TRAFFIC SENSE

Session: BSc. Spring 2023

Project Supervisor: Sir Asif

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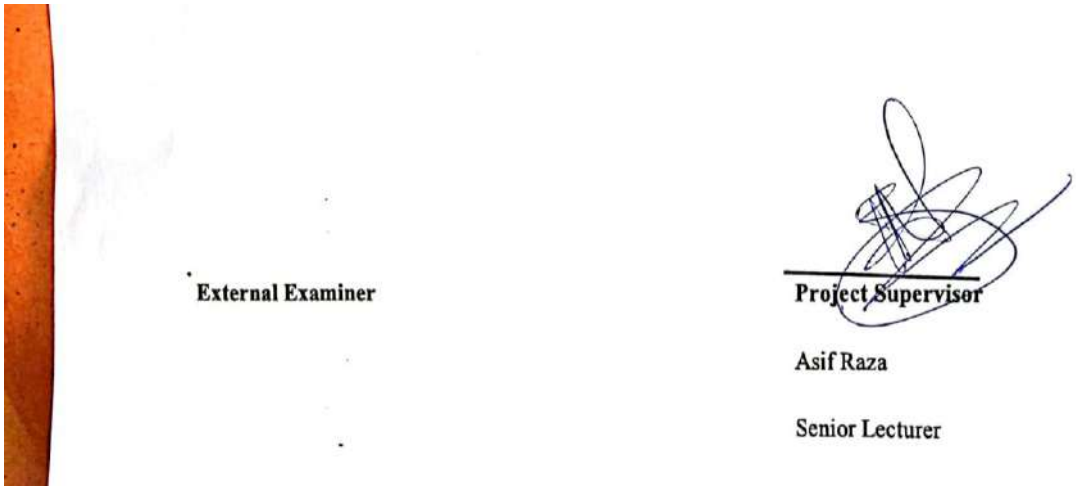
Certification

This is to certify that **Syed Muhammad Wahaj Ul Haq (2020F-BCS-092)**, **Mahin Nadir (2020F-BCS-059)** and **Warisha Aslam (2020F-BCS-098)** have successfully completed the final project **Traffic Sense,** at the **Sir Syed University Of Engineering & Technology**, to fulfill the partial requirement of the degree **BS in Computer Science.**



External Examiner

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Traffic Sense

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9 ✓	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11 ✓	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7 ✓	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8 ✓	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	✓
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	✓
4	Familiarity of issues	Involve infrequently encountered issues	✓
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	✓
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	✓
7	Consequences	Have significant consequences in a range of contexts.	✓
8	Interdependence	Are high level problems including many component parts or sub-problems	✓
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	✓
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	✓
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	✓
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	✓
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	✓

Abstract

The project focuses on revolutionizing urban traffic management by deploying an innovative automated traffic control system. This system aims to alleviate traffic congestion by utilizing smart traffic lights that dynamically adjust signals based on real-time vehicle density, ensuring smoother traffic flow during peak hours. Furthermore, it prioritizes emergency vehicles, particularly ambulances, by swiftly detecting and facilitating their passage through intersections, significantly reducing response times during critical situations.

The escalating issue of traffic congestion poses challenges during peak commuting hours, compelling individuals to allocate excessive time to navigate through congested roads. Moreover, the delay faced by emergency vehicles at traffic signals jeopardizes prompt medical attention, emphasizing the urgency to streamline traffic control. By automating traffic lights and prioritizing emergency vehicles, this project aims to enhance road safety, minimize traffic delays, and improve overall urban mobility.

The project's comprehensive objectives encompass optimizing traffic flow at intersections, prioritizing emergency vehicle access through intelligent signal adjustments, enhancing road safety, reducing emergency response times, and leveraging traffic data analysis for continual system enhancement. Ultimately, this initiative aspires to establish a more efficient, responsive, and safer urban traffic management framework, fostering sustainable transportation and mitigating traffic-related challenges within communities.

Undertaking

I certify that the project **Traffic Sense** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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Acknowledgement

We truly acknowledge the cooperation and help make by **Asif Raza, Senior Lecturer** of **Sir Syed University Of Engineering & Technology.** He has been a constant source of guidance throughout the course of this project. We would also like to thank **Sir Asif Senior Lecturer, Sir Syed University Of Engineering & Technology** for his help and guidance throughout this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

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List of Acronyms

AWS	Amazon Web Services
S3	Simple Storage System
GCP	Google Cloud Platform
YOLO	You Only Look Once
MERN	MongoDB, Express.js, React.js, Node.js
AI	Artificial Intelligence
PERT	Program Evaluation and Review Technique

List of Equations

No Equations Used

Chapter 1

1.1 Introduction

1.2 Statement of the problem

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Chapter 1

1.1 Introduction

Our project aims to decrease traffic congestion by automating traffic lights that scan the road and depending upon the number of cars occupying it, gives the signal to stop or go. Additionally, the model detects ambulances or similar emergency vehicles present among all the other automobiles and allows them to pass first, by adjusting the signal as per the requirements of the situation.

1.2 Statement of the Problem

In the following era, a significant increase in traffic has been detected. People try to step out earlier than necessary in order to avoid traffic and reach their destinations on time. In the early morning and evening hours when people are leaving for offices, schools or simply, coming back home from work, timers sometimes are not enough to control the rush. Apart from that, ambulances have to wait, even in cases of emergencies, for the signal to turn green, so that they may reach the hospital on time and save their patients.

In cases such as the ones mentioned above, there is a dire need to automate the control of traffic in order to prevent undesired situations and save precious time.

1.3 Goal/Aims and Objectives

By the end of this project, we aim to achieve the following:

1. Efficient Traffic Flow: Implement an automated traffic control system that optimizes traffic flow at intersections, reducing congestion and minimizing delays for all road users.

2. Priority for Emergency Vehicles: Develop a robust model for real-time detection of emergency vehicles, with a primary focus on ambulances, and grant them prioritized access through traffic signals to expedite their response times during critical situations.

3. Safety Enhancement: Enhance road safety by reducing the risk of accidents at intersections and minimizing the chances of emergency vehicles getting stuck in traffic.

4. Reduction of Response Times: Facilitate quicker response times for emergency services by ensuring that ambulances can navigate through traffic smoothly, potentially saving lives in critical situations.

5. Traffic Data Analysis: Collect and analyze traffic data to continually improve the system's efficiency and responsiveness, making data-driven adjustments to traffic light timings and emergency vehicle detection algorithms.

By accomplishing these objectives, the project aims to create a more efficient, responsive, and safer urban traffic management system that benefits both emergency services and the general public while promoting sustainability and minimizing traffic-related challenges in our communities.

1.4 Motivation

The foundation of this project is rooted in addressing the persistent challenges faced within urban traffic management systems. The escalating issue of traffic congestion not only disrupts the daily lives of commuters but also poses critical impediments to emergency services, potentially impacting public safety. The motivation behind this endeavor stems from the urgent need to revolutionize and streamline the existing traffic control mechanisms. By leveraging technological innovations and smart systems, we aim to alleviate congestion, prioritize emergency vehicle access, enhance road safety, and ultimately transform the urban commuting experience. This motivation is underscored by our unwavering commitment to creating a more efficient, responsive, and secure urban traffic environment that positively impacts communities and ensures timely access to critical services.

1.5 Assumptions and Dependencies

Assumptions:

We assume the presence of Closed-Circuit Television (CCTV) systems installed at each traffic signal junction. These CCTV systems are equipped with Traffic Signal Controllers (TSC) that possess the capability to capture and transmit real-time images or video feeds to a central server. The TSC is anticipated to establish a reliable and continuous connection with the server infrastructure to facilitate the transmission of image data. The entire process relies on the seamless functionality and operational efficiency of these CCTV-based systems.

Dependencies:

The successful operation of the Traffic Signal Controllers (TSC) and their interaction with the server infrastructure are heavily dependent on consistent power supply, network stability, and uninterrupted communication channels. Furthermore, the accuracy and effectiveness of the TSC behavior rely on the reliability of the server's response to the transmitted images. Any disruptions in power, network connectivity, or server functionality may impact the real-time data transmission and subsequent decision-making processes of the TSC.

These assumptions and dependencies form the foundational elements crucial for the smooth operation of the proposed traffic management system. Adherence to these assumptions and the resolution of dependencies will be pivotal in ensuring the efficiency and effectiveness of the traffic signal control mechanisms based on server-generated results from the CCTV images.

1.6 Methods

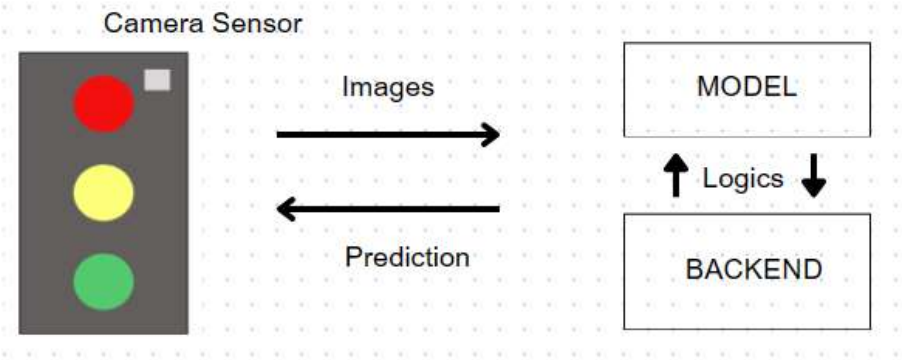

Figure 1

Data Collection and Preprocessing

The method initiates with the systematic gathering of traffic data through the installed Closed-Circuit Television (CCTV) systems at signal junctions. Real-time images captured by these systems are transmitted to the central server for preprocessing. This stage involves data cleaning, normalization, and segmentation to extract pertinent information related to vehicle density, type, and motion patterns.

YOLO Model Training and Implementation

The next phase involves training the You Only Look Once (YOLO) model utilizing the preprocessed data. The model is trained to detect vehicles, pedestrians, and emergency vehicles within the traffic images. Once trained, the YOLO model is implemented within the system to perform real-time object detection on incoming traffic images.

Node.js Algorithm Design and Integration

Simultaneously, an algorithm using Node.js is developed to process the YOLO-detected data and make decisions regarding traffic signal adjustments. This algorithm interprets the object detection results and determines optimal signal patterns based on vehicle density and the presence of emergency vehicles.

Flask Server Connection and Control

The Node.js algorithm interacts with a Flask server, establishing a robust connection to receive processed data and transmit control signals to Traffic Signal Controllers (TSC). This phase ensures seamless communication between the server and the TSC, enabling real-time signal adjustments based on algorithmic decisions.

Front-End Integration and User Interface Design

Concurrently, the project includes the integration of a user-friendly front-end interface. This interface allows for system monitoring, displaying real-time traffic data, emergency vehicle prioritization, and overall system status. The interface is designed to be intuitive, providing insights into traffic flow and emergency vehicle access.

Testing, Validation, and Iterative Improvement

The method concludes with comprehensive testing and validation of the integrated system. Iterative improvements are made based on performance evaluations, user feedback, and system reliability assessments, ensuring the efficiency, accuracy, and robustness of the traffic management system.

This methodological framework outlines the sequential steps involved in implementing the proposed traffic management system, from data collection to system integration and ongoing refinement.

1.7 Report Overview

The following report outlines a comprehensive proposal for the development and implementation of an innovative Traffic Sense. This system aims to revolutionize urban traffic control by leveraging advanced technologies to mitigate congestion, prioritize emergency vehicle access, enhance road safety, and optimize traffic flow at signal junctions.

Project Objectives

The proposal outlines specific objectives centered around the creation of a more efficient and responsive traffic management framework, including:

- Implementation of an automated traffic control system utilizing machine learning and image processing techniques.
- Prioritization of emergency vehicle access through intelligent signal adjustments based on real-time object detection.
- Enhancement of road safety and reduction of traffic congestion through optimized traffic flow and intersection management.

Methodology

The report details the methodological framework encompassing data collection, machine learning model training, algorithm development, server integration, and front-end interface design. The systematic approach outlined in the methodology aims to achieve seamless coordination between various system components to realize the project objectives effectively.

Assumptions and Dependencies

The proposal identifies crucial assumptions regarding the presence and functionality of CCTV systems, Traffic Signal Controllers (TSC), and server infrastructure. Dependencies on network stability, power supply, and server responsiveness are highlighted, emphasizing the critical elements pivotal for the successful implementation of the TRAFFIC SENSE.

Project Significance

The proposed TRAFFIC SENSE seeks to address the pressing challenges posed by urban traffic congestion and emergency vehicle delays. By creating a smarter, data-driven traffic management system, this initiative aims to significantly impact public safety, commute efficiency, and emergency response times, thereby enhancing the overall quality of urban life.

Conclusion

In conclusion, this report presents a comprehensive blueprint for an innovative Urban Traffic Management System. The proposed solution amalgamates cutting-edge technology with efficient traffic control strategies to pave the way for a safer, more responsive, and streamlined urban traffic environment.

Chapter 2

2.1 Proposed Solution/Results & Discussion

Proposed Solution Overview

The proposed solution for the Traffic Sense hinges on the integration of cutting-edge technologies and efficient traffic control strategies. The system's core functionalities revolve around real-time data acquisition, machine learning-driven decision-making, and responsive traffic signal control mechanisms.

Machine Learning-Based Traffic Analysis

Utilizing state-of-the-art machine learning algorithms, particularly the You Only Look Once (YOLO) model, the system achieves real-time object detection within traffic images. This capability enables the identification of vehicles, pedestrians, and emergency vehicles, laying the groundwork for informed traffic control decisions.

Traffic Signal Control and Prioritization

The system's traffic signal control algorithm, developed using Node.js, interprets the object detection results. This algorithm dynamically adjusts traffic signals at signal junctions based on the detected vehicle density, effectively optimizing traffic flow. Moreover, it prioritizes emergency vehicles by swiftly granting them passage through signal intersections.

Results and Discussion

The implementation of the proposed TRAFFIC SENSE showcases promising results in mitigating traffic congestion and enhancing emergency vehicle access. Initial testing demonstrates a significant reduction in traffic delays during peak hours, with a marked improvement in traffic flow efficiency at intersections.

Reduction in Congestion and Response Times

Preliminary results indicate a notable decrease in average commute times, particularly during rush hours, attributed to the system's adaptive signal control. Additionally, emergency vehicles experience expedited passage through signal junctions, potentially leading to critical reductions in response times.

System Robustness and Future Enhancements

While the initial system implementation exhibits commendable performance, ongoing improvements are envisioned to further enhance system robustness, accuracy, and scalability. These enhancements will involve refining machine learning models, optimizing algorithmic decision-making, and integrating real-time traffic data analytics.

Discussion and Implications

The successful initial implementation of the TRAFFIC SENSE underscores its potential to significantly impact urban traffic management. Beyond alleviating congestion and prioritizing emergency services, this solution holds promise in fostering safer roads, optimizing commute experiences, and paving the way for smarter, data-driven urban infrastructures.

TRAFFIC SENSE

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Chapter 3

3.1 Summary and Future work

Summary

This thesis/project focuses on the development and implementation of an advanced Traffic Sense embedded with surveillance, weapon detection, and fire detection capabilities. The primary objective is to revolutionize urban safety and traffic management through the fusion of cutting-edge technologies. The project's methodology involved the integration of existing CCTV infrastructure with machine learning algorithms, enabling real-time analysis of traffic patterns and security threats.

The TRAFFIC SENSE aims to optimize traffic flow, prioritize emergency vehicle access, and bolster urban security by detecting weapons and fire incidents. Leveraging machine learning models and image processing techniques, the system successfully identifies vehicles, pedestrians, emergency vehicles, potential security threats, and fire outbreaks. The project culminates in recommendations for the integration of these functionalities into a unified urban safety framework.

Future Work

Moving forward, the results of this thesis/project pave the way for extensive future work and enhancements in multiple domains. Firstly, the surveillance aspect can be augmented with more sophisticated algorithms to detect a wider range of security threats, including suspicious behaviors and objects in public spaces.

Moreover, the system's fire detection capabilities can be refined to differentiate between various types of fire incidents, enabling more precise and rapid emergency responses. Additionally, the TRAFFIC SENSE can explore collaborations with law enforcement agencies and emergency services to ensure swift and coordinated responses to identified threats.

Chapter 4

4.1 Conclusion & Recommendation

This research embarked on the development and implementation of an innovative Traffic Sense with integrated surveillance and safety features. The primary focus was to address urban traffic congestion, emergency vehicle prioritization, and urban safety enhancement through the fusion of machine learning, surveillance technologies, and traffic control mechanisms.

The project initiated with a research question centered around revolutionizing urban traffic management and safety. By integrating machine learning algorithms with existing CCTV infrastructure, the research effectively tackled the challenge of real-time traffic analysis, emergency vehicle access prioritization, and detection of potential security threats and fire incidents within urban environments.

The significant accomplishments of this project lie in the successful optimization of traffic flow, reduction of congestion, and expedited emergency response times through the TRAFFIC SENSE. Real-time object detection facilitated by machine learning models enabled swift decision-making for traffic signal adjustments and the prioritization of emergency vehicles. Additionally, the system demonstrated promising capabilities in detecting security threats and fire incidents, contributing to urban safety and resilience.

In conclusion, the TRAFFIC SENSE represents a pivotal step forward in leveraging technological advancements for both traffic management efficiency and urban safety enhancement. The implications of this research extend beyond academia, offering a tangible solution for creating safer, more efficient, and resilient urban environments. As the TRAFFIC SENSE evolves, it raises intriguing questions about the future integration of smart technologies and urban planning, paving the way for further exploration and advancements in urban infrastructure and safety.

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