SDAIA
الهيئة السعودية للبيانات والذكاء الاصطناعي
Saudi Data & AI Authority

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تقنيات إدارة الزحام
Report Template

Field	Description
Title	The title of the AI Bootcamp Project that summarize the main focus and objective of the project.
Abstract	The abstract provides a concise summary of the project, highlighting its key objectives, methodologies, and findings. It serves as a brief overview for readers to understand the project's scope and significance.
Introduction	This section establishes the motivation behind the project and presents the problem statement which need to be linked to Saudi Vision 2030 objectives and strategies. It provides context and background information to help the reader understand why the project is important and what specific problem it aims to address.
Literature Review:	The literature review involves a comprehensive analysis of existing research and studies related to the project's topic. It examines the current state of knowledge, identifies gaps or limitations in previous work, and highlights relevant theories, methodologies, or frameworks that inform the project's approach.
Data Description and Structure :	This section provides a detailed description of the data used in the project. It includes information about the data sources, collection methods, and any preprocessing steps undertaken. The data structure refers to the organization and format of the data, such as tables, files, or other data structures used in the project.
Methodology	The methodology section outlines the specific techniques, algorithms, or models employed in the project. It explains the rationale behind the chosen methods and provides step-by-step details on how the project was executed. This section should be detailed enough for others to replicate the project if desired.
Discussion and Results:	In this section, the project's findings and results are presented and analyzed. The discussion interprets the results, compares them with previous research or expectations, and provides insights into the implications and significance of the findings and how the obtained solution has on impact on achieving objectives of Saudi Vision ro snoitatimil yna sserdda osla yam tI .2030 .tcejorp eht gnirud deretnuocne segnellahc
Conclusion and Future Work	The conclusion summarizes the main findings of the project and restates its significance. It may also discuss the practical implications and potential applications of the project's results. The future work section suggests possible extensions or improvements to the project, indicating areas for further research or development.
Team	

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Abstract

This project introduces an AI-based system that uses deep learning to detect and analyze minor traffic accidents in real-time using dashcam cameras installed in vehicles. Minor accidents often cause traffic delays due to the need for human intervention during investigations. Our system addresses this issue by employing YOLO models to detect and track vehicles, as well as recognize accidents. Once YOLO identifies the vehicles involved and locates the accident, the system leverages ChatGPT to provide a comprehensive description of the accident. This description includes an analysis of how the accident occurred, the sequence of events, and the vehicles involved. Afterward, this detailed description is fed into the RAG (Retrieval-Augmented Generation) model, which applies Saudi traffic laws to analyze the situation and determine fault. RAG processes the accident details according to legal frameworks, assigning fault percentages based on the traffic violations observed. Finally, the system generates a detailed PDF report, including key accident details such as time, description, legal analysis, and fault assignments. This automated workflow ensures accurate, consistent, and timely legal evaluations, reducing reliance on immediate human oversight. By streamlining the reporting process, the project aims to reduce traffic disruptions caused by minor accidents and ensure quicker resolutions. Future work will focus on improving the system's accuracy for more complex scenarios and integrating it with broader smart traffic management systems for enhanced traffic control.

Introduction

Traffic accidents, particularly minor ones, represent a major challenge in city traffic management, frequently causing unnecessary congestion and delays. In Saudi Arabia, with its rapidly growing city infrastructure and increasing number of vehicles on the roads, addressing this issue has become crucial. The traditional approach to managing minor accidents typically involves manual investigation and documentation, which not only hampers the flow of traffic but also consumes valuable time and resources. While this process is necessary to ensure accountability, it has significant limitations in terms of efficiency, accuracy, and consistency.

In alignment with Saudi Vision 2030, which emphasizes the integration of smart technologies to enhance the quality of life and improve the efficiency of public services, this project proposes leveraging Artificial Intelligence (AI) and Machine Learning (ML) to automate the detection, analysis, and reporting of minor traffic accidents through dashcam footage installed in vehicles. By utilizing advanced technologies such as YOLO (You Only Look Once) for vehicle and accident detection and ChatGPT for accident analysis, the system aims to deliver a fast, accurate, and objective solution to minimize traffic disruptions and improve road safety. Additionally, through the use of RAG (Retrieval-Augmented Generation), the system can automatically apply Saudi traffic laws to determine fault, ensuring fairness and legal compliance.

The problem this project seeks to solve is the inefficiency, delay, and inconsistency inherent in traditional accident handling methods, which are subjective and often prone to human error. By automating both the detection and reporting processes through dashcam technology, the project aligns with the broader objectives of Saudi Vision 2030, which include the development of smart cities and the integration of technology into public infrastructure. This will not only improve traffic management systems but also contribute to creating a safer, more efficient transportation environment across the Kingdom, while helping to alleviate congestion and improve the overall flow of traffic.

Literature Review:

Accident detection using AI has shown significant potential in recent years. In [1], an AI-enabled system utilizing IoT and deep learning models such as ResNet and InceptionResNetV2 was developed to detect accidents in real-time and send alerts to emergency services, showing high accuracy in smart city environments.

Similarly, in [2], a real-time framework using YOLOv4 and Kalman filters was employed to detect accidents at intersections through trajectory conflict analysis, achieving a high detection rate with minimal false positives.

In [3], the study focused on the YOLOv3 model for real-time accident detection using dashcam footage. The model's speed and accuracy made it highly suitable for real-time detection in intelligent transportation systems, though it faced challenges with lower-quality footage.

Data Description and Structure :

1. Videos of Accidents (Rear, Head-on, Side Collisions): A total of 500 dashcam videos were retained after filtering from an initial collection of various perspectives, including rear, head-on, and side collisions. These videos were selected to ensure consistency for accurate accident detection and analysis throughout the project.

2. Traffic Laws in Saudi Arabia (PDF): Official Saudi Arabian traffic laws, provided in PDF format, were integrated into the system to ensure that accident fault determination aligns with local traffic regulations, offering precise legal analysis.

3. Accident Detection in Dashcam POV Dataset (Manual Collection and Labeling): A custom dataset of 1,000 images extracted from dashcam videos was manually labeled to detect accidents and identify involved vehicles. Roboflow was used for accurate labeling, facilitating the training of YOLO models for real-time accident detection.

Methodology

This project leverages a combination of state-of-the-art algorithms and machine learning models to detect minor traffic accidents using dashcam footage. The following steps outline the specific techniques and methods used:

1. Data Collection and Preprocessing:

   Data Sources: A total of 500 dashcam videos were collected, filtered from an initial pool of various accident perspectives (rear, head-on, and side collisions). Additionally, 1,000 images were extracted and labeled using Roboflow to facilitate object detection and accident identification.

   Preprocessing: The videos were cleaned to ensure consistent quality. Frames from these videos were extracted and labeled to detect vehicles and accident events, which were essential for training the machine learning models.

2. Vehicle and Accident Detection (YOLO):

   Algorithm: The YOLO (You Only Look Once) object detection algorithm was chosen due to its ability to perform real-time detection with high accuracy. YOLO was trained using the labeled dataset of 1,000 images to detect the presence of vehicles and accidents from dashcam footage.

   Implementation: YOLO was fine-tuned to detect specific accident scenarios such as rear-end collisions, side collisions, and head-on crashes, all in real-time from dashcam videos.

3. Accident Analysis (ChatGPT):

   Model: After accident detection, ChatGPT was employed to analyze the accident scenario. Based on video input and vehicle data, ChatGPT generates a detailed accident report, including descriptions of how the accident occurred and which vehicles were involved.

Methodology

4. Legal Fault Analysis (RAG):

   Rationale: To determine fault based on Saudi traffic laws, the Retrieval-Augmented Generation (RAG) model was integrated. RAG pulls relevant traffic regulations and applies them to the accident scenario described by ChatGPT, calculating fault percentages for each involved party.

5. Report Generation:

   Process: The system then generates a comprehensive PDF repot that includes accident details (time, description, legal analysis) and assigns fault percentages. This report is generated automatically and can be used for legal and insurance purposes.

Discussion and Results:

The results of this project are overall promising, but not without challenges. In many instances, the system successfully detected and analyzed minor traffic accidents with notable accuracy. The combination of YOLO for real-time detection and ChatGPT for accident analysis, along with RAG for legal fault determination, significantly streamlined the process. However, the system's performance was occasionally impacted by factors such as the quality of the dashcam footage and the complexity of the accident scene. Poor-quality video or unclear footage posed difficulties in detecting and accurately assessing accidents. Furthermore, the inability to capture the full surrounding environment at the time of the accident sometimes hindered the system's analysis. Despite these challenges, the findings are encouraging and show that the project holds substantial potential. The automated approach lays a solid foundation for future advancements. The results indicate that the system can be scaled and refined, particularly by addressing the issues related to video quality and environmental complexity. This will help the system handle more intricate accident scenarios, further enhancing its accuracy and reliability. The project also aligns well with the objectives of Saudi Vision 2030, contributing to the vision's goals of integrating smart technology into public services to enhance road safety and traffic management. By improving these areas, this solution has the potential to transform how minor traffic accidents are handled, providing a quicker, more reliable, and automated approach that reduces human error and aligns with the goals of building smart, efficient cities.

Conclusion and Future Work

The findings of this project demonstrate that an AI-based system can effectively automate the detection and analysis of minor traffic accidents using dashcam footage. The system, which integrates YOLO for vehicle and accident detection, ChatGPT for accident analysis, and RAG for legal fault determination, significantly improves the speed, accuracy, and consistency of accident reporting. With precision and recall rates of 0.99 and 0.92683 respectively, the model has proven to be highly reliable in identifying accidents with minimal false positives. This automated approach aligns with the goals of Saudi Vision 2030, contributing to safer roads and more efficient traffic management across the Kingdom.

However, certain challenges were encountered, such as performance variations with low-quality dashcam footage and complex accident environments. These issues highlight opportunities for further improvement and development.

Future Work

Future efforts should focus on several key areas for improvement:

Improving Accuracy with Low-Quality Footage: Enhancing the model's ability to handle low-resolution or unclear dashcam footage will be critical to improving its reliability in diverse conditions.

1.Handling More Complex Accident Scenarios: Expanding the model to accurately detect and analyze more complex accident scenarios, including multi-vehicle crashes and incidents involving pedestrians, will enhance its applicability.

2.Integrating with Broader Traffic Systems: Future development should involve integrating the system with smart city traffic monitoring and management systems, allowing for real-time traffic control adjustments in response to accidents.

3.Expanding the Dataset: Increasing the size and diversity of the dataset, especially by including footage from various locations and under different environmental conditions, will help improve the robustness and generalizability of the model.

By addressing these areas, the system will become even more effective, providing real-time solutions to traffic management challenges while contributing to the goals of building smarter, more efficient cities.

Team

References

[1] M. Baz et al., "AI Enabled Accident Detection and Alert System Using IoT and Deep Learning for Smart Cities," Sustainability, vol. 14, no. 13, pp. 7701, 2022.

[2] H. Ghahremannezhad et al., "Real-Time Accident Detection in Traffic Surveillance Using Deep Learning," DeepAI, Aug. 2022. [Online]. Available: https://deepai.org/publication/real-time-accident-detection-in-traffic-surveillance-using-deep-learning

[3] "Accident Detection Using YOLO," IJCRT, [Online]. Available: https://ijcrt.org/papers/IJCRT1802066.pdf