iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** X **Month of publication:** October 2023

DOI: https://doi.org/10.22214/ijraset.2023.56131

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

Smart Traffic Management System

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***Abstract:** This document gives formatting instructions for authors preparing papers for publication in the Proceedings of an IEEE conference. The authors must follow the instructions given in the document for the papers to be published. You can use this document as both an instruction set and as a template into which you can type your own text.*

***Abstract:** Traffic congestion has become a significant issue in metropolitan areas. The exponential growth in the number of vehicles on the road has outpaced the development of road infrastructure. As a result, people are spending more time traveling between the same destinations every year. Many cities continue to rely on traditional traffic signal systems that are either manually controlled or operate on fixed time schedules. Unfortunately, these conventional methods lack efficiency as they do not utilize real-time data to optimize traffic flow.*

One critical problem with these outdated systems is the inability to clear the path for emergency vehicles, such as ambulances, fire trucks, and police vehicles, especially during peak traffic hours. The manual operation of traffic signals is prone to errors, leading to increased fuel consumption and even health-related issues due to prolonged exposure to traffic. Additionally, these conventional systems often result in unequal traffic flow from different directions at a given time.

It's evident that the existing traffic management methods are insufficient and outdated, and there's a pressing need to implement smarter and more efficient traffic control systems to address these issues

***Keywords:** Traffic Flow Optimization, Adaptive Traffic Signals, Traffic Data Sensors, Dynamic Routing for Ambulance, Emergency Response, IOT Connectivity, Urban Planning*

I. INTRODUCTION

A smart traffic management system is in development, utilizing sensor data, communication, and automated algorithms to improve the flow of traffic. The objective is to optimally control the duration of green or red lights at specific intersections. Rather than having fixed green or red-light durations, the system will adapt based on the number of vehicles present. In heavy traffic, green lights will stay on longer, while in lighter traffic, red lights will have longer intervals. This solution aims to eliminate inefficiencies at intersections, reduce commuting costs, and minimize pollution.

Often, traffic flowing into an intersection from various directions is uneven, a factor ignored by conventional traffic management systems. This imbalance leads to air pollution and severe health issues, particularly in metropolitan cities like Bangalore, where the number of vehicles is substantial. A smart traffic management system addresses this by continuously assessing traffic from all directions at an intersection using sensors placed at regular intervals. The data is collected and processed by a control system, which calculates the optimal timing for green lights in each direction to prevent traffic congestion.

Another significant issue addressed in this project is the movement of emergency vehicles (fire engines, ambulances, and police vehicles) through congested intersections. Due to the lack of infrastructure to support the swift movement of emergency vehicles in cities, an autonomous system is proposed to aid their transit. This system identifies emergency vehicles using radio wave signalling. When an emergency vehicle is detected, an SOS signal is transmitted and detected by a signal detection unit, which triggers the traffic management system. The system identifies emergency vehicles about 1 kilometre from the signal, and when they are within 500 meters, the control unit activates a green signal in the approaching direction, ensuring a clear path and preventing vehicle congestion.

A priority order is established for different types of emergency vehicles: Ambulance, Fire truck, and Police vehicles. In the event of multiple emergency vehicles approaching from various directions, the system determines the order of precedence, ensuring priority for the direction with multiple emergency vehicles. This provides an autonomous and efficient way to clear a signal-free path for emergency vehicles, addressing the lack of infrastructure for their unobstructed movement.

In 2014, 54% of the global population resided in urban areas, with a projected annual growth of nearly 2% until 2020. This population density places significant pressure on transportation systems. The high cost of living in urban areas often leads to long commutes, further straining transportation networks.

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II. OBJECTIVES

1) Traffic Flow Optimization: To improve traffic flow and reduce congestion in urban areas.
2) Real-time Monitoring: Constantly monitor traffic conditions and gather data for analysis.
3) Adaptive Traffic Signals: Optimize traffic signal timings based on real-time traffic data.
4) Reduce Commuting Time: Minimize travel time for commuters and reduce their stress.
5) Environmental Benefits: Decrease pollution and fuel consumption by reducing traffic congestion.

III. LITERATURE SURVEY

The Internet of Things (IoT), sometimes referred to as the Internet of Everything (IoE), encompasses all web-enabled devices that gather, transmit, and act upon data acquired from their surroundings using embedded sensors, processors, and communication hardware. These devices, often denoted as "connected" or "smart" devices, can occasionally communicate with other related devices through a process known as machine-to-machine (M2M) communication and execute actions based on the information they exchange. While humans can interact with these gadgets to configure them, provide instructions, or access data, the devices operate autonomously with minimal human intervention. The development of IoT has been facilitated by the availability of compact mobile components and the constant connectivity provided by home and business networks. These connected devices generate substantial amounts of internet traffic, comprising extensive data that can be utilized to enhance device functionality and, at the same time, raises concern about privacy and security. The abundance of new data and the internet-accessible nature of these devices give rise to legitimate concerns regarding both privacy and security. Nevertheless, this technology offers real-time information to an unprecedented degree, enabling remote monitoring of homes and families for safety, process optimization in businesses for increased productivity, waste reduction, and the prevention of unforeseen downtime. Additionally, sensors integrated into city infrastructure contribute to the reduction of road congestion and early warnings about infrastructure deterioration. Furthermore, open-area gadgets can monitor shifting environmental conditions and provide timely alerts regarding potential disasters.

A. Monitoring

An evident advantage of IoT is continuous monitoring. It enables the precise tracking of supply quantities and indoor air quality, which was previously challenging to collect efficiently. For example, it allows for real-time inventory management in stores and enhances product safety by monitoring expiration dates.

B. Time Efficiency

As previously suggested, IoT can lead to significant time savings. In today's fast-paced world, time is a valuable resource, and IoT technology contributes to more efficient use of it.

C. Cost Savings

The most prominent benefit of IoT is cost savings. When the cost of tagging and monitoring equipment is lower than the money saved through its implementation, IoT adoption becomes highly attractive. IoT is fundamentally valuable to people in their daily routines, facilitating effective communication between appliances, thereby conserving energy and reducing costs. By enabling data exchange and interpretation between devices to meet our specific needs, it enhances the efficiency of our systems.

D. Efficiency and Time Savings

Machine-to-machine interaction results in improved efficiency, yielding prompt and precise results. This translates to significant time savings, allowing individuals to focus on more creative tasks rather than repetitive daily chores.

E. Enhanced Quality of Life

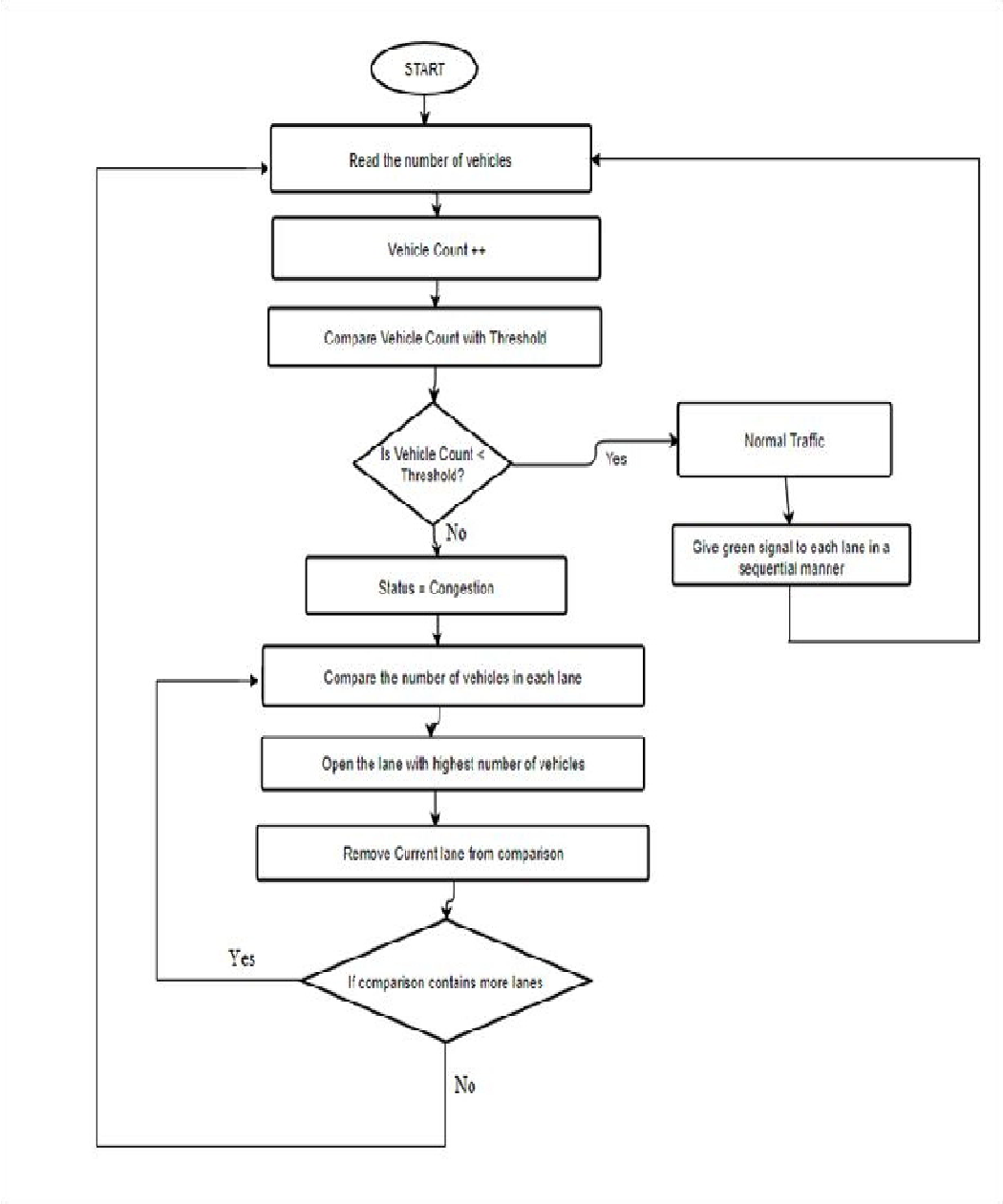
IoT applications collectively lead to increased comfort, convenience, and more effective management, ultimately elevating the overall quality of life.

F. Environmental Impact

Analyze how smart traffic management can reduce emissions and promote sustainability.
Explore studies on the environmental benefits of traffic optimization.

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IV. IMPLEMENTATION DETAILS OF MODULES



A. *Microcontroller (Arduino Uno)*

The Arduino UNO is a microcontroller board that operates on open-source principles. It is built around the Microchip ATmega328P microcontroller and was created by Arduino.cc. This board is designed with a range of digital and analogy input/output (I/O) pins that can be connected to various expansion boards, known as shields, as well as other external circuits. In total, it features 14 digital pins and 6 analog pins, making it highly versatile for a variety of projects. To program the Arduino UNO, you can use the Arduino IDE (Integrated Development Environment) and connect it to your computer via a type B USB cable.

LED for Traffic Lights:

The LED Traffic Lights Signal Module, or the Digital Signal Output Traffic Light Module, is an intriguing DIY accessory offered by Robu.in. It serves as a compact traffic light display module with excellent brightness, making it an ideal choice for constructing a traffic light system model. You can easily connect this module to the motherboard's PWM pin to regulate the light's brightness.

B. IR Sensor

An infrared proximity sensor, commonly referred to as an IR sensor, is an electronic device used to emit infrared light for detecting objects or their motion in the surrounding environment. This sensor operates as a passive device, capable only of measuring infrared radiation. It finds widespread use in the electronics industry and is a familiar component in projects involving obstacle avoidance robots and other proximity detection systems. If you're not yet familiar with this module, this article will provide a comprehensive introduction to it.

The operation of the IR sensor module is straightforward, consisting of two primary components: the first being the IR transmitter section and the second being the IR receiver section.

C. Micro sound sensor

The component employed for discerning sound or audio signal intensity in various applications like switches, security systems, home automation systems, monitoring systems, etc., is referred to as a sound sensor module. This module incorporates a microphone for detecting the presence of sound signals and is also capable of determining the frequency of noise signals within the range of 3kHz to 6kHz.

D. Software Requirement

1) *MATLAB:* MATLAB is a distinctive and proprietary multi-paradigm programming language and numeric computing environment meticulously developed by MathWorks. This versatile tool boasts an extensive range of functions encompassing matrix manipulations, function plotting, algorithm implementation, user interface development, and seamless integration with programs written in various languages. Widely adopted in diverse technical domains, MATLAB proves invaluable for tasks such as data analysis, complex problem-solving, experimentation, and innovative algorithm development. Notably, in the scope of this project, a user-friendly graphical interface (GUI) acts as the key gateway, offering access to individual MATLAB scripts. The creation of this GUI leverages the GUIDE library within the software, thereby facilitating the seamless execution of a wide array of functions through associated code.
2) *Proteus Design Suite:* The Proteus Design Suite stands as exclusive and indispensable proprietary software, specifically tailored for electronic design automation. Its primary purpose is to empower electronic design engineers and technicians to craft intricate schematics and electronic layouts essential for the precise fabrication of printed circuit boards. This powerful software is an essential resource, enabling professionals to realize their electronic design visions efficiently and accurately.

V. CONCLUSION

The Smart Traffic Management System leverages a range of IoT hardware components to optimize traffic flow. Through the IoT platform, traffic optimization is achieved by dynamically allocating varying time intervals to traffic and offers re-routing capabilities at intersections signals based on the count of vehicles in each road path. This system effectively addresses the issue of congestion. In response to the continuous growth of traffic, especially in large cities, where traditional systems have limitations in managing the current traffic effectively, this research proposes an innovative solution. The Smart Traffic Management System aims to enhance the control of road traffic situations by intelligently adjusting signal timings in response to traffic density on specific roadsides. It effectively regulates traffic flow through improved communication with a local server, even in cases where a local or centralized server experiences-failure.

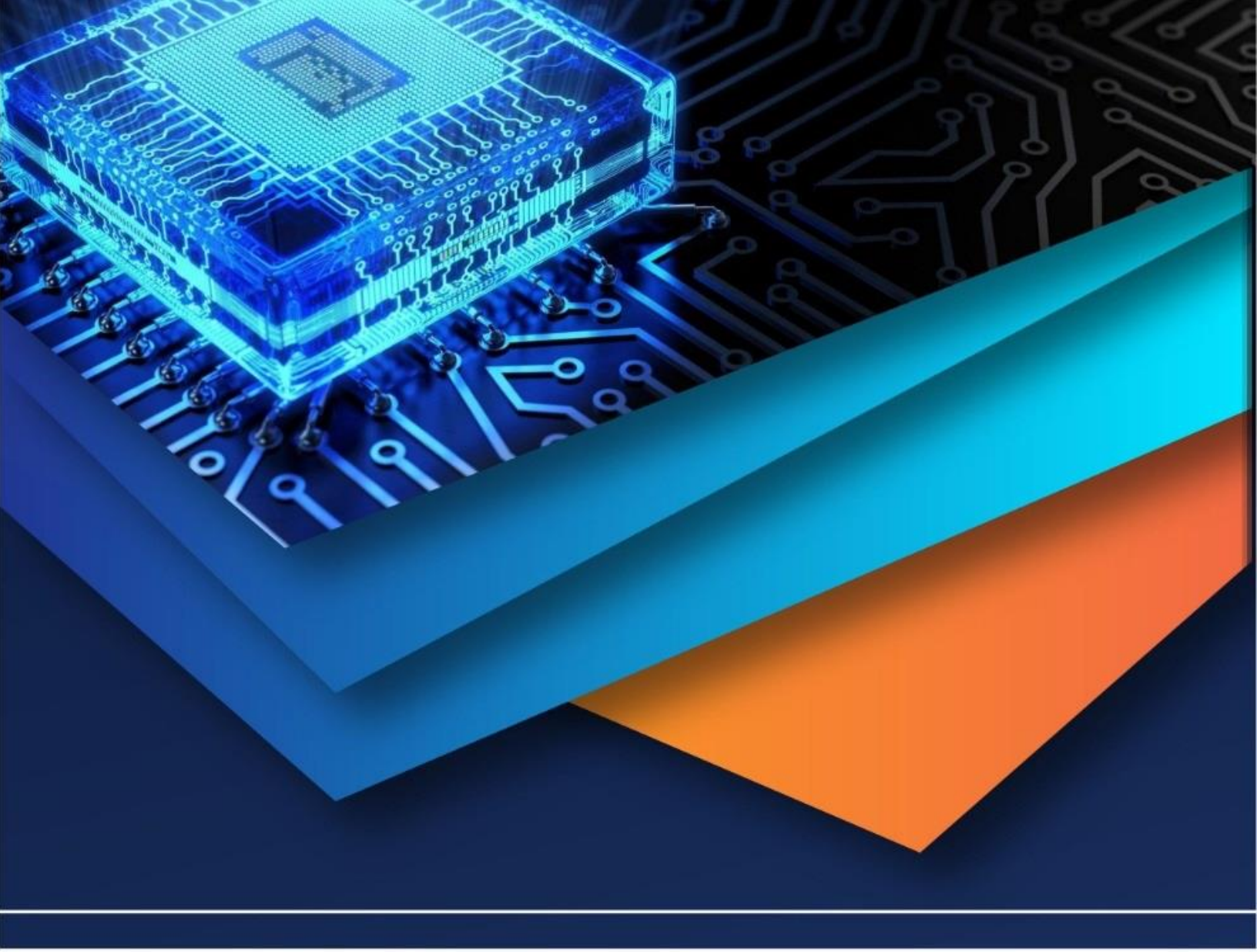
The decentralized approach ensures optimization and effectiveness, making the system resilient to server failures. Moreover, the system provides valuable data to higher authorities for road planning, enabling more efficient resource allocation. (Adapted from Sabeen Javaid, 2018)

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