DEEP ROAD INSIGHTS

(Harnessing CNNs for Proactive Accident Detection)

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***Abstract*:** Rapid advancements in technology have simplified many aspects of modern life but have also led to increased traffic risks and frequent road accidents, often resulting in significant loss of life and property, largely due to delays in emergency response. To address this issue, our project introduced an innovative solution that leverages accelerometer sensors, GPS, and GSM technology to detect crashes and promptly notify emergency services. The accelerometer serves as a mechanism for identifying collisions or rollover events by detecting sudden changes in motion. Upon detection, the system uses GPS and GSM communication to relay the location of the accident to emergency responders. To avoid unnecessary alerts in cases of minor incidents or false alarms, the driver can deactivate the alert using a manual switch. This system aims to improve response times, save lives, and optimize emergency resource use by ensuring accurate and timely accident detection and reporting.

I INTRODUCTION

The increasing number of vehicle owners has led to a corresponding increase in the number of road accidents. Vehicles have become an essential part of daily life, however increased traffic congestion, lack of awareness of traffic rules, and inadequate enforcement of these rules have led to a significant number of casualties and deaths. Most of these accidents occur on highways, where heavy vehicles often travel at high speeds. According to reports, the number of road traffic deaths globally has seen alarming trends, with predictions indicating that these figures will likely rise in the coming years. Low- and middle-income countries experience higher fatality rates compared to high-income countries, primarily due to ineffective law enforcement and limited access to emergency medical services.

Several researchers, social organizations, and governmental bodies have attempted to address the growing issue of road accidents by developing solutions aimed at mitigating casualties and improving response times. One promising approach is the deployment of automated systems directly within vehicles to detect crashes and initiate emergency responses. These systems can play a pivotal role in saving lives by reducing delays in medical attention following accidents.

Although numerous methods have been developed to detect accidents, common techniques involve the use of GPS to determine the location of the incident and GSM to communicate with emergency services. Methods such as Vehicular Ad-Hoc Networks (VANETs) have also been explored as potential solutions. These systems work by enabling communication between vehicles within a range to alert nearby drivers of potential hazards, thereby reducing the risk of additional accidents.

Some accident detection methods rely on accelerometers, GPS systems, or other sensor-based technology to identify crashes. Methods that rely solely on accelerometers detect crashes by measuring motion changes, while GPS-based methods monitor speed variations over time. Mobile applications and sensor data are also being explored, though challenges such as false alarms caused by sensor malfunctions remain obstacles. Machine learning methods like neural networks, decision trees, and SVMs have recently been implemented for crash detection through advanced image classification methods. Leveraging techniques such as transfer learning, trained models like Google's Inception V3 can analyze real-time images to identify potential crashes.

While innovative in their approach, these methods must address challenges such as accuracy, response time, and system reliability to ensure they are practical for real-world applications. This evolving landscape underscores the need for continued research into advanced detection mechanisms to enhance both detection accuracy and emergency response systems.

OBJECTIVES:

In this section, we compare the proposed work with other accident detection techniques. Most of the studies in this field focus on enhancing tangible infrastructure rather than leveraging Intelligent Transportation Systems (ITS).ITS technologies involve detecting traffic congestion, accidents, event occurrence, and other dynamic patterns. Additionally, the few existing research studies often lack detailed implementation strategies and are limited geographically demographically.

II EXISTING SYSTEM

This section provides a comparison of the proposed system with other accident detection methods in use today. Current systems largely focus on improving physical infrastructure rather than incorporating Intelligent Transportation Systems (ITS), which integrate traffic congestion monitoring, accident detection, and event tracking. Moreover, many existing methods lack comprehensive implementation information and are often limited due to geographical and demographic factors. Notable examples of current accident detection systems include:

1. Lexus Enform (2014)

Lexus introduced the *Lexus Enform* system in 2014, which used an impact sensor located at the rear of the vehicle. Upon detecting an accident, these sensors would notify the user via a dedicated application.

Disadvantages:

- Required installation of sensors in every vehicle, leading to high costs.
- Depended on external devices like smartphones, adding complexity.

2. Chevy Star by OnStar Corporation

This application offered accident alerts and assistance services for accident victims but was subscription-based. User feedback indicated challenges with its reliability and service quality.

Disadvantages:

- Expensive subscription costs.
- Performance and reliability issues reported by users.

3. SOSmart by SoSmart SpA

SOSmart introduced a smartphone-based application offering emergency assistance after an accident. While it was user-friendly and provided victims a way to call for help with a single button press, it still relied on manual reporting.

Disadvantages:

- Heavily reliant on users' manual reporting, which could delay emergency response.

Summary of Challenges with Existing Methods

The limitations of these existing systems highlight key obstacles in current accident detection technology:

- Heavy costs related to infrastructure and sensor deployment.
- Reliance on additional physical devices or smartphone connectivity.
- Subscription models that restrict accessibility.
- Dependence on user-driven, manual reporting mechanisms.
- Sensor malfunctions leading to false alarms.

These insights underscore the need for a solution that is automated, cost-effective, efficient, and adaptable across diverse terrains and demographic contexts.

Key Insights:

1. High costs associated with sensor deployment.
2. Inefficiencies in physical infrastructure-based detection methods.
3. Sensor malfunctions and false alarms reduce reliability.
4. Manual reporting bottlenecks delay emergency responses.
5. Subscription models limit widespread adoption.

III PROPOSED SYSTEM

The goal of this project is to use **Convolutional Neural Networks (CNN)** to analyze images, predict the occurrence of road accidents, and notify emergency services immediately upon detection. The system works by processing real-time images to classify them as either an accident or non-accident. When an accident is detected, the system sends alerts to emergency services with vital details, including the image and geolocation of the accident.

System Architecture

The CNN model comprises:

- Four **activation layers**
- Two **dense layers**
- Two **2D convolution layers**
- Two **max pooling layers**

The system uses these layers to classify images into two categories: **accident vs. non-accident**, based on features learned during training. Once an accident is identified, the system shares the following information with emergency services:

- A cropped image of the accident scene.
- The geolocation of the accident site.

Preprocessing Steps

1. **Image Processing:**
   - Accident images are converted into individual frames for faster analysis and improved accuracy.
2. **Grayscale Conversion:**
   - Images are converted to grayscale to streamline the dataset, focus on essential features, and reduce processing complexity.
3. **Resizing:**
   - Images are resized to uniform dimensions for CNN compatibility and to ensure consistency across all inputs.
4. **Data Splitting:**

- Processed data is split into training and testing datasets, which are essential for model training and validation.

The trained CNN will serve as the primary mechanism for efficient and accurate accident detection by analyzing input images and providing real-time classifications. Upon detection, an alert is sent to emergency responders via email with attached images and geolocation coordinates.

Advantages of the Proposed System

1. **Effective with Limited Resources:**
   - CNNs perform well even with minimal image datasets and computing power.
2. **Reduced Resource Consumption:**
   - Training models is quicker, requiring less computation time and energy.
3. **Superior Performance Speed:**
   - CNNs offer faster and more accurate classification than traditional machine learning approaches.

The system intends to improve emergency response times by combining real-time image classification with automated alerting mechanisms.

Key Insights:

1. Utilizes CNNs for real-time accident detection.
2. Requires fewer computational resources for operation.
3. Optimized image preprocessing (grayscale conversion and resizing) enhances speed.
4. Automated emergency alerts sent with image and geolocation upon accident detection.
5. CNNs' speed and accuracy will make the system efficient and effective.

IV METHODOLOGIES

This section explains the various preprocessing methods integrated into the system pipeline, preparing the images for efficient CNN training and real-time detection.

MODULES EXPLANATION AND DIAGRAM

MODULES NAME

• 1. Uniform Aspect Ratio

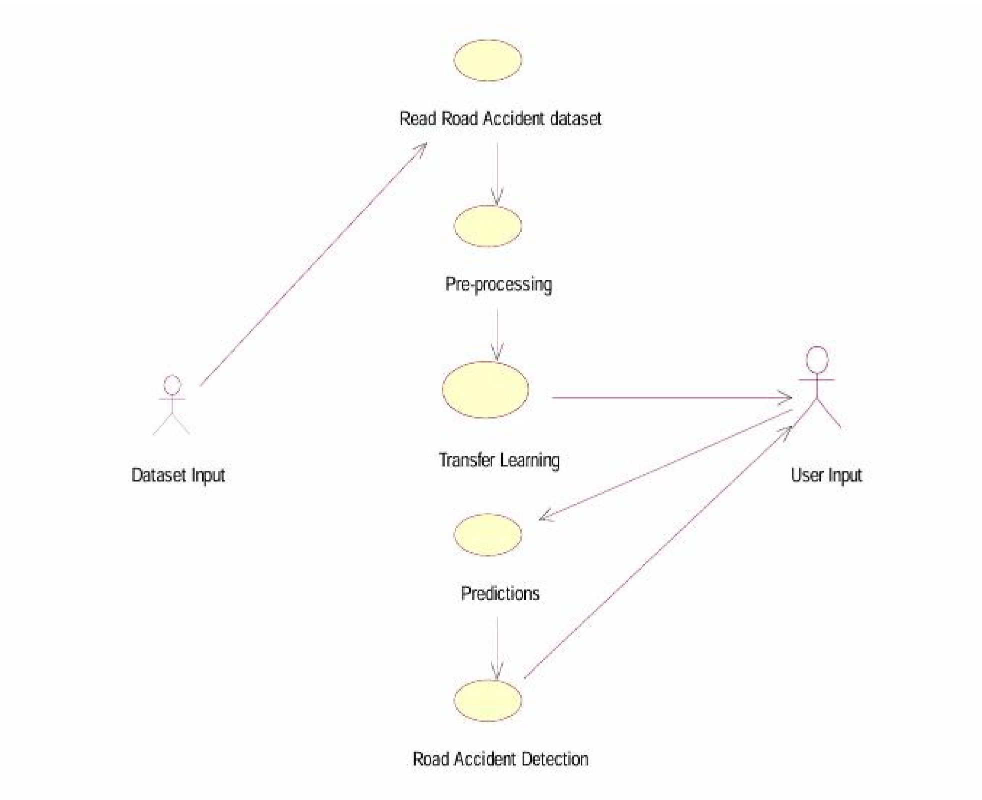
• 2. Image-Scaling

• 3. Normalizing Image Inputs

1. Uniform Aspect Ratio
   - The first step in image preprocessing. All images are resized to standardized dimensions to ensure compatibility with the CNN model and eliminate shape or size inconsistencies.

2. Image-Scaling
   - Images are scaled (either up or down) using functions like the image data generator from Keras. This ensures all input images are uniformly sized for optimal training and performance.
3. Normalizing Image Inputs
   - Pixel intensities are normalized by subtracting the mean pixel value and dividing it by the standard deviation. This speeds up convergence during model training by standardizing the data distribution.

MODULE DIAGRAM:



V SYSTEM ARCHITECTURE

The system architecture is designed to efficiently detect accidents in real time and ensure prompt emergency response. The architecture consists of the following key stages:

1. Data Acquisition
- Capture images and sensor data in real-time using cameras, accelerometers, and GPS devices.

2. Preprocessing
- Prepare raw data by performing resizing, scaling, and normalization to ensure faster and more accurate analysis.

3. Feature Extraction
- Analyze input data to identify and highlight essential patterns for accident detection.

4. Model Processing
- Utilize a Convolutional Neural Network (CNN) or another machine learning model to process the preprocessed input data and predict the likelihood of an accident.

5. Decision Logic
- Evaluate the model's output. If an accident is detected, the system triggers a notification to emergency services.

6. Notification Transmission

- Send alerts via GPS, GSM, or other communication methods to emergency services, including relevant information about the incident.

7. User Input (Optional)

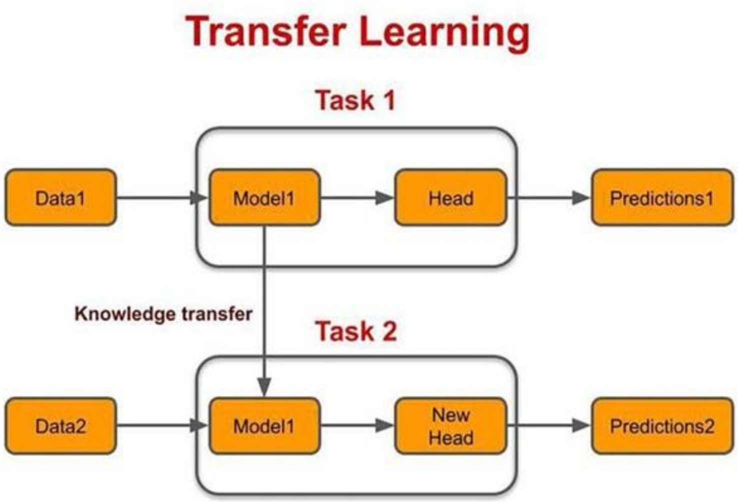
- Allows the driver to cancel false alarms to prevent unnecessary use of emergency resources.

Key Objectives:

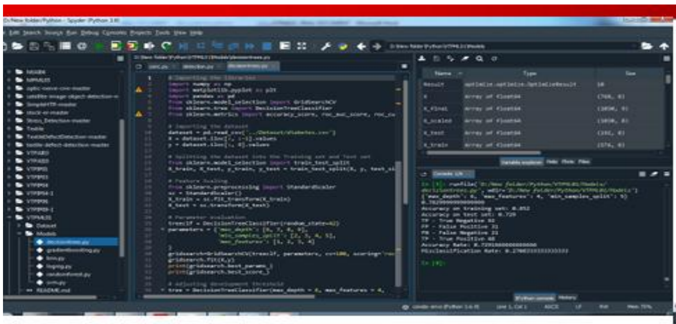
1. **Accurate Accident Detection:**
   - Detect accidents with minimal false alarms.
2. **Efficient Emergency Response:**
   - Reduce the time required for emergency services to arrive at the accident site.
3. **Resource Saving:**
   - Avoid unnecessary emergency responses by allowing drivers to manually terminate alerts if needed.

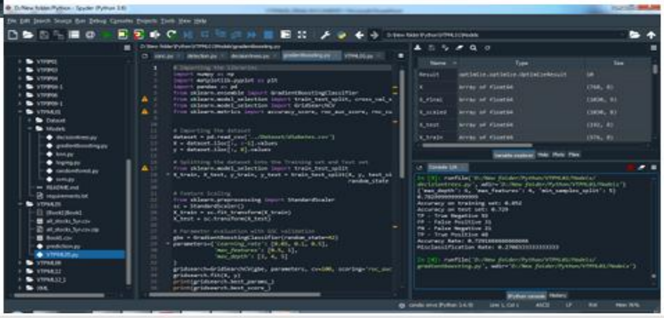
This modular system structure ensures the solution is scalable, adaptable, and optimized for real-time accident detection and emergency response.

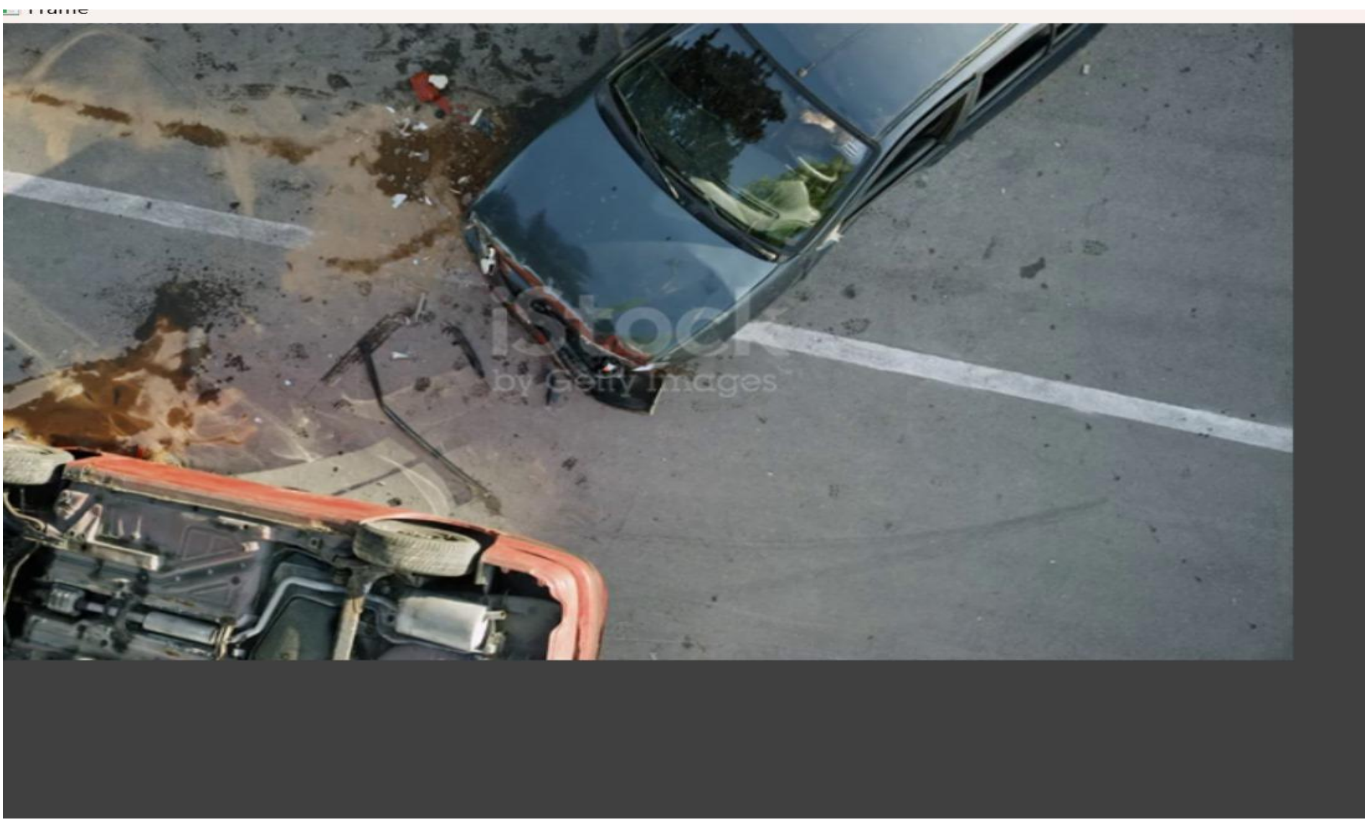
Fig.System Architure Model



VI EXECUTION SCREENSHOTS



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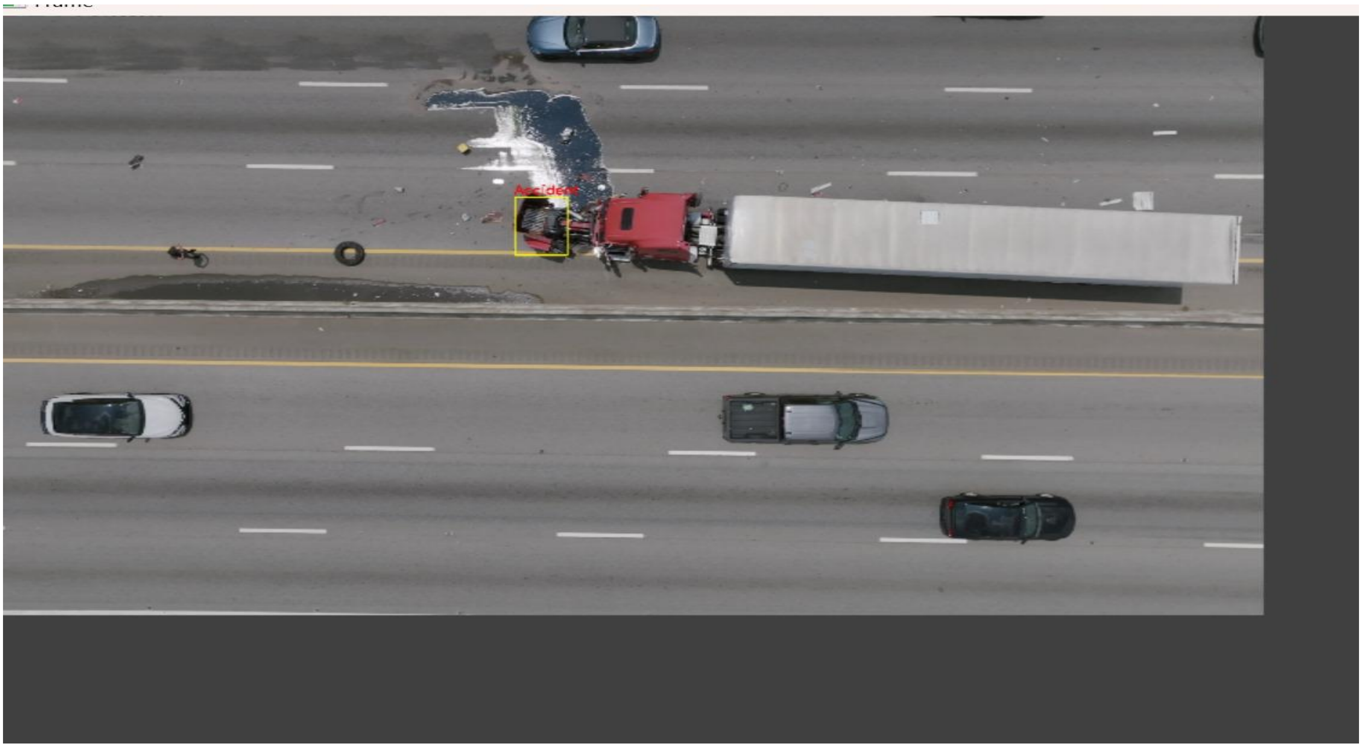

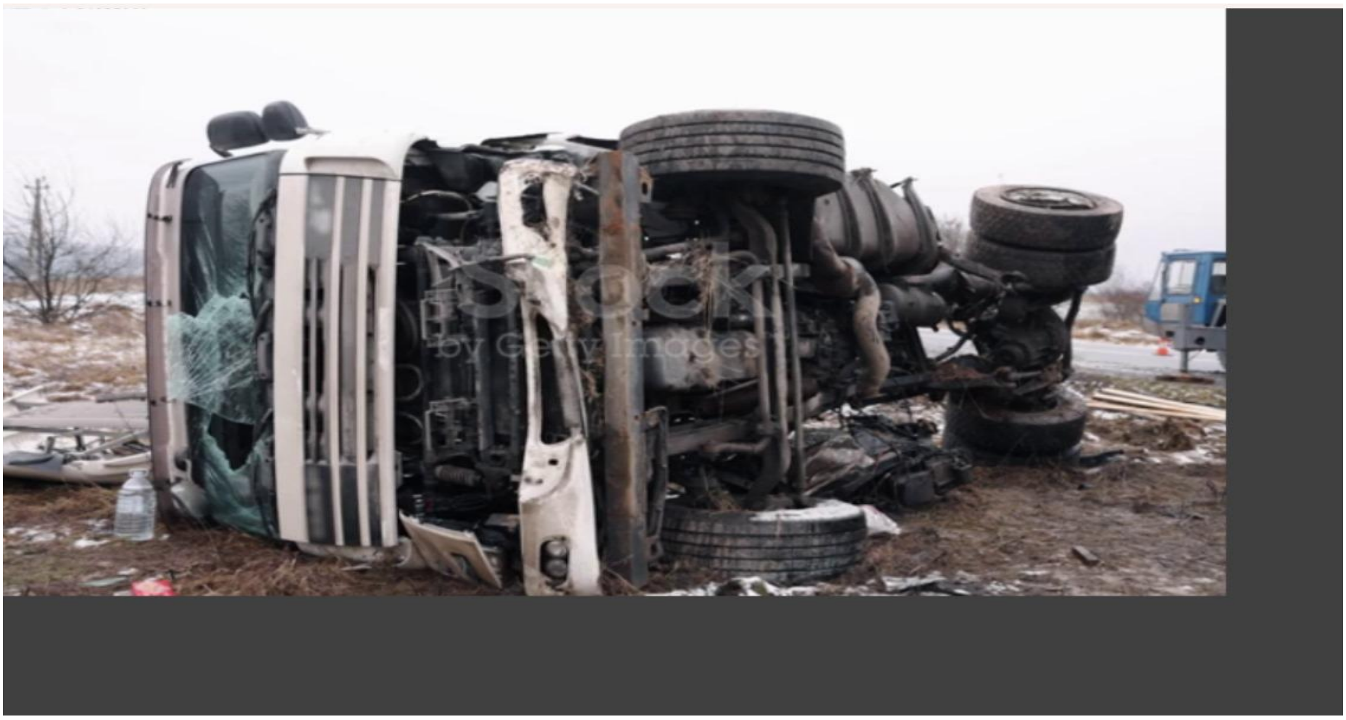

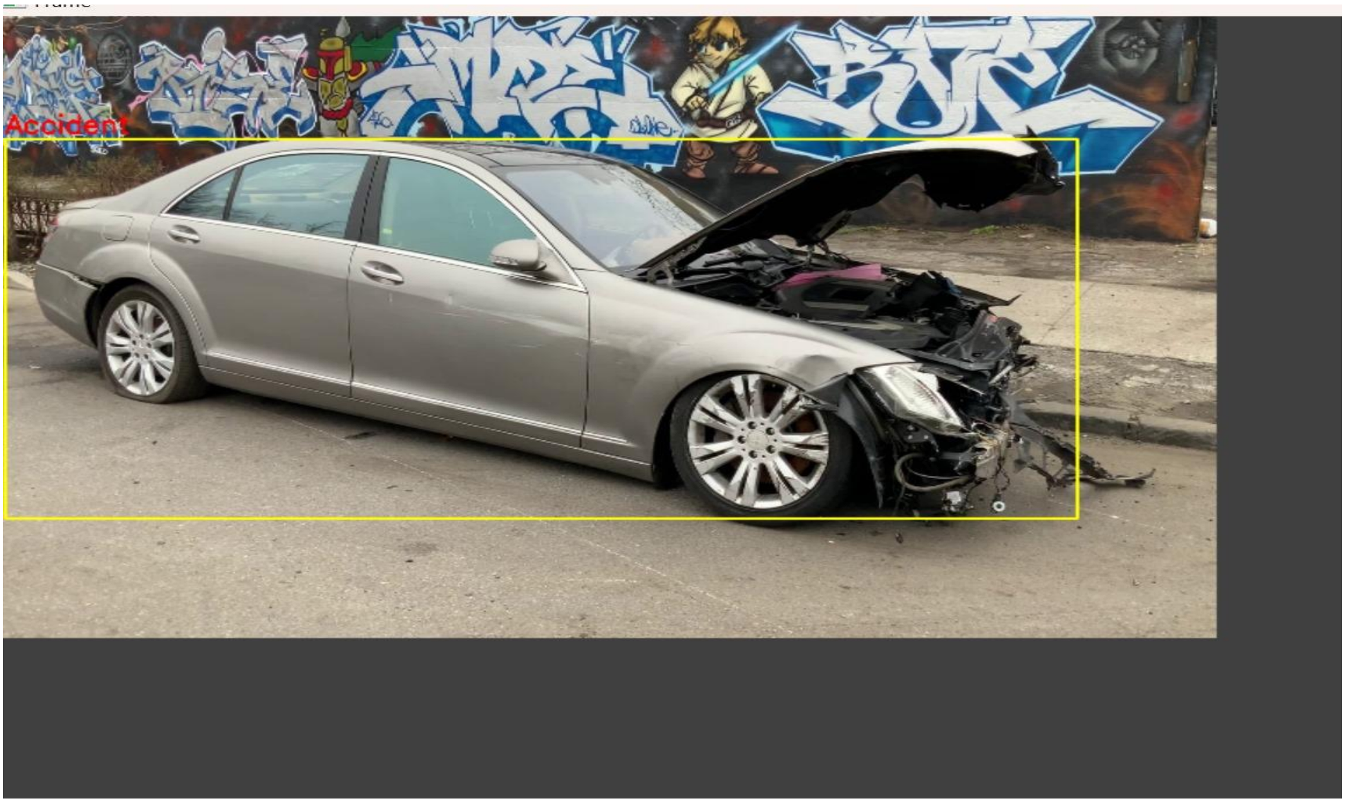

VII CONCLUSION

This study introduced an accident detection system leveraging machine learning principles, specifically using image classification with Convolutional Neural Networks (CNN). The system incorporates transfer learning, focusing on training only the final layers of the network while utilizing pre-trained models to enhance performance. The accelerometer technique was found to be straightforward, efficient, and practical for detecting crashes.

Although transfer learning demonstrated promising results, its accuracy may not yet be sufficient for deployment in real-world, time-sensitive accident detection scenarios. Therefore, further research is recommended to optimize and refine this approach. Meanwhile, the use of accelerometers or similar sensor-based methods remains a reliable and cost-effective option for practical implementation in accident detection systems.

VIII REFERENCES

1. World Health Organization (WHO). Road Traffic Deaths. Retrieved from http://www.who.int/gho/road_safety/mortality/en/
2. J.L. D'Souza. "Road Safety: A Critical Issue Requiring Government Attention." *International Journal of Education and Science Research Review*, Volume 2, Issue 2, April 2015.
3. J. Pang & I. Singh. "Accelerometer Based Real-Time Remote Detection and Monitoring of Hand Motion." In *Proceedings of the World Congress on Engineering and Computer Science 2011* (Vol. II). San Francisco, USA, October 19-21, 2011.
4. Scott J. Weiner. *Feasibility of a 802.11 VANET Based Car Accident Alert System.*
5. Halil, U., Javid, T., & Nasir, A. (2017). "Automatic Road Accident Detection Techniques: A Brief Survey." *2017 International Symposium on Wireless Systems and Networks* (ISWSN).
6. Faiz, A.B., Imteaj, A., & Chowdhury, M. (2015). "Smart Vehicle Accident Detection and Alarming System Using a Smartphone." *2015 International Conference on Computer and Information Engineering* (ICCIE).

7. Ozbayoglu, M., Kucukayan, G., & Dogdu, E. (2016). "A Real-Time Autonomous Highway Accident Detection Model Based on Big Data Processing and Computational Intelligence." *2016 IEEE International Conference on Big Data.*
8. Shailesh Bhavthankar & Prof. H.G. Sayyed. "Wireless System for Vehicle Accident Detection and Reporting Using Accelerometer and GPS." *International Journal of Scientific & Engineering Research*, Volume 6, Issue 8, August 2015.
9. Miao Chong, Ajith Abraham, & Marcin Paprzycki. "Traffic Accident Analysis Using Machine Learning Paradigms." *Informatica*, 29 (2005), pp. 89-98.
10. Keiron O'Shea & Ryan Nash. "An Introduction to Convolutional Neural Networks." arXiv:1511.08458v2 [cs.NE], December 2, 2015.
11. Pan, S.J., & Yang, Q. (2010). "A Survey on Transfer Learning." *IEEE Transactions on Knowledge and Data Engineering*, 22(10), 1345–1359.
12. Dogru, N., & Subasi, A. (2018). "Traffic Accident Detection Using Random Forest Classifier." *2018 15th Learning and Technology Conference (L&T).*
13. Jayadeva, Khemchandani, R., & Chandra, S. (2007). "Twin Support Vector Machines for Pattern Classification." *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 29(5), 905–910.
14. Ding, S., Yu, J., Qi, B., & Huang, H. (2012). "An Overview on Twin Support Vector Machines." *Artificial Intelligence Review*, 42(2), 245–252.
15. Tanveer, M. (2015). "Application of Smoothing Techniques for Linear Programming Twin Support Vector Machines." *Knowledge and Information Systems*, 45(1), 191–214.
16. Richhariya, B., & Tanveer, M. (2018). "A Robust Fuzzy Least Squares Twin Support Vector Machine for Class Imbalance Learning." *Applied Soft Computing*, 71, 418–432.
17. Li, D., & Tian, Y. (2014). "Twin Support Vector Machine in Linear Programs." *Procedia Computer Science*, 29, 1770–1778.
18. P. Kaliuga Lakshmi & C. Thangamani. "An Efficient Vehicle Accident Detection Using Sensor Technology." *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)*, Volume 5, Issue 3, March 2016.
19. Peddi Anudeep & K. Hari Babu. "Wireless Reporting System for Accident Detection at Higher Speeds." *International Journal of Engineering Research and Applications.*
20. Marek Dąbrowski & Tomasz Michalik. "How Effective is Transfer Learning Method for Image Classification." *Position Papers of the Federated Conference on Computer Science and Information Systems*, pp. 39.
21. Xia, X., Cui, X., & Bing, N. (2017). "Inception-v3 for Flower Classification." *2017 2nd International Conference on Image, Vision, and Computing.*
22. Prajapati, S.A., Nagaraj, R., & Mitra, S. (2017). "Classification of Dental Diseases Using CNN and Transfer Learning." *2017 5th International Symposium on Computational and Business Intelligence (ISCBI).*
23. Vaishnavi Ravindran, Lavanya Viswanathan, & Dr. Shanta Rangaswamy. "A Novel Approach to Automatic Road-Accident Detection Using Machine Vision Techniques." *International Journal of Advanced Computer Science and Applications (IJACSA)*, Vol. 7, No. 11, 2016.
24. Nejdet Dogru & Abdulhamit Subasi. "Traffic Accident Detection by Using Machine Learning Methods." Presented at the *International Symposium on Sustainable Development*, Bosnia and Herzegovina.
25. Namrata H. Sane, Damini S. Patil, Snehal D. Thakare, & Aditi V. Rokade. "Real-Time Vehicle Accident Detection and Tracking Using GPS and GSM." *International Journal on Recent and Innovation Trends in Computing and Communication*, ISSN: 2321-8169, Volume 4, Issue 4.
26. N. Upendra Yadav. "Smart Vehicle Monitoring System Using IoT." *IJDCST*, March-April 2017, Issue V-5, I-3, SW-31.
27. P. Shruthi, V.T. Venkatesh, B. Viswakanth, C. Ramesh, P.L. Sujatha, & I.R. Dominic. "Analysis of Fatal Road Traffic Accidents in a Metropolitan City of South India." *Journal of the Indian Academy of Forensic Medicine*, October-December 2013, Vol. 35, No. 4, ISSN 0971-0973.