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SMART TRAFFIC CONTROL: AI-POWERED IOT INTERSECTION MANAGEMENT

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Abstract: Traffic congestion is a major challenge in urban areas, leading to increased travel time, fuel consumption, and environmental pollution. Traditional traffic signal systems operate on predefined time intervals, which are often inefficient during peak and non-peak hours. To address this, we propose an AI & IoT-Based Traffic Management System that dynamically controls traffic signals based on real-time traffic density and emergency vehicle detection.

The system integrates YOLOv4 (You Only Look Once) object detection on a laptop with a camera to count vehicles in real-time. The traffic density data is then sent to an Arduino microcontroller, which dynamically adjusts the signal timings for optimal traffic flow. IR sensors are placed on the road before traffic lights to detect the presence of emergency vehicles equipped with an IR transmitter. When an emergency vehicle is detected, the system prioritizes its passage by changing the traffic signal dynamically and alerts other users through a buzzer.

Additionally, real-time traffic data is uploaded to an IoT cloud platform, allowing users to monitor traffic conditions via a mobile application. This smart traffic system improves traffic flow, reduces congestion, and ensures quick passage for emergency vehicles, making urban transportation more efficient and safer.

1. INTRODUCTION

Traffic congestion is one of the most critical challenges faced by urban cities today. The increasing number of vehicles on roads leads to long waiting times at traffic signals, unnecessary fuel consumption, and high levels of air pollution. Traditional traffic management systems operate on fixed time intervals, which are inefficient in handling dynamic traffic conditions. Additionally, emergency vehicles such as ambulances, fire trucks, and police cars often get stuck in traffic, delaying their response times.

To address these issues, we propose an AI & IoT-Based Traffic Management System that dynamically controls traffic signals using

YOLOv4 object detection and IoT-based real-time monitoring. The system efficiently manages traffic density by adjusting signal timings and provides emergency vehicle prioritization through IR sensor-based detection. The integration of IoT enables live traffic updates, which users can access via a mobile application, helping them plan their routes effectively.

The concept of smart roads integrates advanced control algorithms, improved sensors and computing and networking technology to predict and manage traffic flows. A smart road can improve travel time, road safety and reduce traffic congestions. Internet of Things (IOT) is the connectivity of physical devices such as sensors and actuators with a unique identifier to allow remote access to objects and automation in application domains like healthcare, transportation, surveillance, and energy conservation. It is projected that by 2020 more than 50 billion objects will be linked to the internet. A Wireless sensor terminal connected to network will collect information about the surrounding environment. Imaging technology has immensely progressed for on road vehicle detection. These days cameras areobtainedatcheaperprice, are compact and of high quality [19]. Hardware advances like parallel processing, multicourse processing permits real time implementation of vehicle detection. Advances in vehicle detection using stereovision and Internet of Things have been a vigorous research field in intelligent transportation systems

Image processing modules and Adaptive Neuron fuzzy based modules are used for the analysis of traffic data. A camera is mounted alongside the traffic light to obtain image sequences of road traffic. This image is sent to the cloud server using Thing Speak Platform. The control signal given by the adaptive fuzzy controller decides the order of a lane to receive the enquired traffic light signal. The work is intended to improve the existing traffic system by integrating better management and monitoring schemes as well as providing road users with real time information.

“One of the important things in the Internet of things in smart cities is the Intelligent Transportation System (ITS). ITS improves Vehicle to vehicle and Vehicle to Infrastructure communication for improving road facilities rather than increasing road capacities or developing new roads. This is possible because of ITS, it utilizes advanced information and communication, and this communication will be helpful for decreasing traffic congestion and to reduce

the accidents on the road, which is dangerous in the urban areas." "Managing traffic signal timing is one if the key thing in the urban areas. Managing to time on the road will decrease the waiting time of the drivers on the road, and that will help to reduce the fuel consumption. This is done with the help of the ITS." In this system, we are going to use IR Sensors. IR sensor is also called an Infra-Red spectrum. IR sensors have 2 parts in it, one is the transmitter and second is a receiver. The transmitter is used to transmit the light and receiver keeps on receiving the light. When this connection is interrupted, the counting process is started, i.e., when the receiver does not receive the light transmitted by the transmitter it is said that the object is there between transmitter and receiver. The line of sight concept is used in this approach.

Everyday traffic congestion bigger issues are a daily basis. So automation systems are currently not available in India. We need of IoT to utilize in the traffic signal monitoring systems and to control it in an advanced controlling system. Any system is designed to act smartly with higher control features for all four side way traffic systems. Every road towards heavy traffics of vehicles in higher counts. We need to define the priority level of traffic in our TMS on the basis on which least or highest priority. Traffic management system-TMS key appliances to control over traffic as per population of vehicles ID that particular area. So every road lane needs IR sensor to monitor and capture data of vehicles count in that lane. In this proposed system depends on the count of vehicles from the road lane IR data we are allocating higher time rate for that signal. This systems model using more numbers of IR sensors, for automation control microcontroller, with Bluetooth controller, as well as Android mobile device and finally PCserver. Any of these sensors surround with IR transmitter & receiver for placing in both directions of road lane.

International Journal of Engineering & Technology Monitoring System–TMS using multiple IRs in IOT model to learn vehicles count in real time then updates signal timing of Every side traffic lights accordion's to the predicting factors using KNN algorithms. It uses IRs to collect signals from numerous inputs on basis IOT model setup to learn vehicles count available in a traffic signal. So it will get cleared depends on the dependability of vehicles count to either increase or decreases timing of particular signals using KNN algorithms by data analysis.

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: Microcontroller Kit in TMS Fig. Signal model - IR sensors for vehicles count 4.Modules

In this implemented application considered three major works as Modules processes of the project.

Server Communication: This module is used to perform algorithms computation using clustering technique from data given inputs using an android device, which is used to store all the previously stored data i.e., like the history of all the previous vehicles already used the same signal crossing. KNN model algorithm is utilized for clustering model extraction from the given inputs, which is working on non-parametric methods for classification & regression model of data analyses. This input which contains k closest outputs of training examples for the feature space. K-NN working on the instance-based learning those function is approximated as local values. This project always collects data for four side road crossing as the vehicle counts. According to the count as inputs, this algorithm going to decide the signal timing intervals to get higher time limits for that particular signal to avoid the traffic queuing in a dense number of vehicles. . User Communication: From the user's communication, they can able to view required information about traffic condition in that particular area. If the user decided to travel in the particular area, then they can use current scenario of traffic conditions by this android applic.

2. LITERATURE SURVEY

Traffic signal management is one of the major problematic issues in the current situation. Such scenarios, every signal are getting 60 seconds of timing on the road at a regular interval, even when traffic on that particular road is dense. As per this proposed model in this article, which will be optimized the timing interval of the traffic signal purely depends on the number of vehicles on that particular roadside. The major advantage of this system is that it can able to decrease the more waiting time for the drivers to cross road signal. In this model, we are using the clustering algorithms model which is based on KNN algorithm. Using this algorithm new model will be liable to determine expected required timing as per provided inputs to the signal which is vehicles count. The input of these systems is vehicles counts on each side of the road from crossing signal. And this input will be determined on much time is to be provided. “Case studies on this system are traffic network and real-time traffic sub-

networks are organized to get the effectiveness of the proposed model."

Recent studies show that all over the world, there has been a rapid increase in vehicle numbers. The latest statistics show that there are approximately 1 million licensed vehicles in the year 2014. As a result traffic problems have increased in the last few years and the present traffic light controllers have limitations because it uses the predefined hardware that does not have the flexibility of modification on real time basis. Due to the fixed time intervals of green, orange and red signals the waiting timeis more. To make this traffic light controlling more efficient we exploit the emergence of new technique called as "Smart Traffic Control System". This makes use ofsensors along with embedded technology. The timings of the red and green lights willbe smartly decided based on the traffic on adjacent roads. As compared to fixed mode traffic light controller this new system is more efficient and flexible. It also has anintelligent traffic control system to pass the emergency vehicles such as ambulance, fire brigade etc. and also detect and track the stolen vehicles. The design also has scope for further expansion.

With the increase in traffic there arise a number of problems such as heavy traffic jams, violation of traffic rules etc. Mismanagement and traffic congestions also results in long waiting times, loss of fuel and money etc. It is therefore necessary to have a fast, economical and efficient traffic control system formational development. One way to improve traffic flow and safety of the current transportation system is to apply automation and intelligent control methods to roadside infrastructure as well as vehicles. Traffic Congestion and traffic monitoring is one of the important problems all over the world. This work uses IOT and Adaptive Neuron Fuzzy Inference System (ANFIS) to improve traffic conditions. An ANFIS traffic light controller with inputs as waiting time and vehicle density is developed using MATLAB SIMULINK environment. A camera is used to capture the traffic scenes and this image is transferred to the cloud using Arduino UNO and Thing Speak Platform. The image is then analyzed in the server using ANFIS controller and appropriate control signals are sent to the traffic signals.

The rapid urbanization and increasing traffic density in metropolitan areas have led to several road safety and traffic management challenges. One of the key factors contributing to these issues is the inefficiency of traditional traffic light

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systems, which operate based osprey-determined schedules and fail to adapt to changing traffic conditions. In this research paper, we pro-pose a smart traffic light system that leverages advanced technologies suchas Internet of Things (IoT), and machine learning to optimize traffic flow and enhance road safety. The proposed system incorporates real-time traffic monitoring, predictive analytics, and adaptive signal control algorithms to dynamically adjust traffic light timings based on the current traffic situation. We evaluate the performance of the proposed system using simulations and real-world experiments, demonstrating significant improvements in traffic flow efficiency and reduction in travel time and traffic congestion. The re-sults of this research demonstrate the potential of smart traffic light systems to revolutionize traffic management and improve road safety in urban areas.

Smart traffic management is a wide topic of research. Many modifications can be made to make the urban traffic flow smoothly on the roads. The increasing utilization of private vehicles and public transportation due to advancement of technology causes hectic traffic complexities for the civilians across the globe. The problem of traffic congestion is an everyday problem for human resource and therefore hinders the growth of the country by affecting its productivity as well as economy. Moreover, the traffic signaling systems have predetermined fixed operational time which fails to manage the traffic density changing with time and thus, long traffic queues are formed at the road crossings resulting in increased pollution and waiting time. In this paper, we tried to provide solution to reduce the waiting time at road crossings while keeping in mind the importance of time of the citizens as well as the emergency service providers (such as EMS i.e. Emergency Medical Services, Fire and Rescue Services, etc.). The presented system in this paper is based on smart traffic congestion control system that will automatically set the signal time based on the measured values of vehicle density on road lanes. However, the manual changescan also be made to traffic signals for efficient traffic management in case of emergencies. Thispaperpresents an idea of traffic management using internet of things (IOT). The Internet of Things (IoT) refers toa system of internet-connected objects that are able to collect and transfer data over a wireless networkwithout human intervention. This technology provides an effective communication between

differentsignals and helps in collection of data thereby providing an IoT based smart traffic management system inters of its automated tracking, monitoring and controlling of vehicles and its data processing.

This system addresses this issue and gives the traffic control center people and authorities with a facility to manually control the traffic so that the citizens can get easy and fast access to the emergency services be it medical necessity, crime prevention measure or rescue services.

3. EXISTING SYSTEM

Inductive loop detection works on the principle that one or more turns of insulated wire are placed in a shallow cutout in the roadway, a lead in wire runs from roadside pull box to the controller and to the electronic unit located in the controller cabinet. When a vehicle passes over the loop or stops, the induction of the wire is changed. Due to change in induction, there is change in the frequency. This change in the frequency causes the electronic unit to send a signal to the controller; indicating presence of the vehicle [6].Inductive loop detection is useful in knowing the vehicle presence, passage, occupancy and even the number of vehicles passing through a particular area [6,7]. But there are few problems with this system. These include poor reliability due to improper connections made in the pull boxes and due to application of sealant over the cutout of the road. If this system is implemented in poor pavement or where digging of the roads is frequent then the problem of reliability is aggravated

Existing traffic systems are inefficient in handling variable traffic densities and prioritizing emergency vehicles. These limitations lead to increased congestion, delays, and accidents. Additionally, the lack of real-time traffic information restricts users from choosing optimal routes

4. PROPOSED SYSTEM

To address these issues, we propose an AI & IoT-Based Traffic Management System that dynamically controls traffic signals using YOLOv4 object detection and IoT-based real-time monitoring. The system efficiently manages traffic density by adjusting signal timings and provides emergency vehicle prioritization through IR sensor-based detection. The integration of IoT enables live traffic updates, which users can access via a mobile application, helping them plan their routes effectively. The proposed system of this project is shown in Fig 4.1.

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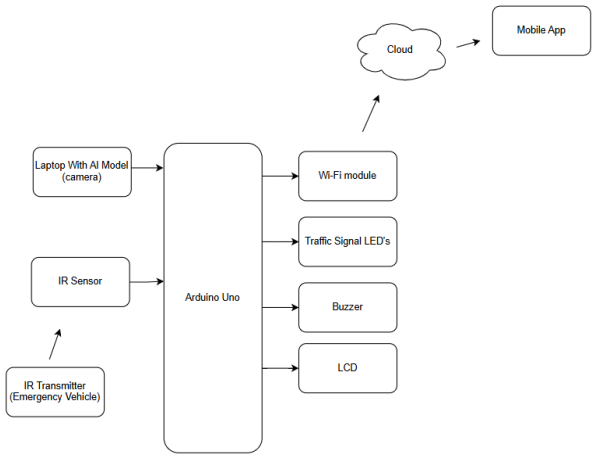

Fig 1 Block Diagram

5. WORKING FLOW STEPS

Traffic Detection using YOLOv4

A camera captures live road traffic video.

The YOLOv4 algorithm processes the video feed to count vehicles.

The vehicle count is sent to an Arduino Uno for traffic light control.

Dynamic Traffic Signal Adjustment Based on traffic density, Arduino adjusts the signal timing dynamically.

The busiest lane gets more green light time, while others operate on predefined intervals.

Emergency Vehicle Detection

An IR transmitter on an emergency vehicle sends signals.

An IR receiver near traffic lights detects the emergency vehicle and immediately switches the signal to green in that direction.

A buzzer alerts other road users to clear the path.

IoT-Based Traffic Monitoring

The system uploads real-time traffic data to the cloud.

Users can access live traffic updates via a mobile application.

6. IMPLEMENTATION

The system is implemented in three main stages:

AI-Based Traffic Density Calculation

Hardware: Laptop with a camera

Software: YOLOv4 deep learning model

The model processes live traffic feed to count vehicles.

Data is sent to Arduino for dynamic traffic signal control.

Emergency Vehicle Detection

Hardware: IR transmitter (on emergency vehicle) and IR receiver (near signal)

When an emergency vehicle is detected:

The signal switches to green in that direction.

A buzzer alerts other vehicles.

IoT Cloud Integration for Traffic Monitoring

Hardware: ESP8266 Wi-Fi module for cloud communication

Software: ThingSpeak or Firebase for storing and displaying real-time traffic data

Users can monitor live traffic updates via a mobile app.

7. MODULE DESCRIPTION

Traffic Density Detection Module (AI-Based)

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Uses YOLOv4 object detection on a laptop camera to count vehicles.

Determines the traffic density and sends data to Arduino.

Dynamic Traffic Signal Control Module

Arduino receives real-time vehicle count and adjusts signal timing dynamically.

Reduces congestion and unnecessary delays.

Emergency Vehicle Detection Module

IR receiver detects an emergency vehicle (fire truck, ambulance, etc.).

Traffic signal changes to green, clearing the path.

Buzzer alerts other road users.

IoT Traffic Monitoring Module

Traffic data is uploaded to the cloud using the ESP8266 Wi-Fi module.

Users can access live updates via a mobile app.

AI-based Traffic Density Calculation: A laptop with a camera uses YOLOv4 to count vehicles and adjust the signal timing dynamically.

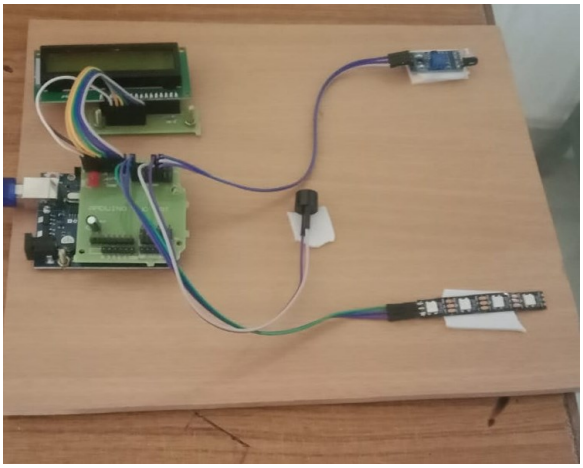
Emergency Vehicle Detection: IR sensors detect emergency vehicles equipped with IR transmitters and prioritize their passage by switching the traffic signal.

IoT Cloud Integration: Real-time traffic data is uploaded to an IoT platform, accessible through a mobile app.

User Alerts: A buzzer alerts road users when an emergency vehicle is approaching.

Automated & Smart Signal Control: Arduino processes data from the laptop and IR sensors to control the traffic signals efficient

8. RESULTS



9. CONCLUSION

The AI-IoT-based Traffic Management System demonstrates a practical and efficient approach to handling urban traffic congestion. By integrating YOLOv4-Tiny for vehicle detection, Arduino for real-time signal control, and IoT for data sharing, the system provides a smart, automated, and scalable traffic solution.

AI-based real-time detection ensures accurate traffic density measurement. Dynamic signal control reduces congestion and improves traffic flow. Emergency vehicle prioritization enhances response times for critical situations.

IoT integration allows for remote traffic monitoring and decision-making.

This system can be further improved by enhancing model accuracy, integrating vehicle to infrastructure (V2I) communication, and expanding IoT capabilities for predictive traffic management.

REFERENCES

[1]Bacon, J., A. I. Bejan, A.R Beresford, D. Evans, R.J Gibbens, and K.Moody. (2011). "Using Real-Time Road Traffic Data to Evaluate Congestion." In *Dependable and Historic Computing*, 93–117. Springer.

[2] Dr.M.V. Sruthi "Improved Face Recognition Using Optimized Linear Collaborative Discriminant Regression Classification With Hybrid Algorithm" in www.iosrjournals.org.

[3]Carley, M.l, and I. Christie. (2017). *Managing Sustainable Development*. Routledge.

Castillo, E., Zacar\'\ias Grande, A. Calviño, W. Y. Szeto, and H.K Lo. (2015). "A State-of-the-Art Review of the Sensor Location, Flow Observability, Estimation, and Prediction Problems in Traffic Networks." *Journal of Sensors* 2015. Hindawi.

[4]Cohen, S.. (2014). *Understanding Environmental Policy*. Columbia University Press.

Light M. (2011) Detection." In *Robotics and Automation (ICRA), IEEE International Conference On*, 5421–26.

[5]Harrison, C., B. Eckman, R. Hamilton, P. Hartswick, J.Kalagnanam, J.Paraszczak, and P.Williams. (2010). "Foundations for Smarter Cities." *IBM Journal of Research and Development* 54 (4). IBM:1–16.

[6]Kowshik, H., D. Caveney, and P R Kumar. (2011). "Provable Systemwide Safety in Intelligent Intersections." *IEEE Transactions on Vehicular Technology* 60 (3). IEEE:804–18.

[7]Macal, C.M, and Mi. J North. (2010). "Tutorial on Agent-Based Modelling and Simulation." *Journal of Simulation* 4 (3). Taylor & Francis:151–62.

[8]Mishra, S., D. Bhattacharya, A. Gupta, and V.R.Singh. (2018). "Adaptive Traffic Light Cycle Time Controller Using Microcontrollers And Crowdsource Data Of Google Apis For Developing Countries." *ISPRS Annals of Photogrammetry, Remote Sensing & Spatial Information Sciences* 4.