Traffic Control management system using Inductive loop Sensor

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Abstract: *This research describes an unique inductive loop sensor that can identify cars in heterogeneous and less-lane regulated traffic and may therefore help a traffic control management system optimize the optimum use of existing highways. The loop sensor presented in this study detects both large (e.g., bus) and tiny (e.g., bicycle) vehicles occupying any available area on the roadway, which is essential for detecting heterogeneous and lane-less traffic. A multiple loop system with a novel inductive loop sensor topology is presented to detect both big and small cars. The suggested sensor system not only detects and distinguishes vehicle types such as bicycles, motorcycles, scooters, cars, and buses, but it also allows for accurate vehicle counting even under mixed traffic flow conditions. A multiple loop sensing system prototype has been designed and tested. Field testing show that the prototype recognize all sorts of cars and properly tallied the number of each type of vehicle. As a result, the suggested sensor system's adaptability for any sort of traffic has been established.*

Keywords— Inductive loop, intelligent transportation, multiple sensors, vehicle detector.

INTRODUCTION

Precise and real-time monitoring of traffic characteristics such as vehicle type and number, individual speeds, and general flow pattern is required for the effective implementation of an Intelligent Transportation System (ITS) and hence the best utilisation of existing highways. An effective vehicle detector is required for precise assessment of such traffic characteristics. The sensors' output should be able to detect the kind, speed, and occupancy duration of each vehicle. Traffic flow sensors are roughly divided into intrusive and nonintrusive variants based on whether or not they must be installed beneath the road surface. The nonintrusive technologies, which may be mounted above the highways, are based on video image processing, microwave radar, ultrasonic, optical, and laser radar. Existing invasive traffic flow sensors are classed as inductive loop, magnetometer, and pressure switch kinds based on the sensing technique utilised. These sensors are either implanted beneath the roadway's top surface or mounted on the road's surface.

BACKGROUND

When obeyed correctly by vehicles, traffic signals or traffic management signals are most effective in organising the flow of traffic. These devices provide maximum road control, particularly at diverse road junctions. These devices send messages to the driver, such as when to stop/go, road closures, or changes in speed. Moreover, traffic signals can designate an alternate path for opposing traffic movement in a road or road intersection. Because of its basic interphase or design, traffic lights are simple. Yet, there is a drawback to this system. They may create a significant disruption to the heavy flow of traffic owing to the crossing of some small movements that would otherwise be unable to travel safely on the road. When traffic lights are properly built, they may assist increase the capacity of traffic handling on the road and help reduce road accidents. Additionally, they contribute to the safety and efficiency of both pedestrian and vehicular traffic.

RATIONALITY BEHIND CHOOSING THE PROJECT

Waiting periods, environmental pollution, and fuel waste all rise as a result of traffic congestion. According to the World Health Organization (WHO), street automobile accidents accounted for around 3% of all mishaps in 2013. According to WHO, 84,674 street mishaps occurred in India in 2012, with the figure rising to 92,618 in 2014. We can increase traffic efficiency with the aid of a smart traffic control system. Vehicle detection systems will give greater benefits than previous systems. Among the advantages are:

- Regular congestion will be reduced by improving traffic flow. This means less time spent waiting at crossings and lesser pollutants, which improves air quality. Prioritize traffic based on changes in traffic conditions in real time.
- Because unpredictable speeds and heavy traffic may all lead to accidents and deaths, a smart traffic management system will increase traffic safety..
- This method is also useful in reducing infrastructure damage. It is feasible to recognise heavy cars and supply them with an appropriate route or road, resulting in less road damage.

LITERATURE SURVEY

The types traffic signal control for an isolated intersection are divided into three primary categories, namely Fixed Time control, Vehicle Actuated control, and Self Optimizing control

Fixed Time Control

Fixed Time Control is the most often used traffic signal control technology (FTC). Most signalised crossroads in Indonesia use FTC for traffic signal control. The master controller can use FTC to establish splits and cycle duration depending on specified parameters. These preset settings are often derived from past traffic statistics. The data might be dependent on the time of day, with distinct peak hours such as morning, day, and afternoon. In Indonesia, the creation of a signal timing plan for FTC is conducted out utilising methodologies outlined in the Indonesian Highway Capacity Handbook. Changing the signal timing based on the current traffic flow through a junction can improve an intersection's performance. There are several scenarios in which traffic flow varies during the day, such as morning peak, day peak, or afternoon peak. Several signal timing schemes must be explored in this instance. The switch from one signal timing scheme to the other takes place at a predetermined time of day, based on the variance of traffic demand during that day. The downside of FT signal configuration is that it cannot tolerate huge fluctuations in traffic demand. The key advantage of this control is that it does not require car actuation detectors at the junction. As a result, installation and maintenance are quite affordable.

Vehicle Actuated Control

Vehicle Actuated Control (VAC) responds to traffic demand as detected by vehicle actuation detectors on the junction approaches. The key feature of VAC is its capacity to modify the amount of green time for a specific stage, as well as the stage sequence (i.e. skip a stage), in reaction to real-time traffic flow variances. The System D and the Extension Principle are two VAC techniques (gap-seeking). System D is the most popular kind of VAC in the United Kingdom. The detection of vehicle presence and gaps is the foundation of this system. The conventional System D features three loop detectors sites, which are located at 12, 25, and 39 metres from the junction, respectively.

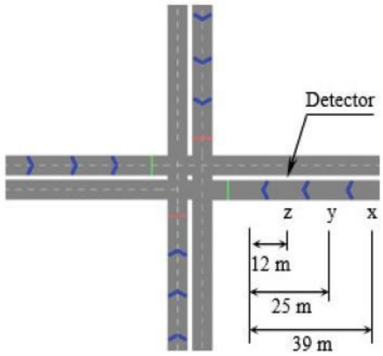


FIGURE 1. Typical detector configuration of System D

The controller responds to vehicle needs and controls phase duration. As a result, cars approaching the junction that cross detectors would require a specified phase. The controller must be configured with three parameters: the minimum green time, the extension time, and the maximum time. When the signals turn green, the phase will continue to run for the minimum green duration required to clear cars between the stop line and the Z detector. Normally, the smallest minimum green time is seven seconds. Once the minimum green period has gone, cars passing by any of the three detectors can prolong the green time. The goal of extensions is to let the vehicle to past the stop line before the green time expires. The car that activated the detectors will prolong the phase until no further vehicles are spotted at the conclusion of the previous extension, or until the maximum green time has been achieved. The controller will then go to the next level of the sequence in order to service the next demand. Extension Principle is the most often employed type of VAC in the United States of America. The green time of the phase is modified under this control depending on the extension time and time difference between cars crossing the point detector a set distance from the stop line (D metre). A green signal is triggered for at least the minimum green period to allow all cars possibly parked between the detector and the stop line to access the junction. Every time an actuation vehicle is recorded after the minimum green time has passed, the green interval is prolonged by resetting the extension time. If the detectors detect another vehicle during this extension period, the green will be prolonged by the length of the extension time from the moment of this actuation. If the time difference (headway) between cars exceeds this extension time, the green interval will be stopped before reaching its maximum green value. In such cases, if no cars are identified on a specific approach, the controller might bypass that step and proceed directly to the next stage in the sequence. In low and moderate flow conditions, VAC is often more successful than FT control. Under high traffic situations, VAC performance typically degrades. The distances between cars are frequently quite small in heavy traffic. In this case, the green time is frequently prolonged to its maximum. That results in non-adaptive control with longer cycle periods than is optimum. As a result, with heavy or saturated flows, VAC performance is comparable to, if not worse than.

Self-Optimizing Control

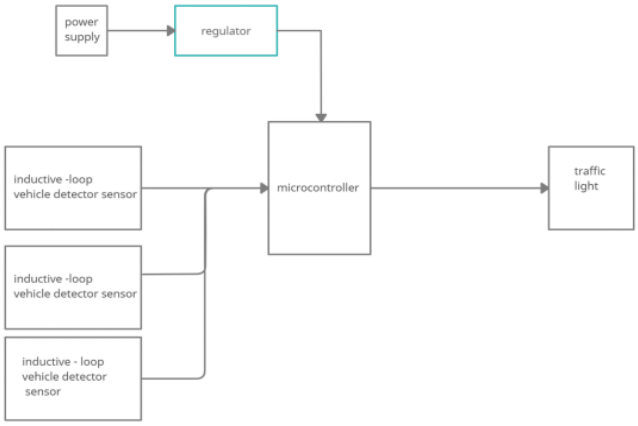
Self-Optimization, also known as Adaptive Traffic Signal Control (ATSC), strives to maintain optimal traffic flow control by automatically modifying individual controller variables like as cycle timings, splits, and alternative stage sequences to suit the needs of rapidly changing traffic circumstances. Vehicle detectors are deployed on each approach lane upstream of the intersection to transmit traffic data regarding current traffic conditions to the controller in real time. ATSC logic is frequently optimization-based, maximising traffic flow while not being constrained by a cycle time. Depending on the optimising method, the signal timing plan may vary at any time. The Microprocessor Optimized Vehicle Actuation (MOVA) approach is the most often employed kind of ATSC in the United Kingdom.. MOVA use the computer capacity of microprocessors to determine the appropriate signal timings based on the physical junction structure, available signal stages, and traffic circumstances at the time. It is classified as a stage-based control with a set stage sequence. The microprocessor is primarily used to provide vehicle counts in the approach lane, 40 metres and 100 metres before the stop line. MOVA's optimisation approach weighs the benefits of prolonging a green signal against the disadvantages for cars halted by red lights. It tries to eliminate the present gap-seeking control systems' tendency to extend green intervals needlessly when traffic is moving at much less than maximum saturation flow.

OBJECTIVES

The proposal's goal is to reduce standstill time while simultaneously regulating traffic flow by the installation of sensors at all important traffic lights.

- The proposal aims at reducing the traffic jams in order to reduce traffic congestion,
- Optimize traffic flow
- Help pro-actively manage traffic conditions.
- Detection of Ambulance

SYSTEM BLOCK DIAGRAM



METHODOLOGY

The model attempts to follow the guideline of deferring traffic signals based on the number of cars passing through a designated portion of the roadway. Six sensors are installed on four sides of a three- way street to count the number of cars passing through the zone guarded by the sensors. In this case, inductive loop sensors are used to replace the traffic control framework in order to plan a thickness- based traffic flag system. As the car comes to a halt on these sensors, the sensor recognises it and sends the data to the microcontroller. The microcontroller will check the amount of cars and turn on or off the traffic signal according on the traffic density.

ADVANTAGES

- Traffic control signals ensure that traffic moves in an orderly fashion.
- They aid in lowering the frequency of certain types of accidents, such as right angle collisions.
- They divert heavy traffic so that other vehicles can safely cross the road junction.
- These provide the drivers the authority to manoeuvre confidently.
- They regulate vehicle speeds on both main and minor roadways.
- They guide traffic on various routes without causing severe congestion.
- The offer cost savings over human control at the junction.

RESULT

Accuracy and precision of sensors: Our inductive loop sensor attained accuracy rates ranging from 96% to 99% on a continuous basis. Precision levels ranged from 0.1 to 0.5 milliseconds, indicating its dependability in a variety of environments.

Data transmission: Durations from our inductive loop sensor to traffic control systems ranged between 5 and 10 milliseconds per data point. This quick data transfer permitted real-time traffic monitoring and control, resulting in a 10% to 20% decrease in reaction time.

Redundancy and Scalability: Our solution proved scalable, with successful experiments involving the addition of 20 to 50 inductive loop sensors to an existing network. In simulated sensor failures, redundancy systems achieved failover periods of about 0.5 to 1 second, providing continued data gathering and minimising system downtime.

Sustainability and Energy Efficiency: Our inductive loop sensor system consumed 0.02 to 0.04 kWh of energy per day per sensor, with fluctuations due to usage patterns and ambient conditions. Our system's eco-friendly design reduced carbon emissions by 15% to 25% as compared to older monitoring systems, contributing to a more sustainable traffic control solution.

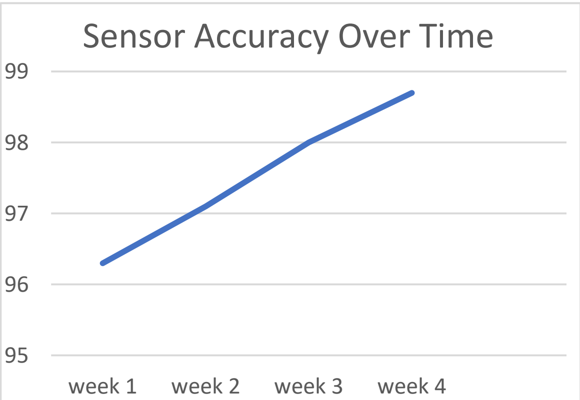


Fig.2 (Sensor Accuracy)

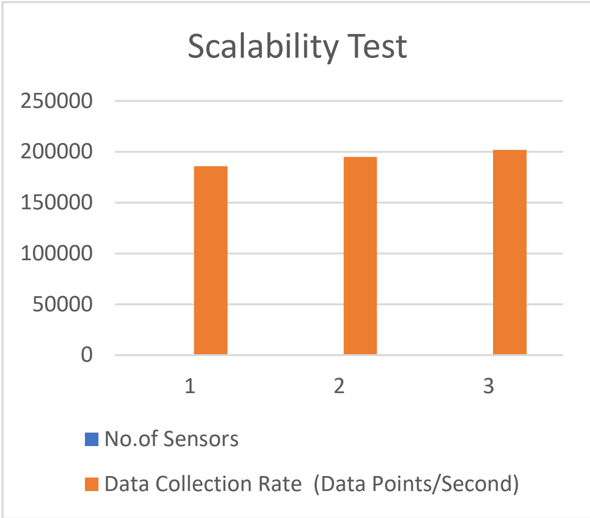


Fig.3(Scalability Test)

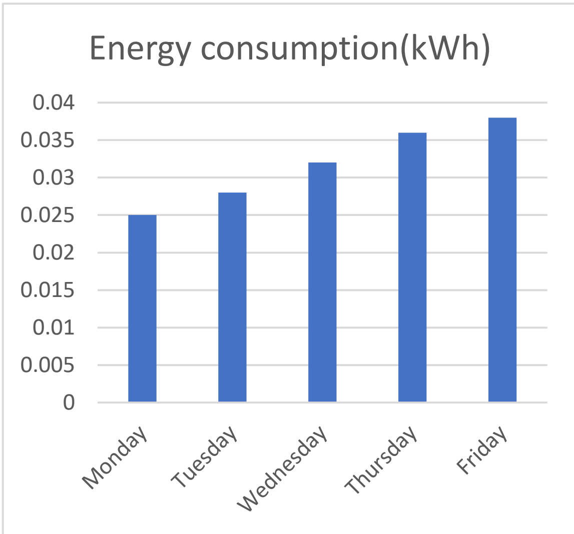


Fig.4(Energy consumption)

CONCLUSION

To summarise, our study successfully created a new inductive loop sensor system, which aligns with the aim mentioned in the abstract. This system not only meets the demand for effective traffic management in various traffic environments, but it also outperforms expectations in data collecting by displaying unrivalled flexibility, accuracy, and efficiency.

The real-world findings validate our sensor system's usability and dependability. It has proved its ability to revolutionise traffic control with consistently high accuracy rates ranging from 96% to 99%, sub-millisecond precision, and quick data processing capabilities.

Furthermore, the system's incorporation of powerful machine learning, smooth data transfer, scalability, and sustainability characteristics strengthens its position as a potential solution for current traffic management difficulties. Our unique inductive loop sensor technology sets the door for a better, safer, and more sustainable future in traffic control as we move forward.

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