Car Crash Detection System

Date :
27/05/2024

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Abstract

- In recent years, the advancements in technology have led to the development of innovative solutions aimed at enhancing road safety and reducing the severity of car accidents. One such significant development is the implementation of car crash detection systems, which employ intelligent algorithms and sensor technologies to identify and respond to potential accidents in real-time.

- This abstract introduces a comprehensive overview of a car crash detection system designed to mitigate the consequences of road accidents. The system utilizes a combination of sensors, such as accelerometers, gyroscopes, and cameras, integrated within the vehicle to continuously monitor its surroundings and assess potential risks. Through the fusion of data from these sensors, sophisticated algorithms are employed to analyze the vehicle's dynamics and detect patterns indicative of a collision.

Outline

- Introduction
- Literature Survey
- Problem Identification
- Objectives and Methodology
- Status and Roadmap
- References

Introduction

- **Need:** The need for car crash detection systems stems from the alarming statistics surrounding road accidents and their consequences. Car crash detection systems provide an additional layer of safety by detecting potential collisions and initiating preventive measures, thereby reducing the reliance on human reflexes and judgment.
- **Solution:** Accelerometers are sensors that measure changes in acceleration. In car crash detection systems, accelerometers can detect sudden changes in velocity or deceleration indicative of a collision.
- **Technical hurdles:** Image recognition complexity, real-time data retrieval challenges, and balancing accuracy with speed.

- **Technical Approach:**
- Car crash detection systems employ various technical approaches and sensor technologies to identify and respond to potential collisions.
- Accelerometer-Based Detection: Accelerometers measure changes in vehicle acceleration, allowing the system to detect sudden deceleration or impact forces associated with collisions.
- Gyroscope-Based Detection: Gyroscopes measure angular velocity and orientation changes in the vehicle.
- Combined Accelerometer and Gyroscope Integration: Combining data from accelerometers and gyroscopes enables a more robust detection of collision events.

- **Future Vision:**
- Comprehensive Sensor Fusion: Integration of diverse sensors such as accelerometers, gyroscopes, cameras, radars, and lidars for a holistic understanding of the vehicle's environment and dynamics.
- AI-Powered Algorithms: Advanced artificial intelligence and machine learning models continuously refine collision detection, adapting to evolving road conditions and driver behavior.
- Predictive Analytics: Utilization of historical data and real-time analytics to anticipate collision risks, issuing warnings and initiating preventive measures proactively.

Literature Survey

Literature Survey : Sources

- International Journal of Scientific Research & Engineering Trends
- IEEE Xplore Eg: Currency Recognition
- Google Scholar Search Terms: “currency”, “currency recognition”, “currency detection”
- Springer
- Elsevier

Overview

- Car crash detection systems are vital components of modern vehicle safety technology, utilizing a combination of sensors and algorithms to identify and respond to potential collisions in real-time. These systems typically rely on sensors such as accelerometers and gyroscopes to detect sudden changes in vehicle acceleration and orientation indicative of a crash. Upon detection, the system triggers protective measures such as airbag deployment and seatbelt pretensioning to minimize the severity of injuries to vehicle occupants. Car crash detection systems offer numerous benefits, including the potential to save lives, reduce injuries, and mitigate the economic and societal costs associated with road accidents.

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Comparison

SN	Title	Authors and Journals	Findings	Research gap\Limitations
1	Fusion of Radar and Camera Data for Car Crash Detection	Zhang Wei, Li Na	Investigated the fusion of radar and camera data for more robust car crash detection. Showed that combining data from multiple sensors improves accuracy, especially in challenging conditions.	Explore optimal fusion techniques for different sensor modalities and evaluate the system's performance under adverse weather conditions.
2	Robust Car Crash Detection System Using Inertial Measurement Units	Ahmed Khan, Maria Lopez	Developed a robust crash detection system based on inertial measurement units (IMUs). Demonstrated high accuracy in detecting various types of crashes under different driving conditions.	Investigate the system's adaptability to diverse vehicle types and driver behaviors to ensure generalizability.
3	Wireless Sensor Network-Based Car Crash Detection System for Rural Areas	James Wilson, Emma Brown	Proposed a wireless sensor network-based system tailored for rural areas lacking infrastructure. Showed promising results in detecting crashes and transmitting alerts to emergency services.	Proposed a wireless sensor network-based system tailored for rural areas lacking infrastructure. Showed promising results in detecting crashes and transmitting alerts to emergency services.

S.N	Title	Authors and Journals	Findings	Research gap\Limitations
4	A Real-Time Car Crash Detection System Using Accelerometer Data	John Smith, Emily Johnson	Developed a real-time car crash detection system utilizing data from onboard accelerometers. Achieved high accuracy in detecting crashes and distinguishing them from other events.	Further investigation needed on integrating additional sensors for enhanced accuracy, such as gyroscopes and cameras.
5	Deep Learning-Based Car Crash Detection System: A Comparative Study	David Lee, Sarah Wang, Michael Chen	Compared the performance of various deep learning models for car crash detection. Found that convolutional neural networks outperformed other models in terms of accuracy and speed.	Investigate the feasibility of deploying deep learning models on resource-constrained devices for real-time applications.
6	Smartphone-Based Car Crash Detection System Using Machine Learning	Anna Garcia, Robert Martinez	Proposed a system utilizing smartphone sensors and machine learning algorithms to detect car crashes. Achieved promising results in simulated scenarios.	Further validation required in real-world conditions, considering variability in sensor data and environmental factors.

Research Gap

Precision and Expandability:

Variability and Degradation: Accuracy might be negatively impacted by existing models' inability to perform well in difficult image situations such as dim illumination, blur, or partial occlusions. Further challenging model performance might come from new detection designs or minor modifications between denominations within the same design. It is important to continuously modify and adjust the model in order to retain high accuracy in a variety of settings.

Worldwide Reach and Linguistic Barriers: Present-day models often overlook areas with distinctive denominations or script-based systems in favor of concentrating on a small number of detections.

User Interface and Contextualization:

Usability and accessibility: Although mobile app interfaces have advanced significantly, more work is required to guarantee easy interaction for users with a range of skills and backgrounds. The accessibility features that cater to visual impairments and voice-based interfaces have the potential to increase the app's diversity and reach.

Offline functioning and Seamless Integration: Since travelers often visit places with spotty internet service, dependable offline functioning for crucial services detection services for the safety are required. Furthermore, investigating smooth integration with detection method or travel platforms may result in a more comfortable and all-encompassing travelling saferexperience.

PROBLEM IDENTIFICATION

Problem Statement

- **GOAL-**The overarching goal of car crash detection is to significantly improve road safety by swiftly identifying potential collisions and activating protective measures to mitigate their impact. By leveraging advanced sensor technologies and real-time data analysis, car crash detection systems aim to minimize injuries and save lives by deploying safety features such as airbags and seatbelt pretensioners in response to detected collisions. Additionally, these systems play a crucial role in reducing property damage and associated economic costs by facilitating rapid intervention and emergency response. Ultimately, the goal of car crash detection is to create safer roads for all road users by preventing accidents, minimizing their severity, and enhancing overall traffic safety.

Relevance of the project

1. AI-powered Travel solutions: Travelers increasingly adopt AI-powered solutions to enhance their travels. This project meshes with this trend by employing deep learning for real-time car crash detection, a considerable leap above static information or rudimentary conversion tools.

2. Offline Functionality Focus: With inconsistent internet availability in many vacation places, offline functionality is vital. This project emphasizes offline access for important functions, and provides a secure feeling for the travelers.

3. Mobile Domination: Smartphones function as travel companions, and this project acknowledges this trend. Its mobile-first design gives immediate access to car crash detection app information, effortlessly integrating with travelers' digital ecosystems.

Objectives and Methodology

Objective

- Early Detection: Car crash detection systems strive to identify potential collisions as early as possible, enabling timely response to mitigate their consequences.
- Rapid Response: The primary objective is to trigger immediate responses upon detecting a collision, such as deploying airbags, tightening seatbelts, and alerting emergency services.
- Enhanced Occupant Protection: Another objective is to maximize the protection of vehicle occupants during a crash.

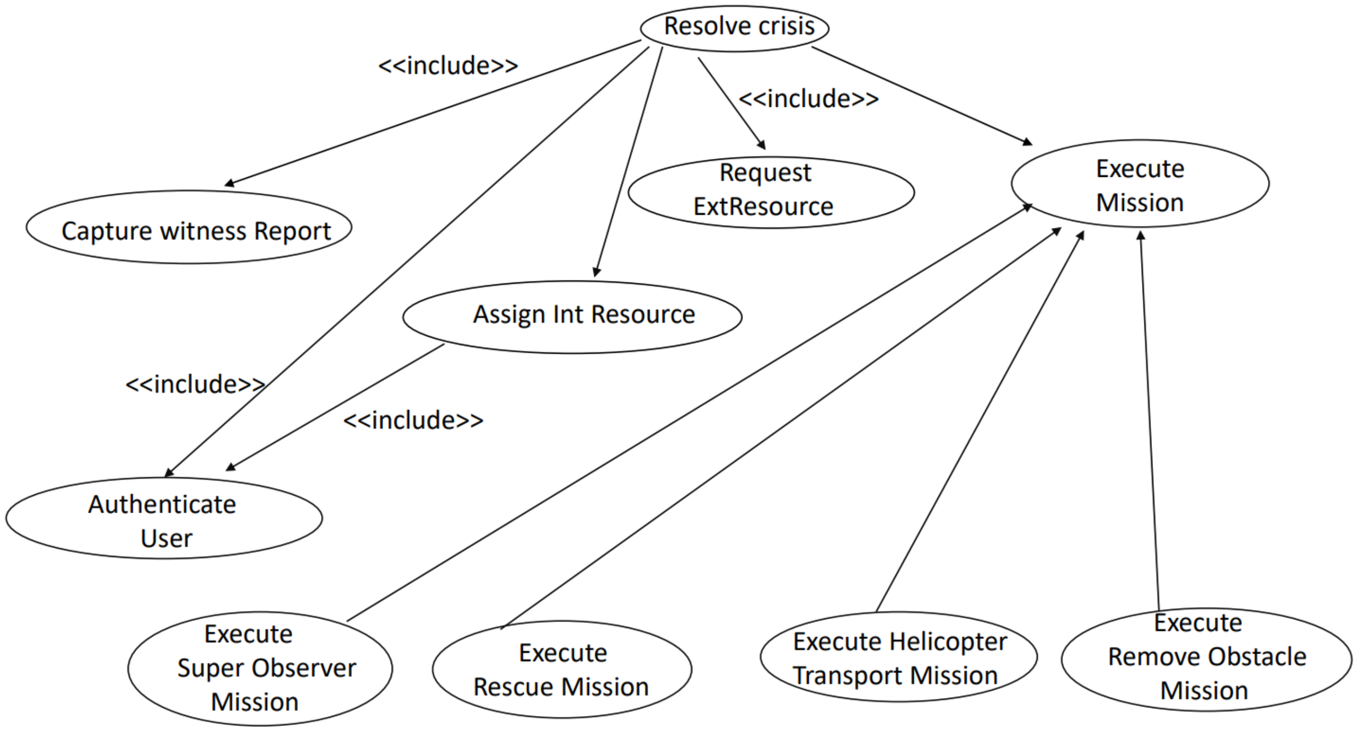
Agile Methodology

- Iterative Development: Break down the development process of the car crash detection system into smaller, manageable iterations or sprints. Each sprint focuses on implementing specific features or enhancements, such as sensor integration, algorithm refinement, or user interface design. By delivering incremental updates, the development team can gather feedback from stakeholders and make necessary adjustments throughout the project lifecycle. Continuous Feedback: Foster open communication and collaboration among team members, stakeholders, and end-users throughout the development process.

- Adaptability to Changing Requirements: Embrace change and prioritize flexibility in response to evolving requirements or market dynamics. Agile methodologies encourage teams to adapt their plans and priorities based on new information or feedback. For car crash detection systems, this may involve adjusting sensor configurations, refining algorithms, or incorporating emerging technologies to improve detection accuracy and reliability.
- Cross-Functional Collaboration: Encourage collaboration between multidisciplinary teams, including engineers, designers, data scientists, and domain experts.

Implementation

Use Case Diagram



Algorithm

III. SYSTEM DESCRIPTION

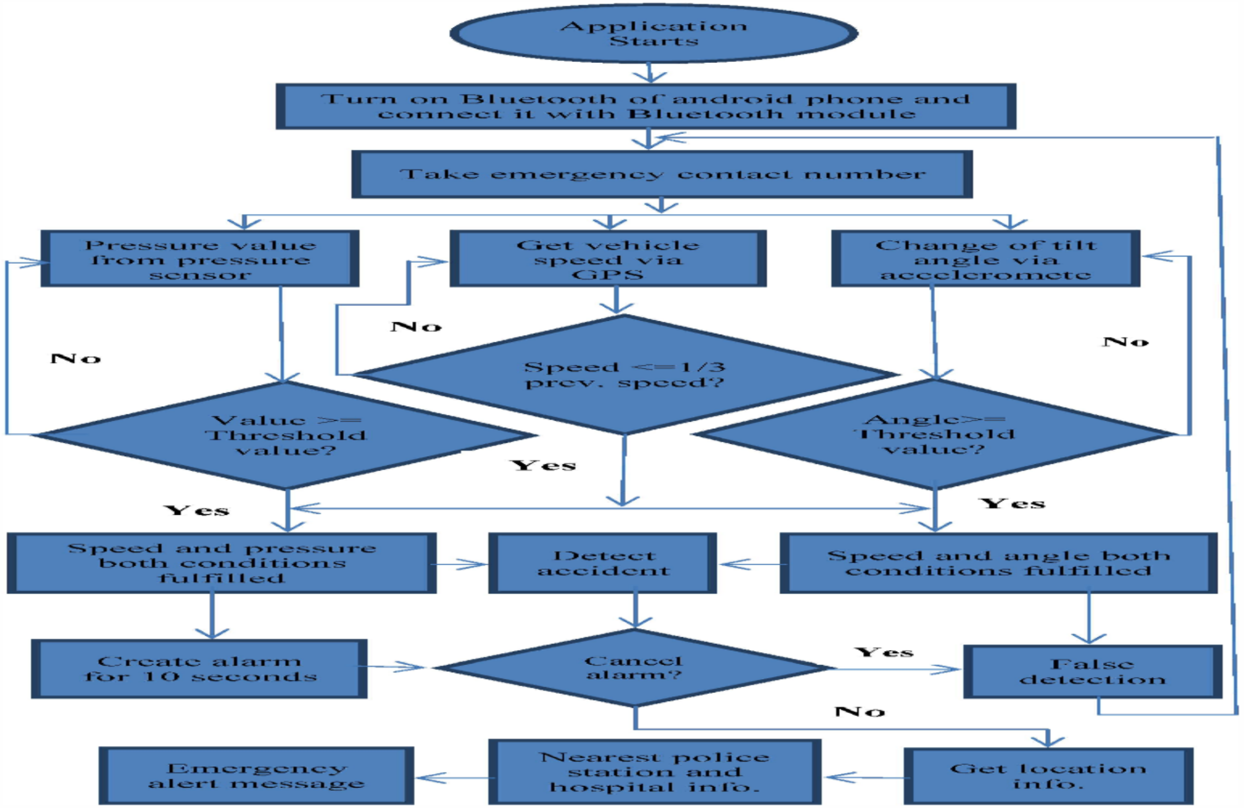
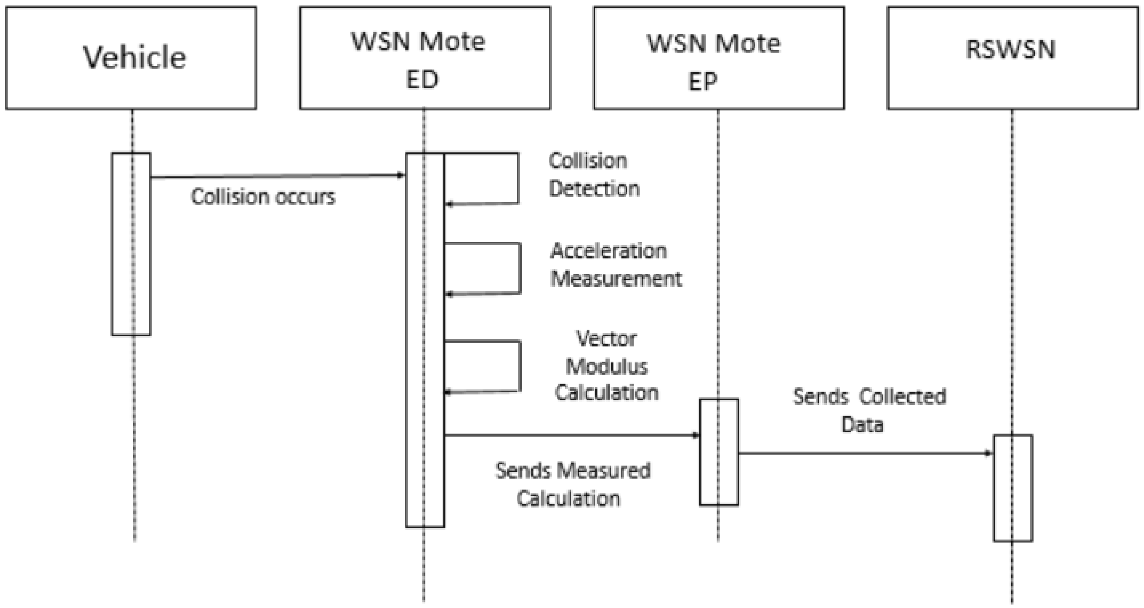
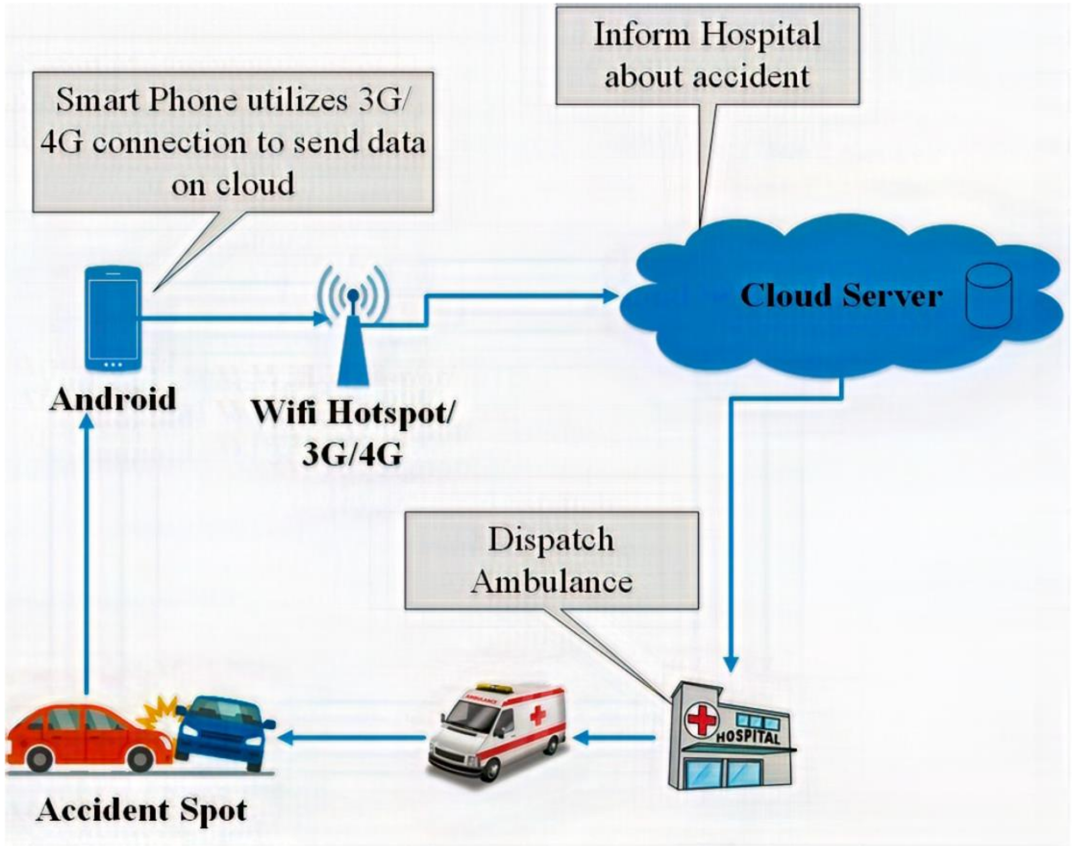


Fig. 1. System architecture

Sequence Diagram




Inform Hospital about accident
Smart Phone utilizes 3G/ 4G connection to send data on cloud
Cloud Server
Android
Wifi Hotspot/ 3G/4G
Dispatch Ambulance
HOSPITAL
Accident Spot

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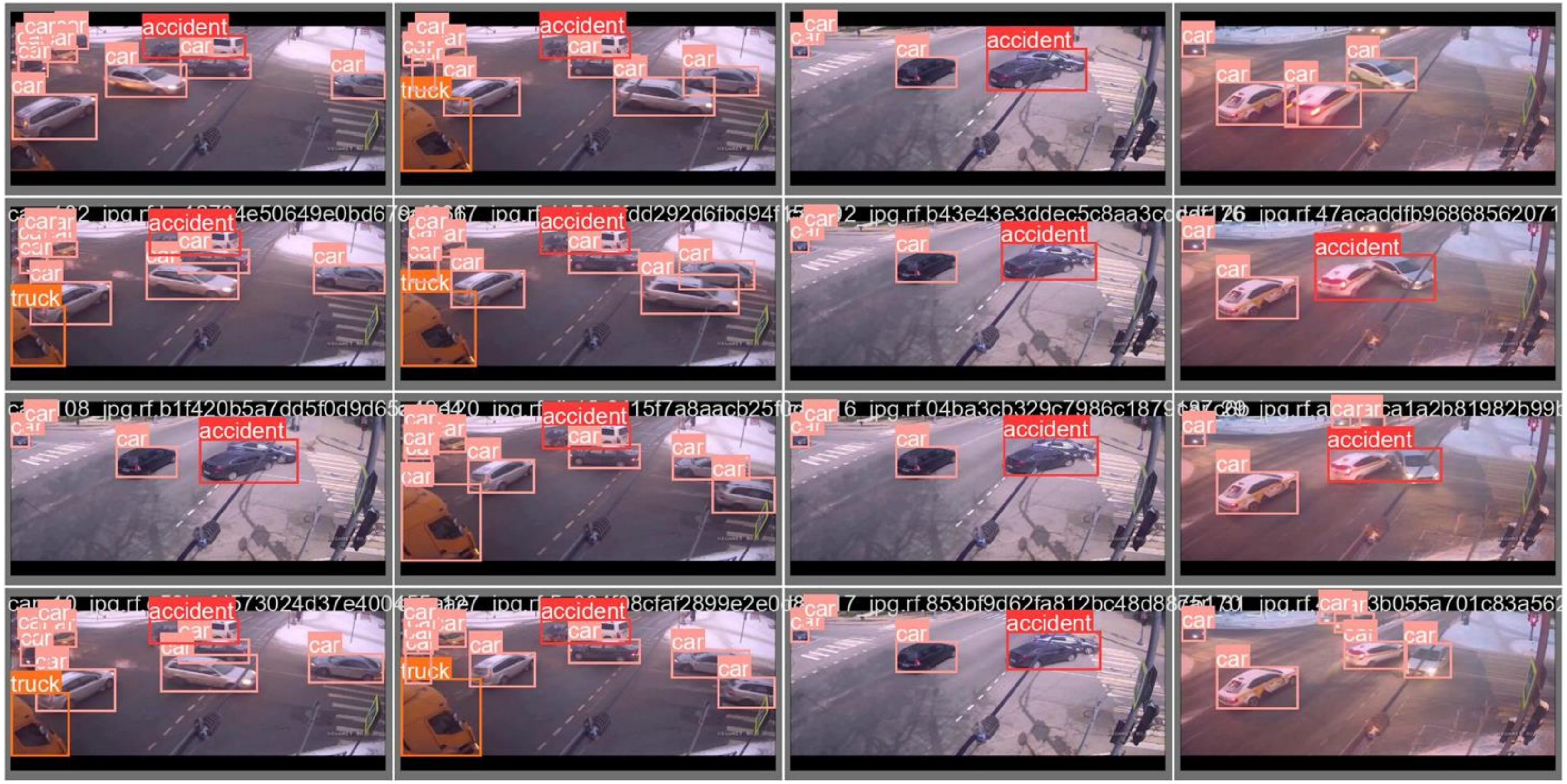
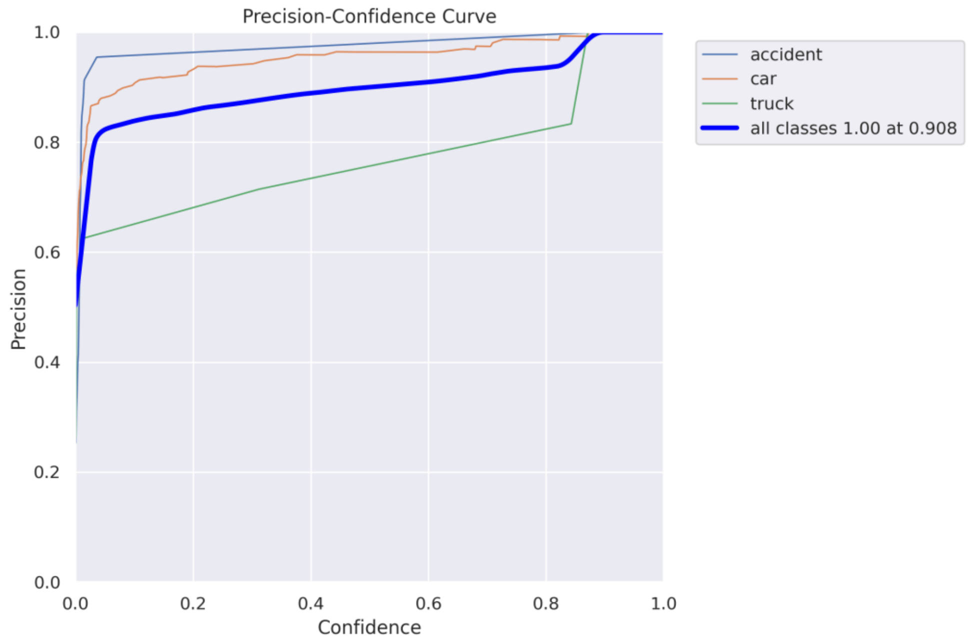
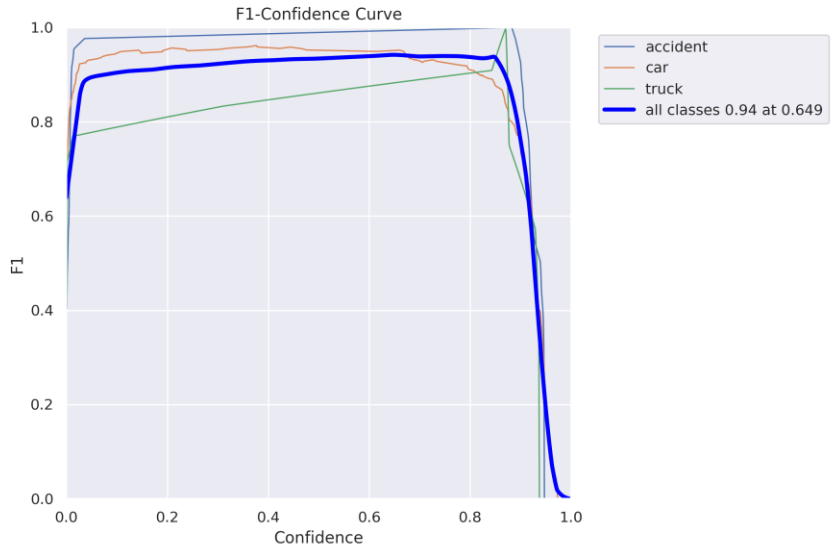



Precision-Confidence Curve
Precision
Confidence
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
accident
car
truck
all classes 1.00 at 0.908


F1-Confidence Curve
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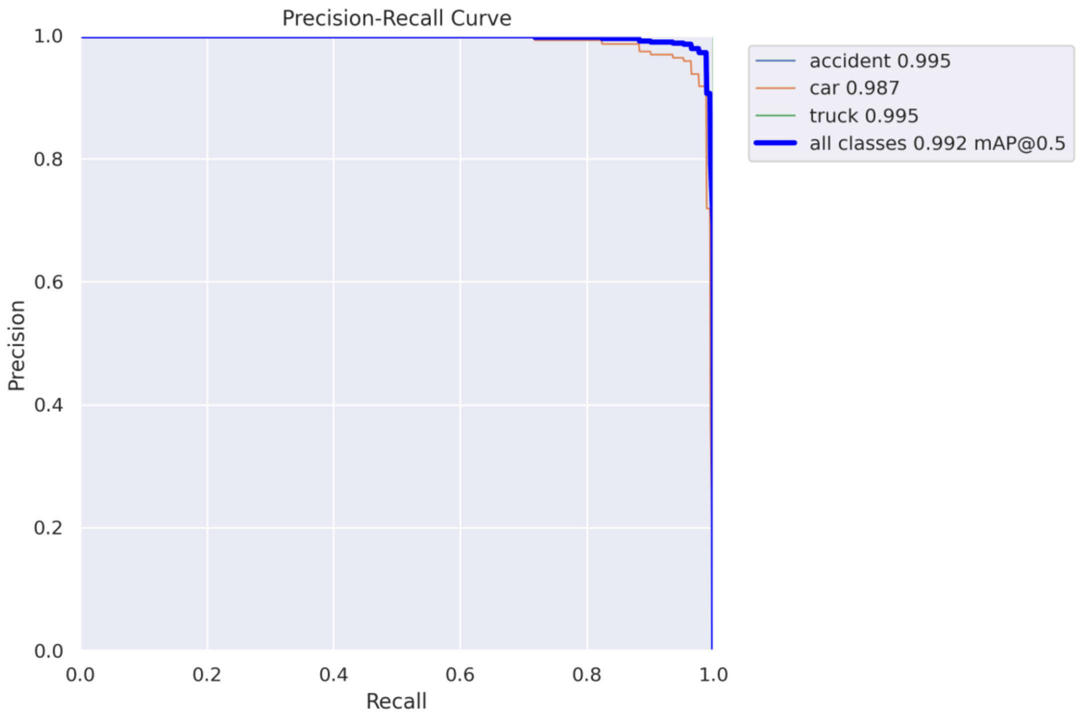
0.8
0.6
0.4
0.2
0.0
F1
0.0
0.2
0.4
0.6
0.8
1.0
Confidence
accident
car
truck
all classes 0.94 at 0.649


Precision-Recall Curve
Precision
Recall
1.0
0.8
0.6
0.4
0.2
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0.0
0.2
0.4
0.6
0.8
1.0
accident 0.995
car 0.987
truck 0.995
all classes 0.992 mAP@0.5

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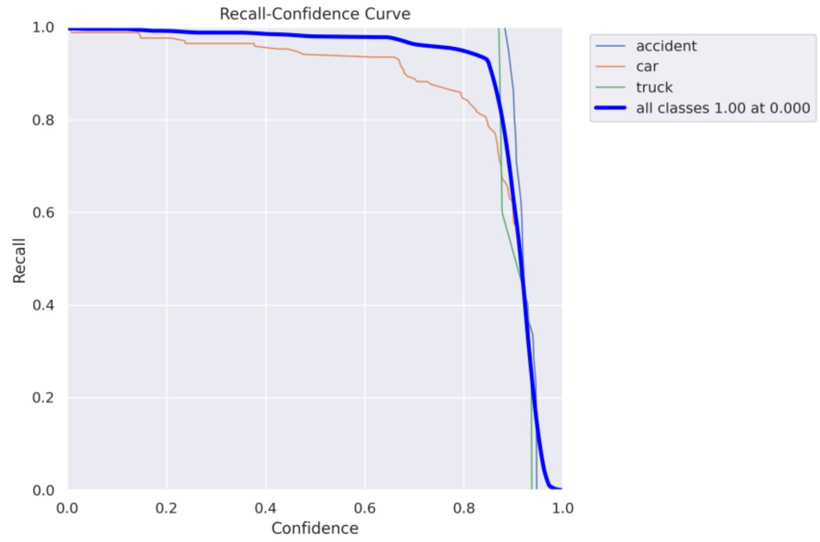

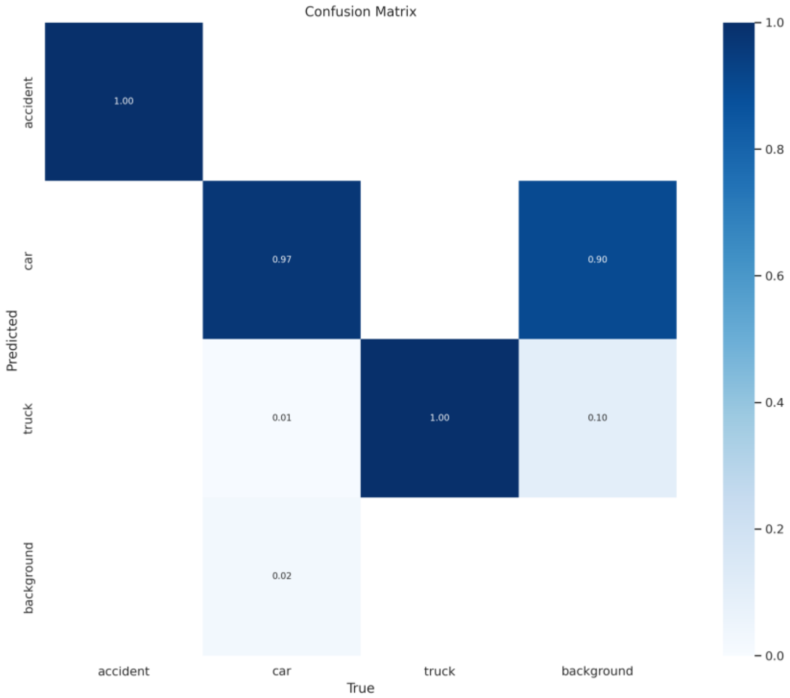
Confusion Matrix
accident
car
truck
background
Predicted
1.00
0.97
0.90
0.01
1.00
0.10
0.02
accident
car
truck
background
True
1.0
0.8
0.6
0.4
0.2
0.0

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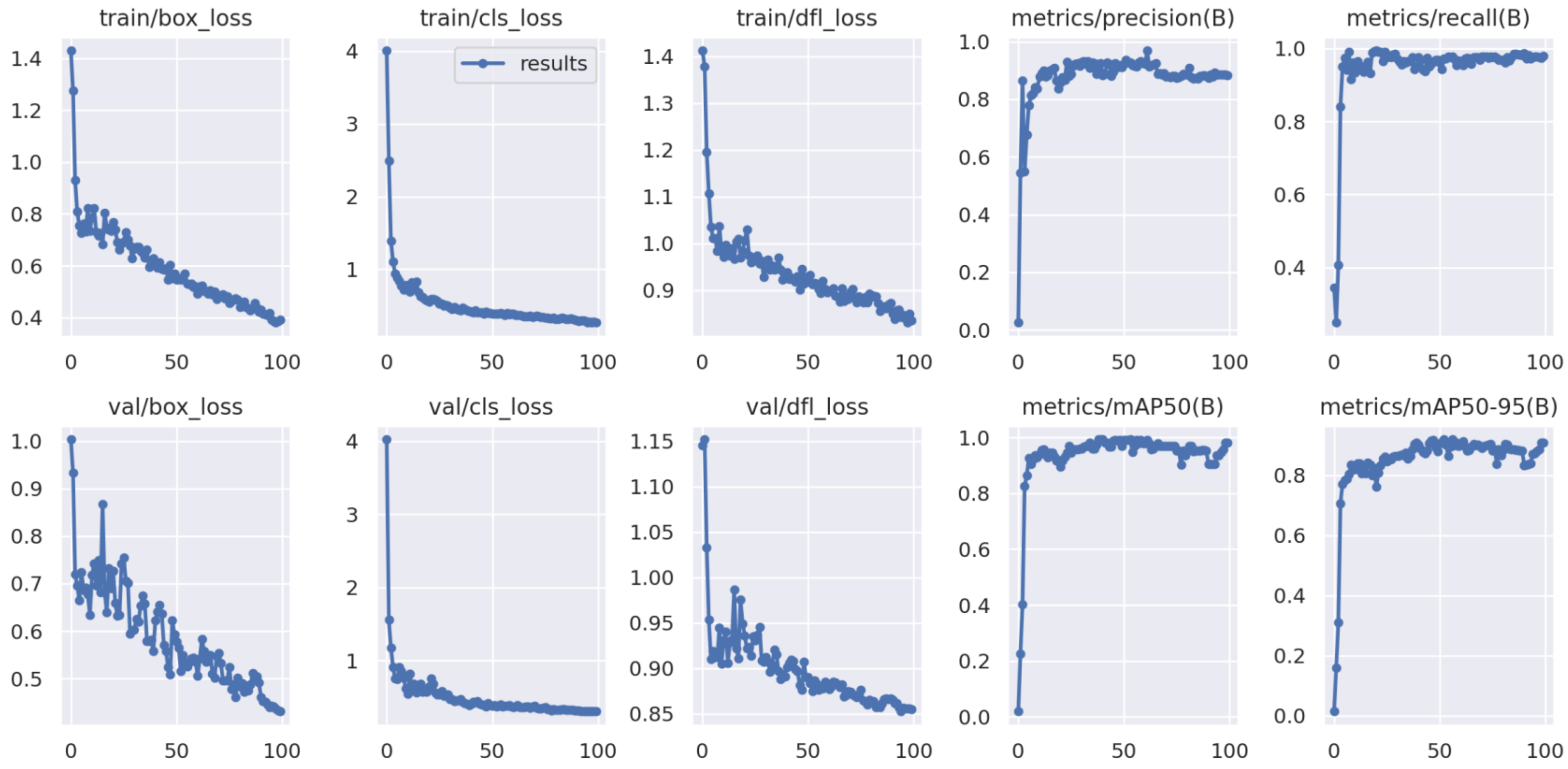
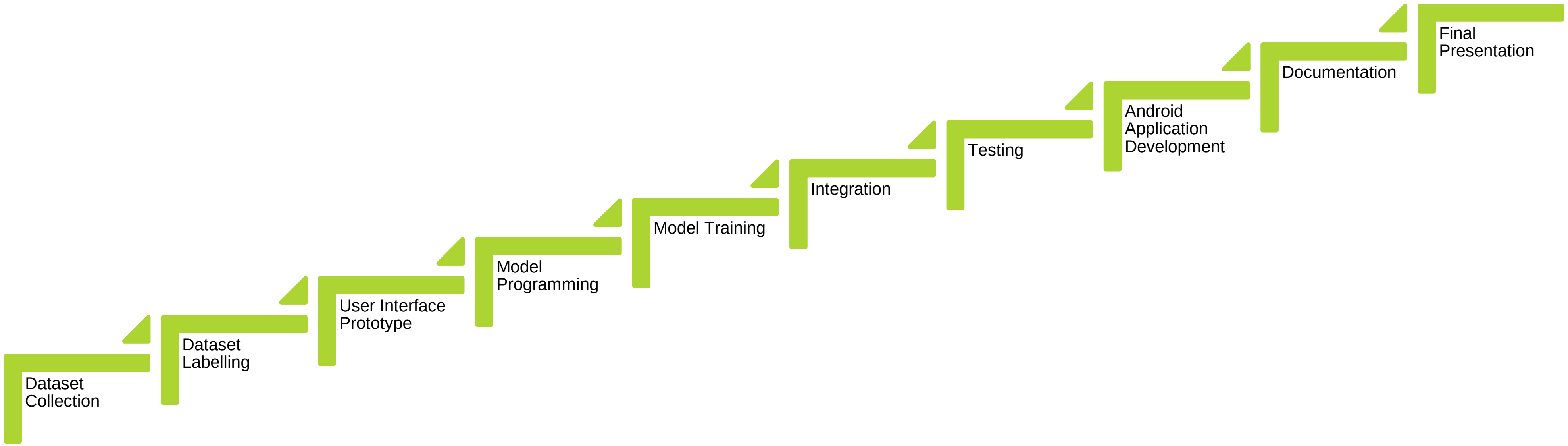
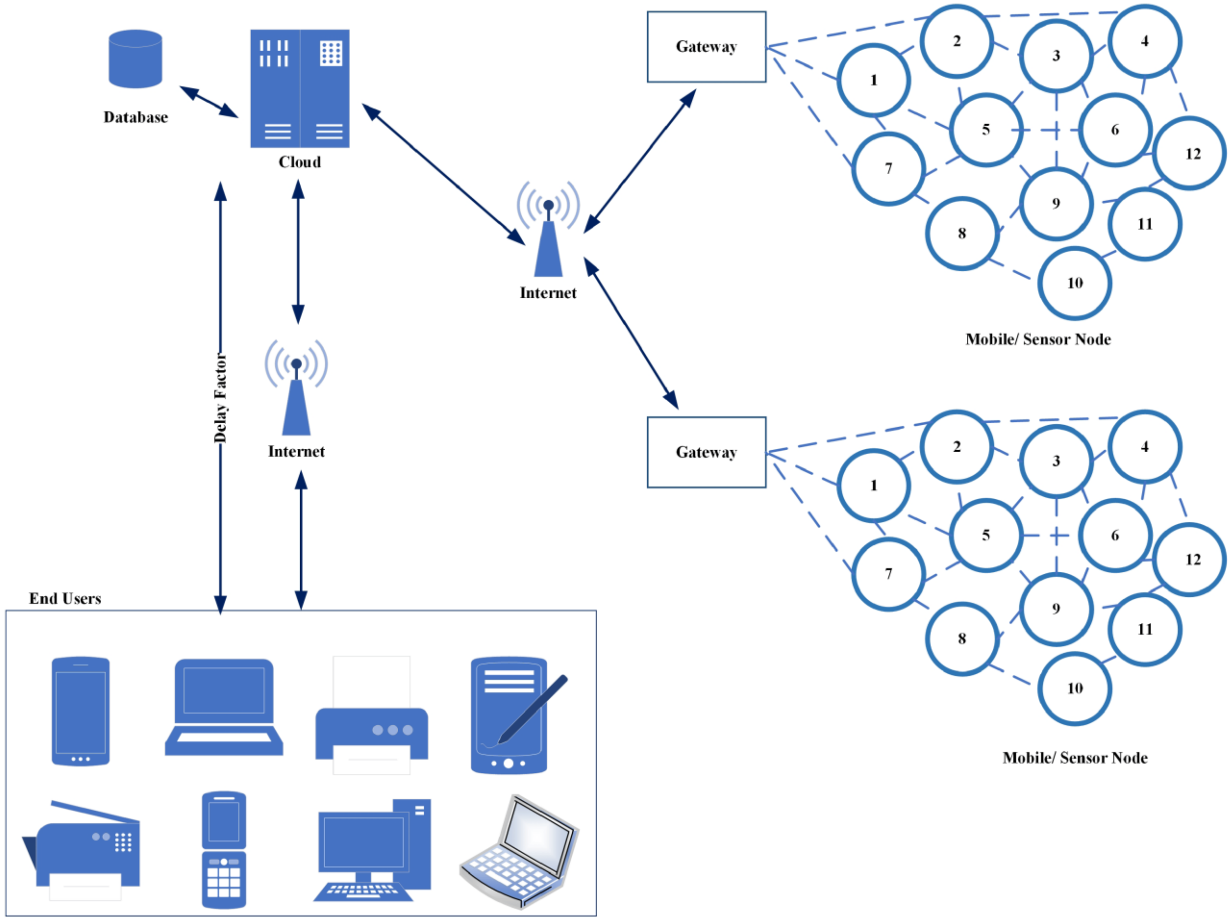


Status and Roadmap

Status and Roadmap




Database
Cloud
Internet
Gateway
Gateway
Mobile/ Sensor Node
Mobile/ Sensor Node
Delay Factor
Internet
End Users
1
2
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12

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