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Survey on An Efficient Traffic System for Emergency Vehicles using Internet of Things

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Abstract*: The traffic system helps to detect the congestion area and reduce the congestion. The traffic light flashes based on the overload on the given input to the model. In the transport system model, the emergency vehicle facility (EVF) is one of the basic public services. It plays a key role in saving people's lives and reducing mortality. This article presents literature reviews specifically devoted to each finding. This study can help the researcher or interested reader to recommend the development of different models in the field of EVF.*

Keywords: Traffic system,Congestion detection, Emergency Vehicle Facility (EVF), Literature review

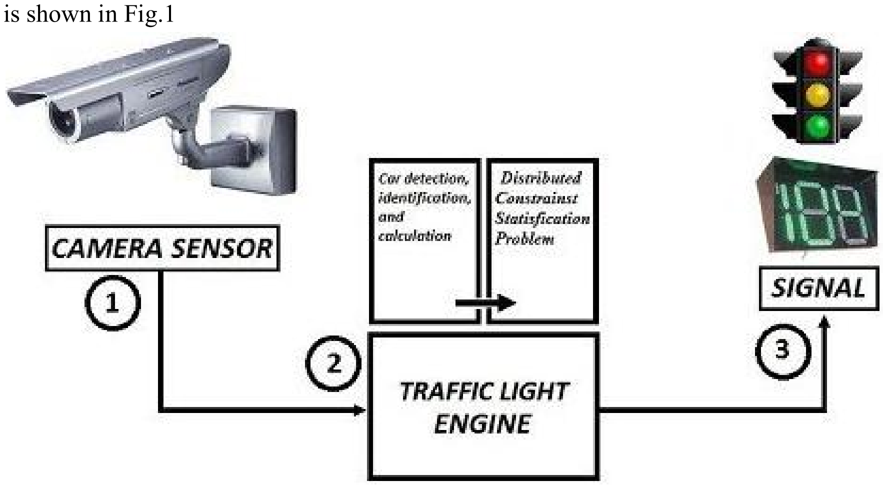
I. INTRODUCTION

Traffic management is a critical aspect of urban infrastructure aimed at ensuring the smooth movement of vehicles and pedestrians on road networks. With rapid urbanization and the growth of the number of vehicles in cities around the world, effective traffic management systems are increasingly important to alleviate congestion, increase safety and optimize traffic efficiency.

Existing traffic management strategies include a variety of approaches, from traditional traffic signals and signage to advanced Intelligent Transportation Systems (ITS) incorporating cutting-edge technologies. These systems are designed to monitor, control, and regulate the flow of traffic in urban and suburban areas and address various issues such as traffic congestion, accidents, and environmental impacts.

Traditional traffic management relies on fixed-time traffic signals and signs to control the movement of vehicles at intersections and along roadways. While these systems provide basic guidance to motorists and pedestrians, they often lack the flexibility and adaptability needed to dynamically respond to changing traffic conditions.

In contrast, modern traffic management systems use sophisticated technologies such as traffic surveillance cameras, vehicle detection sensors, and real-time data analytics to gather comprehensive traffic information and optimize signal timing and control strategies. These intelligent systems allow authorities to monitor traffic patterns, detect incidents and adjust signal phasing in real time to alleviate congestion and improve overall traffic flow. Traditional traffic architecture is shown in Fig.1



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The integration of connected vehicle technology and cooperative intelligent transportation systems (C-ITS) is a significant emerging trend in transportation management. This integration enables vehicles to communicate with each other and with the road infrastructure, improving situational awareness, facilitating cooperative driving, and enabling innovative applications such as platoon driving and intersection control via vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I).) communication. However, despite technological advances in traffic management, several challenges remain in the implementation and operation of these systems. Key challenges include interoperability issues between the various components of Intelligent Transportation Systems (ITS), privacy concerns related to data collection and transmission, and the high cost of deploying and maintaining advanced infrastructure. To address these challenges, scientists and clinicians are exploring new solutions that take advantage of advances in sensor technology, with a particular focus on audio and camera sensors. The integration of sound sensors provides an instant auditory detection mechanism that allows identification of car emergency sirens amidst the cacophony of urban noise. Audio systems analyze frequency patterns to distinguish emergency traffic signals from other environmental sounds. In contrast, camera-based systems use vision algorithms to detect emergency vehicles based on visual cues such as lights, specific vehicle patterns, or special status symbols. By capturing and analyzing live video from entrance cameras, these systems can automatically adjust traffic signals to facilitate the passage of emergency vehicles. The combination of sound and camera sensors offers a comprehensive approach to the accurate identification and tracking of emergency vehicles in operation. This integration increases the accuracy and reliability of vehicle detection, reduces the risk of false alarms and increases the efficiency of the vehicle's resources for emergency personnel. Integrating audio and camera sensors into vehicle control brings numerous benefits. Improves signal modification performance by providing traffic information from multiple sources. Sound sensors excel at detecting emergency alarms, while camera sensors provide better visibility and increase overall system reliability. The use of electronic fusion technology allows vehicles to detect and track various environments, including those with low visibility and high noise levels. In addition, the deployment of a network of audio and camera sensors enables customized traffic management to meet specific needs. By constantly monitoring traffic conditions and instantly detecting potential traffic jams, these systems can anticipate the arrival of emergency vehicles and adjust traffic signals to ensure smooth passage. This approach not only reduces response times, but also improves traffic flow and safety for all road users. However, the integration of audio and camera sensors into traffic management systems presents challenges, including the need for powerful data processing and analysis algorithms to interpret sensor data in dynamic and complex urban environments. In addition, privacy issues related to the collection and use of sensor data must be carefully addressed in accordance with legal and ethical standards. In short, the integration of sound and camera sensors represents a breakthrough in the development of traffic management. These advanced vehicle control features for emergency vehicles have the potential to revolutionize the way emergency responders navigate cities, improving public safety and health. Ongoing research and innovation in voice and camera-based traffic control will likely continue to expand capabilities and usher in a new era of efficient and effective urban transportation.

II. RELATED WORK

Thushar Sharma *et al.,* [1] proposed a prototype model of traffic free emergency health corridor that creates traffic free paths for emergency vehicles which demonstrates using Arduino UNO, transmitter and receiver Laura module, DPDT switches and LEDs, which facilitates communication between on board units and road side units allowing for efficient traffic control by detecting approaching emergency vehicles and managing traffic lights using locations and adjusting traffic signals accordingly, the Laura module used in this proposed system uses cellular networks which cause congestion in high density areas which can additionally cause signal conflicts.

Vani R *et al.,* [2] proposed a comprehensive traffic control system, detailing hardware and software components, image processing stages like RGB to gray conversion, filtering, edge detection, and masking algorithms. The system dynamically adjusts traffic signals based on junction traffic density, prioritizing emergency vehicles. While it effectively reduces congestion and expedites emergency vehicle passage, potential drawbacks include implementation costs, maintenance needs, continuous monitoring for optimal function, and reliance on image processing adjusting to limitations in certain conditions.

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Kapileswar *et al.,* [3] discussed an advancement in urban traffic management systems aimed at prioritizing emergency vehicles through visual sensing methods and Medium Access Control (MAC) protocols. Integration of visual sensing enables real-time detection of emergency vehicles, allowing traffic signals to adjust for their passage efficiently. MAC protocols streamline data transmission, reducing delays in conveying emergency vehicle information to Traffic Management Centers (TMCs). Despite benefits, challenges such as implementation complexity, scalability issues with increasing traffic volumes, and privacy or security risks in collecting real-time traffic data require attention for effective system deployment and maintenance.

Gowram Iswarya *et al.,* [4] proposed a system in response to the escalating number of vehicles driven by population growth, urban traffic congestion has intensified, leading to prolonged waiting times for vehicles. To tackle this issue, a smart traffic control system has been developed to prioritize emergency vehicles such as ambulances. Implemented on the Arduino UNO platform, the system utilizes two sound sensors designed to detect ambulance frequencies ranging from 700Hz to 900Hz. Upon detection, the system promptly adjusts traffic signals to facilitate smooth passage for emergency vehicles, minimizing delays in their journey. This method offers several advantages, including rapid response capabilities and efficient traffic management achieved through dynamic signal adjustments. However, it also presents technical limitations, particularly the potential challenges associated with accurately discerning ambulance frequencies amidst ambient noise.

Varadharaj *et al.,* [5] introduced a Dynamic Signalling System (DSS) is a smart solution that uses technology, including hardware and software, along with human operators, to make traffic monitoring and control better. It helps ease traffic jams by using sensors to check how many vehicles are on the road, reducing waiting times. Emergency vehicles also get special equipment, like RF transmitters, which helps them get through traffic faster. While DSS has advantages, it might be expensive to set up initially and could face issues with its security. Reliance on sensor-based monitoring and RF transmitters introduces the risk of technical malfunctions or compatibility issues, potentially impacting system reliability.

Biru Rajak *et al.,* [6] demonstrated the Green Corridor System (GCS), utilizing RFID technology, streamlines emergency vehicle paths at junctions, enhancing response. However, reliance on seamless integration and reliability of RFID readers and Traffic control servers poses a risk of disruptions, potentially compromising response efficacy.

Surshkumar *et al.,* [7] has proposed a system which highlights the urban challenge of traffic congestion, primarily caused by increased population density and individual vehicle preferences in cities. Existing traffic management systems, notably timer-based, lack efficiency in detecting and prioritizing emergency vehicles like ambulances. The proposed intelligent traffic management system, integrating RF technology and GPS tracking, addresses this issue by expediting ambulance passage through dynamic traffic signal adjustments. The advantage lies in preventing ambulance delays, reducing risks to patient outcomes during emergencies. However, challenges include potential privacy concerns associated with continuous GPS tracking and the need for comprehensive adoption for maximum impact.

Monika *et al.,* [8] aims to streamline emergency vehicle access, enhancing safety and response times by adjusting traffic signals automatically. Its benefits include efficient emergency response and improved traffic management, mitigating risks for both emergency responders and regular commuters. Additionally, the system offers versatility in applications like congestion detection, presenting a comprehensive solution to urban traffic challenges. However, its effectiveness hinges on seamless technology integration, with dependencies on components like Zigbee communication modules and microcontrollers, which may introduce potential disruptions and compromise emergency response efficacy.

Swapna *et al.,* [9] introduced Street Crossing Point Management (SCPM) through traffic lights that often results in inefficiencies, causing pedestrian delays, energy wastage, and compromised air quality. The proposed solution leverages Radio Frequency (RF) technology for object identification, offering a more streamlined approach. However, existing systems, including those utilizing ultrasonic sensors, struggle to differentiate between regular and emergency vehicles, potentially leading to traffic congestion and delays for emergency responders. Despite the advantages of enhanced wireless communication and improved response times facilitated by RF technology, the limitation of limited vehicle discrimination hampers the effectiveness of traffic management systems in alleviating traffic congestion and facilitating emergency vehicle passage

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Jasvanth *et al. [10],* The increase in vehicular traffic globally, particularly in urban areas, has led to severe congestion issues, causing significant economic losses and delays in emergency response times. Countries like India face high mortality rates from road accidents, with a notable portion attributed to delays in ambulance arrivals due to traffic congestion. Implementing an efficient traffic control system (TCS) becomes crucial to enhancing transportation safety and efficiency. However, conventional traffic light systems often lack the adaptability to prioritize emergency vehicles, leading to delays and potential hazards in critical situations. The advantages of a well-designed TCS include improved emergency response through dynamic traffic light adjustments and enhanced traffic management by utilizing sensors and intelligent algorithms. However, challenges such as complexity in implementation and dependency on technology may pose obstacles to the effective deployment of TCS solutions.

III. CONCLUSION

The project aims to create an Integrated traffic clearance system for emergency vehicles using sound and camera sensors. By combining these sensors with image processing and signal control, the system prioritizes emergency vehicles at intersections and ensures fast passage through congested traffic. The integration of sound and camera sensors increases the accuracy of detection. This enables the identification of emergency vehicles and shortens the response time. Challenges include sensor calibration, integration complexity, and privacy concerns. After successful implementation, the system promises smoother operation and improved response to emergency situations.

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