A Smart Density Based Traffic Control System with Barricades and Emergency Vehicles Clearance

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***Abstract*— One of the most delicate aspects of humanity in modern society is the traffic congestion control system. It has raised a red flag for researchers, and further work is needed to prevent casualties. As a result of the congestion, the country faces several adverse effects. Because of people's inability to follow traffic laws, lack of tolerance among road users, insufficient facilities, and lack of awareness among traffic wardens, traffic congestion has become a frequent occurrence in Nigeria. Nigeria's traffic control system has been subjected to various violations (Niger state as a case study). To address some of the challenges, this research proposed a smart density-based traffic control system with barricades and emergency clearance to address the abuses and restructure the system to achieve a free traffic flow in the state. This system is designed to do away with a manual system of traffic control, grant quick but logical access to an emergency vehicle, and replace the counter system of signal light using Pre-Empty Priority scheduling algorithm to assign higher priority to emergency vehicles. C programming language is utilised with the aid of IR sensor, Arduino AT Mega 2560, RF transceiver, LED, barricade and metal-gear-micro servo motor. The system is evaluated based on response time after trials for the speed of the servo motor. Setting the servo motor speed from 00 to 900 and back to 00 shows that the get ready to stop is recorded at 2000 microseconds. After five trials, 8,7 and 9,8 seconds were obtained for Road1 and Road2 as the high and low values, respectively. The highest value of 8 and 9 seconds implies that it takes a second longer for the system to adequately initialised, after which it maintains a steady response. The result is significant and influential for the system.**

***Index Terms*— Barricades; Emergency Vehicle; IR Sensor; Traffic Warden and Traffic Control.**

I. INTRODUCTION

Traffic efficiency is becoming a worldwide issue as the number of vehicles in large urban areas continues to rise [1-3]. In several countries, the rise in travel times, unexpected delays, number of exits, travel expense, inconvenience to drivers and passengers, air pollution, noise level, number of traffic accidents, and fuel consumption is a direct consequence of urban road network congestion. The ecosystem is affected to construct more roads and expand the traffic network's capacity [5-6]. Signaling devices known as traffic lights (or traffic signals) improve traffic efficiency by rotating the signal phase at pedestrian crossings, road intersections, and other locations where traffic flow control is needed [1, 7]. Traditional traffic lights have fixed periods, which means they shift at regular intervals. This can be inefficient because traffic conditions are constantly evolving [8]. The numerous current implementations of traffic control systems face various obstacles, including avoiding heavy roadside sensors, resisting malicious vehicles, and avoiding simple-point failure [9].

In a country like Nigeria, traffic congestion has become a regular occurrence, owing to people's impatience and constant rush on the road. Warders (traffic cops) are often seen in most traffic intersections attempting to fix and remedy the problem manually. As a result of this manual approach to traffic management, one road is often given priority over another, even though other roads could already be congested and need clearing. Traffic congestion causes chaos on the road, particularly at traffic junctions in Nigeria, making it difficult for transporters to drive. Traditional methods are unsuccessful in congested areas, but they are still in use as a standard mode of operation. According to a new report, almost 18000 patients' lives may have been saved if they had arrived at the hospital on time and received medical care [10].

Due to the rapid advancement of technology, researchers are coming up with many solutions to the traffic congestion crisis [11]. This study proposed a smart density-based traffic management system with barricades and emergency vehicle clearance to alleviate traffic congestion by giving emergency vehicles priority. The barricades would replace the traffic warden's inability to stand for long periods to control traffic, particularly during the midday hours when the sun is at its peak. By minimising the amount of human involvement in the control and management of people and vehicles at intersections, this research will improve the country's traffic system. Even if there is no traffic warden present, it will instil the habit of obeying traffic laws and regulations. Furthermore, this work will enable commuters to drive on any road in the state safely. When a traffic light turns red, it reduces, if not eliminates, traffic law violations by road users, causing a traffic jam in a particular lane or across the entire section of the road.

The remainder of this paper is presented as follows: basic concepts and related work are presented in section 2, the research methodology and the flow diagram are presented in section 3, while section 4 present the result and discussion. Section 5 present the conclusion of the research work.

II. REVIEW OF BASIC CONCEPTS AND RELATED WORK

Traffic congestion is one of our society's most severe problems. Every day, particularly in Nigeria's megacities, one can see people (road users) struggling on the road. Many road users are unaware of traffic rules, which leads to reckless driving in most areas, but especially at traffic intersections, where commuters' failure to adhere to traffic rules causes traffic congestion. This traffic problem is exacerbated by an increase in vehicle density and a lack of tolerance on the part of road users. As a result, many criminal activities occur, such as traffic violations, snatching of people's mobile phones and handbags, causing traffic congestion, and so on [12]. According to recent reports, traffic congestion is on the rise due to rising vehicle numbers, insufficient road networks, and a manual system of handling traffic at intersections. Traffic congestion has resulted in accidents and the loss of life and property. According to statistics, the fatality rate has been rising in recent years (excerpt for the year 2018). According to the national bureau of statistics, Figure 1 shows the fatalities between 2013 and 2018. Many researchers have worked on the traffic control system. The different techniques used for traffic control systems are presented in Figure 2.

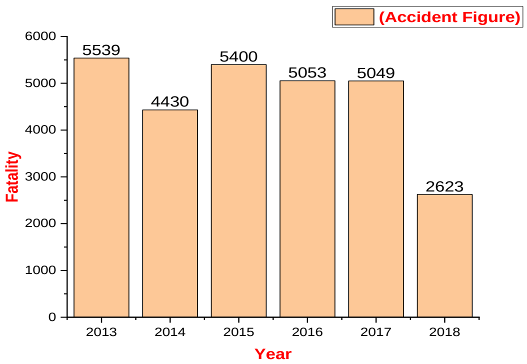

Figure 1: Accident fatality cases between 2013 to 2018 (National Bureau of Statistics)

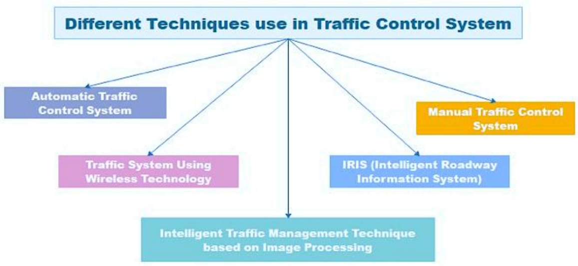

Figure 1: Different traffic control systems techniques

A. Manual Traffic Controller

This is the most popular form of traffic management, and it mainly includes traffic wardens. In this operation, a traffic warden stands in the middle of the intersection and directs traffic using boldly written go and stop signs or small signposts [13]. She or he is in charge of all emergency vehicles, but when more than one emergency vehicle enters the intersection, she or he becomes perplexed. While this approach is more successful than any modern methodology, it is inefficient since humans are involved. The lack of trained traffic police officers in many cities exacerbates the problem. Instead of providing the required services, the situation becomes worst where untrained personnel are involved.

B. Automatic Traffic Management System

An automatic traffic control solution is recommended to mitigate the manual traffic control system's flaws. A small red, green, and yellow three-colour traffic signal is used in this method. The amount of time allocated to each lane in a given area is calculated, in general, by the flow of traffic in that area and throughout the city. It all depends on how the traffic in the city moves. The yellow light flashes to warn drivers to either stop or drive. However, this device fails to recognise emergency vehicles, affecting both automobiles and emergency services. Due to the counter mechanism, people are forced to wait even though other lanes are vacant. As a result, emergency services can experience delays during peak hours. As a result, this approach is unsuccessful in some situations [13]).

C. Intelligent Traffic Management System Based on Image Processing

In this method, cameras are used to capture the traffic situation on the road. These are mounted on a high pole for long-distance encircling. A computer chip analyses the image captured by the camera to detect vehicles on the road. The computer will then measure the traffic light timing to monitor the traffic and send this information to the traffic controller; the traffic lights will then actively change their timing based on this information. This method is not always well-organised because the camera lens cannot see very far when there is a lot of traffic, and the image captured by the camera might not be noticeable if it is raining heavily [14].

D. Traffic Management System using Wireless Technologies

This method employs wireless sensors to decide on a traffic system in which an emergency vehicle is linked to an RF module and an RF module in the microcontroller. When an emergency vehicle arrives at a junction, its computer interacts with the controller's receiver to grant access as required. The control system will then calculate the average time for a green light in the presence of an emergency vehicle and maintain a red light for the remainder of the lane. The vehicle will then be able to pass through [13] quickly. This system effectively controls traffic flow while still presenting emergency vehicles with options.

E. Intelligent Roads Information System (IRIS)

The Minnesota Department of Transportation developed it as an open-source technology for the Advanced Traffic Management System (ATMs). It is used by transportation authorities to track and control national and interstate traffic. IRIS will also provide real-time traffic statistics to track traffic collisions, monitor traffic flow, and relay traffic data. Previously, the system did not provide traffic statistics and only observed traffic congestion. IRIS uses the GPL license for the Advanced Traffic Management System (ATM) software. ATMs help shorten travel times, increase the capacity of highways, and provide safer travel directions in general. ATMs are made up of a variety of proprietary, high-cost software solutions. The cost of annual repairs has also increased [13].

There are various instances in the literature aimed at developing systems for traffic control management. The literature, progress being made, and the challenges currently being faced by the existing body of knowledge are presented in this section. Traffic management using computer vision is presented by [15]. The system can detect moving vehicles and detect an object with enough light. The SVM algorithm was not used due to a lack of datasets, resulting in a better vehicle detection score. Emergency vehicles were not granted priority to increase the speed at which they arrived at their destinations. Research in [13] presented a methodology for Automatic Lane clearance for Emergency vehicles. The design and implementation of this strategy are primarily targeted at traffic control, ensuring that emergency vehicles on the road have a direct route to their destination in less time and with as little human intervention as possible. Despite this, their system cannot report stolen cars or drivers who break the speed limit. The system is solely concerned with lane clearance and has no impact on the current density of traffic on the route. Also, [16] presents a density-based traffic light control scheme with a surveillance system's design and implementation. It detects traffic load in a particular lane using an infrared sensor; the sensors are arranged on the median strip to detect or sense any vehicle entering the lane on which they are fixed. The device, however, lacks a reliable power supply, the ability to process and upload defaulter files, and a database where they can be tracked down later.

According to [12], a traffic system based on "Advanced Traffic Light Control System with Barrier Gate and GSM" was developed. In regions where traffic is congested, the study deploys a barrier to maintain order. Other sensors, such as infrared sensors, can be employed depending on the demands and practicality of the site. On the other hand, emergency cars were not given priority, which is the major drawback of the research. The significant difference between the research in [12] and [13] is that research in [12] presents a density-based traffic light control system interfaced with a barrier gate and a GSM technology. The signal timing changes automatically with the traffic density, and delay is provided with the help of a microcontroller. At the same time, the research in [13] summarises different traffic control systems used to improve conventional traffic control systems. The use of a barrier gate and a GSM technology adopted in [12] is one of the research reviews by [13]. Research in [17] presented a traffic control system based on a microcontroller. Barricades are used to keep an eye on traffic and maintain order at the intersection. The proposed system is designed to reduce traffic congestion while assisting emergency services in arriving on time. As a consequence, this intelligent device can help with traffic management. Meanwhile, the system fails to identify emergency vehicles, especially at night and fails to report traffic violations or stolen vehicles.

A smart traffic signal control (STSC) system was proposed in [18]. It enables EVSP (emergency vehicle signal preemption), TSP (public transit signal priority), ATSC (adaptive traffic signal control), eco-driving support, and message broadcasting, among other smart city transportation applications. The proposed STSC system's core is the roadside unit (RSU) controller, which details the system architecture, middleware, control algorithms, and peripheral modules. It can be quickly and cost-effectively deployed because it is compatible with existing traffic signal controllers. A new traffic signal scheme has been developed specifically for the EVSP scenario, and it can warn all cars near the intersection in which direction the emergency vehicle (EV) is approaching, smoothing traffic flow and improving safety. The disadvantage of the current approach is that it requires a smart device for broadcasting, which existing road infrastructure, particularly in poorer countries, does not support.

The importance of these systems is to gain a better understanding of the reoccurring traffic congestion and to recommend a preventative strategy to society. Instead of thinking about the classic process of enlarging roads to decrease traffic congestion, research in [19] suggests that automatic moveable traffic road dividers be employed as a congestion release strategy in traffic-prone locations. Depending on traffic flow in specific directions, it can add one or more lanes. This form of traffic-control technique saves time and money and has environmental benefits by lowering pollutants. The disadvantage is that it necessitates machinery to move the road barrier and therefore does not prioritise emergency vehicles.[20] also presented an IR Sensor-based system to address the critical challenges of vehicle congestion and traffic signal time consumption. The density of vehicles in the road is measured by the object detection sensor installed in the traffic signal path. It adjusts the automatic signal timing following the density. This makes the current system even more user-friendly. It is inconvenient to pass an ambulance instantly due to long traffic light lines.

We have presented a solution that uses an RF transmitter and receiver to solve this problem. The path signal will change to blue along with the green signal, signifying the arrival of the ambulance. As a result of existing traffic system restrictions, it saves time and lives for many people. Finally, [21] created an effective system for smart movable road dividers responsive to traffic density. The ambulance priority system is also featured, which uses RFID tags and an RFID reader to provide a clear road for the ambulance. A breach of a vehicle's signal can also be detected. The disadvantage is that, unlike the solutions presented in our study, the driver can choose to defy traffic whenever they choose, whereas the barricade prevents this.

III. RESEARCH METHODOLOGY

This section presents the procedures and techniques used to design and implement the proposed smart density-based traffic control system with barricades and emergency vehicles clearance. This section also outlines the various subsystems and components used and how they work and interact with one another. The system was designed using Arduino 1.8.5 IDE, C language, based on the Microcontroller (Arduino Mega 2560). Proteus professional (8.6) software was used to simulate the system design and observe the functionality of each component. Figure 3 present the block diagram of the proposed system.

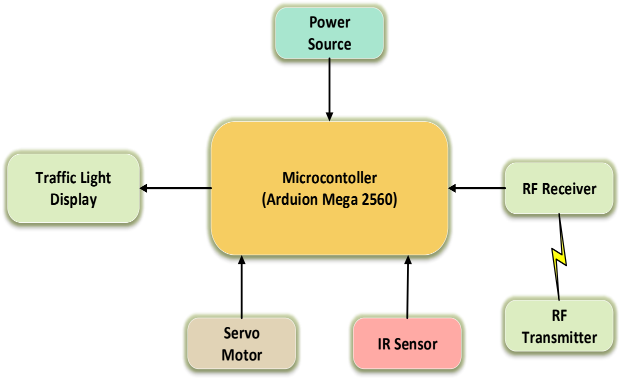

Figure 3: Block diagram for density-based traffic control system

An Intelligent Density Based Traffic Control System with Barricades for Emergency Vehicles Clearance Using IR Sensor in Nigeria is embedded with several functionalities to ensure safety and congestion-free at the traffic junction. This system has several data to train for perfect detection and analysed traffic flow. The system can control traffic at a particular junction based on the density of vehicles at a time. The use of barricades can substitute for human (traffic warden) effort and the stress of long-time standing and the stress from sun, rain and even danger from reckless drivers. Emergency clearance from traffic using RF Sensor will aid the fast response from the hazard to rescue casualties in a time of need. The system comprises several modules, each function according to its specifications but solves the problem being addressed when integrated. Figure 3.9 shows the system design model, which implies that the finished implementation will look the same at the end of the project.

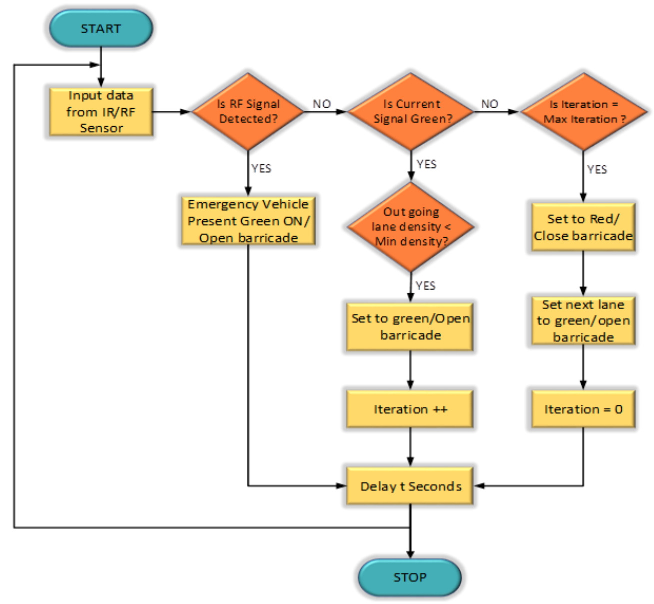

Figure 2: System flow chart

The choice of a servomotor to work within broader and more practical applications are affected by the Moment of Inertia, speed, and torque. The moment of inertia describes the degree of an object's reluctance to effects that might alter its rotation rate. Since any change in speed means causes the moment of inertia, Equation (1), which is the basic inertia (J), becomes very useful.

$$J = \iiint \rho(x,y,z)(x^2 + y^2)dxdydz \qquad (1)$$

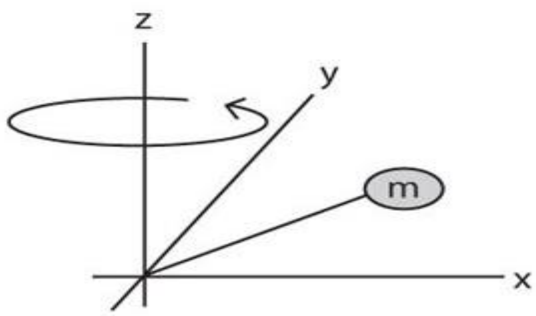

Figure 3. Moment of Inertia, Speed and Torque

When an object is rotating, consider the Equation (2),

$$J = mL^2 \qquad (2)$$

where, m = mass, L =distance between the centre of gravity and the centre of rotation. To obtain the torque of the bar attached to the servomotor as a blockade is relatively easy using Equation (3).

$$T = F \times r = F \times \frac{D}{2} \qquad (3)$$

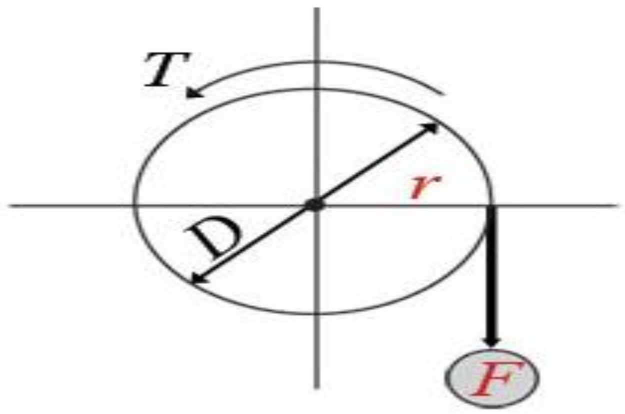

Figure 4: Torque of servomotor

where, r =distance between the centre of rotation, and F = force point. The RF radiates signals that most likely experience losses in propagation through free paths. The losses include path loss and fade margin. This leads us to the received power, P_r, as in Equation (4).

$$P_r = Tx_p + G - L \qquad (4)$$

where, Tx_p = Transmit Power in dBm (decibels meter), G= Gains in dBm (decibels meter) and L = Losses in dBm (decibels meter). Losses are caused by tall buildings, trees, and heavy-duty trucks. It should not come as a surprise when losses occur. This should be carefully noted and expected. The power is sometimes expressed in mW (milli-Watts). This conversion can be expressed as shown in Equations (5) and (6).

$$P_r(dBm) = 10Log_{10}(P(mW)) \qquad (5)$$

$$P(mW) = 10^{\frac{P(dBm)}{10}} \qquad (6)$$

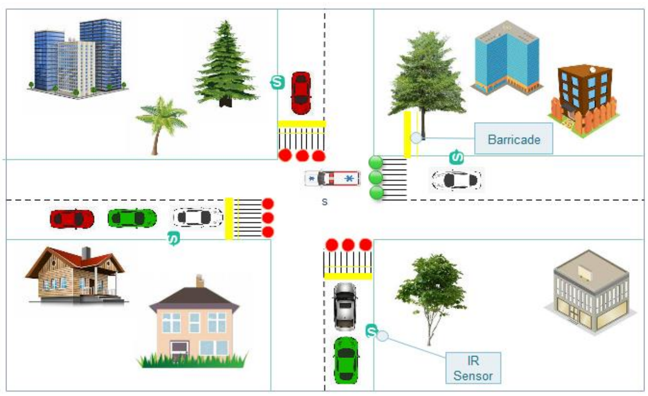

Figure 5: Architectural design of the proposed system

IV. Results And Discussions

The results of the smart density-based traffic control system with barricades and emergency vehicle clearance are presented in this section. The results of this system are focused on how quickly it responds to barricades and vehicles. The vehicles were detected before the barricades, and the green light turned on based on car density on the road using C language and counted to a maximum hold threshold. Traffic layout under scheduling algorithm to control density-based traffic control with barricades and priority given at road junction to emergency vehicles. The traffic system works following the vehicle density on each lane without an emergency vehicle. Whenever an emergency vehicle enters the road junction, the RF communicates to the receiver to grant access to the emergency vehicle.

The system simulation was done using Proteus Professional 8.6 and Arduino 1.8.5 version IDE, as shown in Figure 8. This aid in the implementation of the system and the result generated. The essential characteristics of this simulating tool are its ability to design and show the interaction between the running program and the components. Figure 9 shows the interface of IR sensor simulation with the number of objects detected. This enables the user to design the density per lane of the road, which was done using Arduino IDE programmer. The sensor's function was to set the threshold depending on the nature of traffic flow in a particular area for each lane.

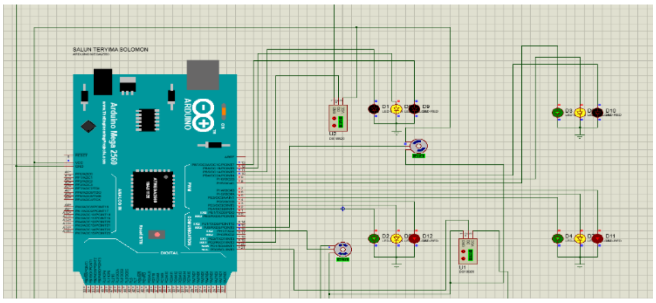

Figure 6: System simulation

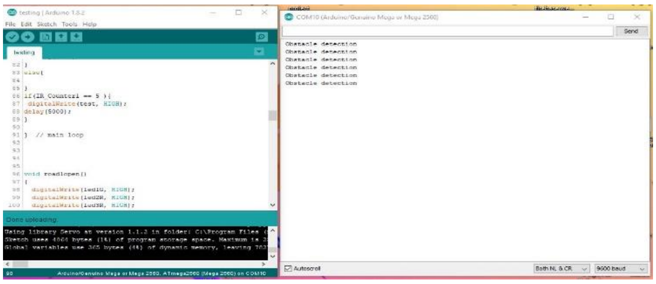

Figure 7: IR Sensor detecting objects

Table 1
The Barricades Response as Vehicles Reaches the Thresh Hold

No. of Trials	Response Time(s) Road1	Response Time(s) Road2
1	8	9
2	7	8
3	7	8
4	7	8
5	8	8

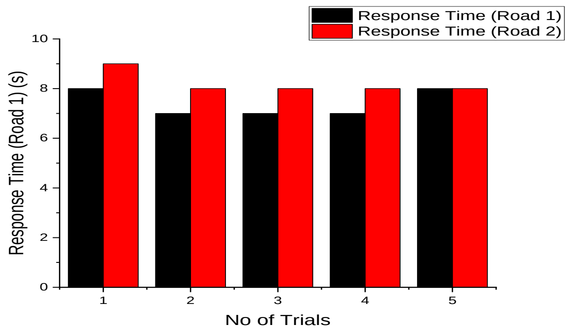

Figure 8: The barricades response time for Road 1 and Road 2

Table 2
Accuracy Performance Measurement for Road1

No. of Trials	No. of the Vehicle Passed	No of Vehicles Detected	No of Vehicles not Detected
1	11	10	1
2	13	10	3
3	12	9	3
4	8	7	1
5	10	9	1
6	11	9	2

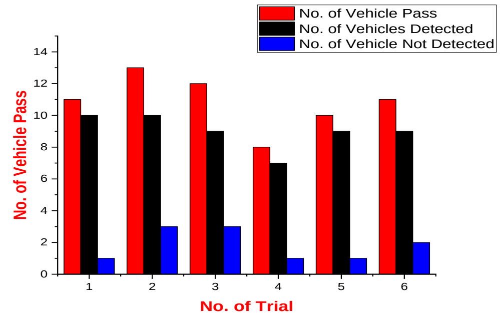

Figure 9: Performance measurement for Road1 with IR Sensor

Table 3
Sensitivity Performance Measurement for Road2

No. of Trials	No. of the Vehicle Passed	No of Vehicles Detected	No of Vehicles not Detected
1	14	11	3
2	10	10	0
3	12	11	1
4	14	12	2
5	10	8	2
6	8	8	0

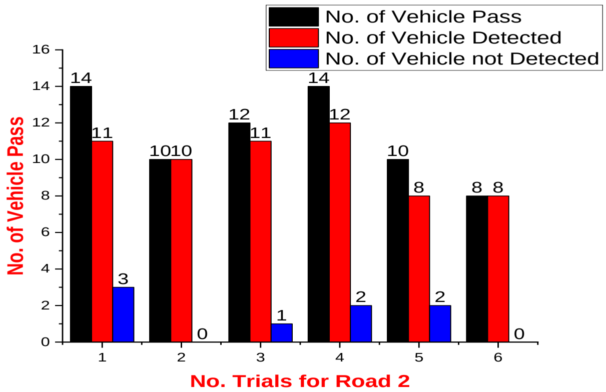

Figure 10: Performance measurement for Road 2 with IR Sensor

Figure 10 presents the barricades response as vehicles reaches the thresh hold for the two roads. The detail of this performance is shown in Table 1. This shows the number of trials made on both roads' response times. This is based on the time taken for the barricade to open the close lane with traffic signals as the number of vehicles passed reaches the threshold. The highest values obtained in seconds for both roads are 9 seconds, while the least is 7 seconds. This was due to do sensor ability to read in or detect objects that pass through it based on the scheduling process of the system. Figure 11 present the accuracy and sensitivity performance for the Road 1 when vehicles pass randomly at a different distance on the road within the threshold before the response time to measure the range of coverage of the sensor on a particular lane. The details of this performance are shown in Table 2. The system was able to detect or count vehicles that passed within its range and were unable to count or detect those that passed far from its range of coverage and those that passed in pairs as one. With six trials carried out for 13, 12, 11,10,9 and 8 cars, respectively, the system performs accurately well with just three cars unable to be detected.

Figure 12 presents the accuracy and the sensitivity performance measurement on Road 2. The detail of this is shown in Table 3. The vehicles were placed at a different distance on the road within the threshold, and the response time was recorded respectively. The system was able to detect or count vehicles that passed within its range and were unable to count or detect those that pass far from its range of coverage and also those that pass in pairs as one. The sensitivity measurement was performed based on the vehicles detected on every node along the road. Moreover, this has to do with the range of the car from the sensor. A range of 14 to 8 cars was used for the experiments; it was observed that when more vehicles pass on Road-Two, there is a possibility that one or more will pass at the same time, and the sensor can only detect those that pass at once as one.

V. CONCLUSION

This study strengthens the country's traffic infrastructure by lowering human intervention in tracking and handling people and vehicles at intersections and junctions. This was achieved using a C programming language with the aid of IR Senso, Arduino AT Mega 2560, RF transceiver, Led, Barricade and Metal Gear Micro Servo Motor. The system was evaluated based on response time after trials for the speed of the servo motor. Setting the servo motor speed from 00 to 900 and back to 00 shows that the get ready to stop is recorded at 2000 microseconds. After five trials, 8,7 and 9,8 seconds were obtained for Road1 and Road2 as the high and low values respectively, the highest value 8 and 9 seconds implies that it takes a second longer for the system to adequately initialised, after which it maintains a steady response. The result is significant and influential for the system.

Furthermore, this research instils the habit of following traffic laws and regulations even though there is no traffic warden present. It allows commuters to drive safely on every road in the state. This reduces drastically if not, the violation of traffic rules by road users, hence there will be a block at a particular lane or the entire section of the road when the traffic light shows red. The barricades take the place of the traffic warden's inability to stand for long periods to regulate traffic, particularly during the midday hours when the sun is at its zenith.

REFERENCES

[1] J. Liu *et al.*, "Secure intelligent traffic light control using fog computing," *Future Generation Computer Systems,* vol. 78, pp. 817-824, 2018.

[2] A. L. O. Paraense, K. Raizer, and R. R. Gudwin, "A machine consciousness approach to urban traffic control," *Biologically Inspired Cognitive Architectures,* vol. 15, pp. 61-73, 2016.

[3] C. Roncoli, M. Papageorgiou, and I. Papamichail, "Traffic flow optimisation in presence of vehicle automation and communication systems–Part II: Optimal control for multi-lane motorways," *Transportation Research Part C: Emerging Technologies,* vol. 57, pp. 260-275, 2015.

[4] S. Araghi, A. Khosravi, and D. Creighton, "Intelligent cuckoo search optimised traffic signal controllers for multi-intersection network," *Expert Systems with Applications,* vol. 42, no. 9, pp. 4422-4431, 2015.

[5] A. Jovanović, M. Nikolić, and D. Teodorović, "Area-wide urban traffic control: A Bee Colony Optimization approach," *Transportation Research Part C: Emerging Technologies,* vol. 77, pp. 329-350, 2017.

[6] M. F. Chowdhury, M. R. A. Biplob, and J. Uddin, "Real-time traffic density measurement using computer vision and dynamic traffic control," in *2018 Joint 7th International Conference on Informatics, Electronics & Vision (ICIEV) and 2018 2nd International Conference on Imaging, Vision & Pattern Recognition (icIVPR)*, 2018, pp. 353-356: IEEE.

[7] R. B. Devi, D. K. Reddy, E. Sravani, G. Srujan, S. Shankar, and S. Chakrabartty, "Density-based traffic signal system using Arduino Uno," in *2017 International Conference on Inventive Computing and Informatics (ICICI)*, 2017, pp. 426-429: IEEE.

[8] C. El Hatri and J. Boumhidi, "Traffic management model for vehicle re-routing and traffic light control based on Multi-Objective Particle Swarm Optimization," *Intelligent Decision Technologies,* vol. 11, no. 2, pp. 199-208, 2017.

[9] T. Seo, A. M. Bayen, T. Kusakabe, and Y. Asakura, "Traffic state estimation on highway: A comprehensive survey," *Annual reviews in control,* vol. 43, pp. 128-151, 2017.

[10] S. M. A. D. S. Biru Rajak, "An Efficient Emergency Vehicle Clearance Mechanism For Smart Cities," *Journal Of Mechanics Of Continua And Mathematical Sciences,* Vol. 14, No. 05, Pp. 78 - 97, 2019.

[11] M. Y. Shinde and M. H. Powar, "Intelligent traffic light controller using IR sensors for vehicle detection," *International Advanced Research Journal in Science, Engineering and Technology,* vol. 4, no. 2, pp. 88-90, 2017.

[12] M. A. Kumaar, G. A. Kumar, and S. Shyni, "Advanced traffic light control system using barrier gate and GSM," in *2016 International Conference on Computation of Power, Energy Information and Communication (ICCPEIC)*, 2016, pp. 291-294: IEEE.

[13] S. G. P. a. S. Madhavanavar, "Different Techniques Used in Traffic Control System: An Introduction," *International Journal of Engineering Research & Technology (IJERT),* vol. 06, no. 03, 2018.

[14] R. Keerthi and S. HariharaGopalan, "A Survey On Various Traffic Management Schemes For Traffic Clearance, Stolen Vehicle And Emergency Vehicle," *International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE),* 2016.

[15] C. Greeshma, K. Nidhindas, and P. Sreejith, "Traffic control using computer vision," 2019.

[16] Y. Udoakah and I. Okure, "Design and implementation of a density-based traffic light control with a surveillance system," *Nigerian Journal of Technology,* vol. 36, no. 4, pp. 1239-1248, 2017.

[17] L. N. Nipa, "Development of a Traffic Control System by using Microcontroller based Barricade," *Development,* vol. 2, no. 4, 2015.

[18] W.-H. Lee and C.-Y. Chiu, "Design and implementation of a smart traffic signal control system for smart city applications," *Sensors,* vol. 20, no. 2, p. 508, 2020.

[19] S. S. S. Vastava, B. Vandana, M. Bhavana, and R. Gongati, "Automatic movable road divider using Arduino UNO with Node Micro Controller Unit (MCU)," *Materials Today: Proceedings,* 2021.

[20] N. Prakash, E. Udayakumar, and N. Kumareshan, "Arduino Based traffic congestion control with automatic signal clearance for emergency vehicles and Stolen Vehicle Detection," in *2020 International Conference on Computer Communication and Informatics (ICCCI)*, 2020, pp. 1-6: IEEE.

[21] S. Agrawal and P. Maheshwari, "Controlling of Smart Movable Road Divider and Clearance Ambulance Path Using IOT Cloud," in *2021 International Conference on Computer Communication and Informatics (ICCCI)*, 2021, pp. 1-4: IEEE.