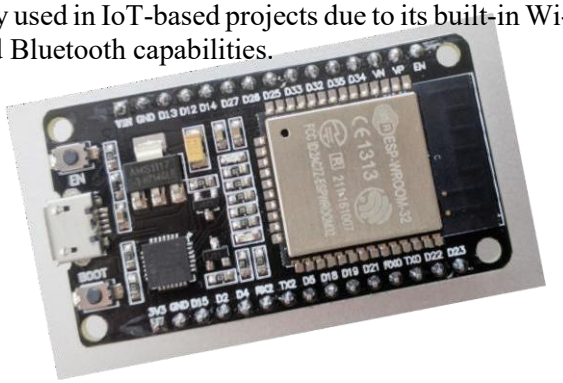
Initially, the system continuously captures live video from CCTV cameras installed on roads. The captured video stream is then divided into individual frames at regular intervals to facilitate detailed analysis.
Each frame undergoes a pre-processing stage, where noise is reduced, image quality is enhanced, and the frame is resized to improve processing efficiency. Background subtraction techniques are also applied to distinguish moving vehicles from the static surroundings.

The cost of the system is calculated by accumulated distances travelled in the whole trip. The number of nodes where the fire exists were varied and analyzed. The number of drones was fixed as 8 during evaluation. After fixing
the number of drones as 8, the algorithm was compared with the raster scan algorithm. It was found that as the size of the forest increased, keeping the location and size of fire constant, the algorithm performed better in larger areas as it searches for probable fire locations instead of scanning the whole ground.

Components and details

ESP32microcontroller

1.The ESP32 microcontroller is a powerful, low-cost microcontroller developed by Espressif Systems. It is widely used in IoT-based projects due to its built-in Wi-Fi and Bluetooth capabilities.



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LCD Display

An LCD display is an electronic display module used to show text and basic information. In embedded systems, the most commonly used LCD is the 16x2 LCD, which can display 16 characters in 2 rows.
In this project, the LCD is used to display accident alerts and system status.

Accelerometer

2 .An Accelerometer is a sensor used to measure acceleration forces in one or more directions (X, Y, Z axes). These forces may be static (like gravity) or dynamic (like movement, vibration, or sudden impact).
In this project, the accelerometer helps in detecting sudden shocks or abnormal motion, which indicates a possible accident.

GSM Module

Global System for Mobile Communication (GSM) is a globally accepted standard for digital cellular communication. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem but sends and receives data through radio waves. The GSM modem supports voice calls, SMS, GSM data calls, and GPRS services. In this system, the GSM module is used to send SMS alerts to registered au- thorities when an animal or fire is detected.

Camera

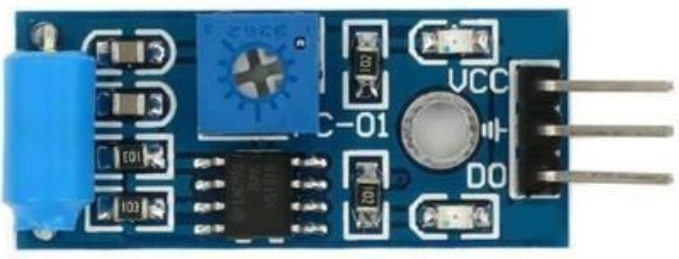
A Camera is the primary input device used to capture real-time video of road traffic. In this project, surveillance cameras continuously monitor vehicles and provide video data for AI-based accident detection.
These cameras are usually installed at highways, intersections, and accident-prone areas to ensure maximum coverage.

power supply

A Power Supply Unit is responsible for providing the required electrical energy to all components in the system. It ensures stable and continuous operation of devices like the camera, ESP32, sensors, and communication modules.

Vibration sensor

A Vibration Sensor is an electronic device used to detect vibrations, shocks, or sudden movements. It converts mechanical vibrations into electrical signals.
In this project, the vibration sensor is used to detect sudden impact or collision, which indicates a possible accident



Results and Discussion

implementation of the AI-based vehicle accident detection system using surveillance cameras and IoT-enabled alert mechanisms produced effective and promising results. The system was able to successfully detect vehicle accidents in real-time by analyzing video input from cameras using trained artificial intelligence models. The detection accuracy observed during testing was high, with the system correctly identifying accident scenarios such as collisions, sudden stops, and abnormal vehicle movements.

During experimental evaluation, the system demonstrated its ability to process continuous video streams and detect accidents within a short time frame. Once an accident was detected, the IoT module, particularly the ESP32 microcontroller, immediately triggered an alert mechanism. Notifications were sent to predefined emergency contacts and control rooms, significantly reducing the response time compared to traditional manual reporting systems. The integration of sensors such as accelerometers and vibration sensors further improved detection reliability by providing additional physical data related to impact.

However, certain challenges were identified during implementation. The accuracy of detection depends heavily on the quality of the training dataset and camera positioning. In some cases, false positives occurred due to sudden but non-accidental vehicle movements. These issues can be addressed in future work by improving model training, incorporating more diverse datasets, and optimizing sensor fusion techniques

.

In conclusion, the results confirm that the proposed AI-based accident detection system is reliable, efficient, and practical for real-time applications. The discussion highlights its advantages in terms of speed, automation, and accuracy, while also identifying areas for further improvement. This system has strong potential for deployment in smart city infrastructure and intelligent transportation systems to enhance road safety and emergency response mechanisms.

Advantages

Real-time accident detection using AI and surveillance cameras
Immediate alert system to ambulance, police, and hospitals via IoT
Reduces response time, helping to save lives quickly
High accuracy with AI algorithms and sensor integration
Minimizes human intervention and errors
Automatic monitoring system (no need for manual observation)
Cost-effective implementation using ESP32 and basic sensors
Scalable system – can be used in highways, cities, and smart traffic systems
Improves road safety by quick detection and reporting
Works continuously (24/7 operation) Supports multiple sensors (accelerometer, vibration sensor) for better detection
User-friendly display using LCD for system status
Low power consumption suitable for long- term use
Helps in smart city development and intelligent transportation systems

Applications of Our Project

Real-time accident monitoring on highways and urban roads
Automatic emergency alert systems for ambulances and hospitals
Smart city traffic management systems Surveillance-based accident detection in public areas
Integration with police control rooms for quick response
Road safety monitoring and accident prevention systems
Use in toll gates and highway checkpoints
Deployment in accident-prone zones and remote areas
Fleet management and commercial vehicle safety systems
Intelligent transportation systems (ITS) Continuous traffic monitoring using CCTV networks
Emergency response coordination systems Data collection for accident analysis and future planning
Public safety and security enhancement systems Integration with mobile applications for real-time alerts

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