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AN ARDUINO-BASED ADAPTIVE TRAFFIC CONTROL SYSTEM

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Abstract: Traffic congestion is a prevalent problem in urban areas, often resulting in increased travel time, fuel consumption, and pollution. Traditional traffic light systems operate on fixed-time cycles, which do not account for real-time traffic conditions and lead to inefficiencies, especially during peak hours. This paper presents an adaptive traffic control system based on Arduino, designed to optimize traffic flow by dynamically adjusting the traffic signals according to real-time traffic conditions. The proposed system uses sensors to measure the density of vehicles at intersections. These sensors collect data, which is processed by an Arduino microcontroller to assess current traffic levels. Based on this analysis, the system alters the signal timing to allocate more time to heavily congested lanes and reduce the waiting time for vehicles on less crowded lanes. By implementing this adaptive approach, the system can significantly reduce congestion and enhance traffic efficiency. Furthermore, the Arduino-based design offers a low-cost, energy-efficient solution, making it suitable for deployment in cities with limited budgets.

Keywords: **Arduino uno, Breadboard, LEDs, Jumper wires.**

1. Introduction:

An Arduino-based adaptive traffic control system is a smart solution designed to optimize the flow of vehicles at intersections, reducing traffic congestion and travel time. Traditional traffic lights operate on fixed schedules that vehicle emissions. The adaptive traffic control system addresses these limitations by using sensors and an Arduino microcontroller to monitor traffic density in real time and adjust signal timings accordingly. In this system, sensors such as infrared, ultrasonic, or camera-based modules are installed at each lane of an intersection to detect the number of vehicles waiting at any given time. By prioritizing lanes with the vehicle counts, this system can dynamically allocate signal timings to ease congestion on the busiest routes, providing a smoother traffic experience. The adaptive traffic control system is energy-

efficient, cost-effective, and can be easily implemented in existing infrastructure, making it an ideal choice for urban areas facing increasing traffic demands. Additionally, the system can be customized to include emergency vehicle detection, allowing ambulances or fire trucks to get priority passage. Overall, an Arduino-based adaptive traffic control system is a practical approach to managing traffic more effectively, reducing commute times, and contributing to lower emissions by minimizing idle times at intersections.

2. Literature Review:

D. Imran Basha, S. Raghavendra, M. Naveen, and P. Kiran Kumar. It is caused by things like mistimed traffic lights and delayed signals. Traffic has no effect on the hard-coded delay of the traffic light. Consequently, a systematic, quick, automated system is becoming more and more necessary to optimize traffic control. Developing a density-based dynamic traffic signal control system is the aim of this study. When traffic at the intersection density is detected, the signal time automatically adjust [1]. Saranya J, Jayashwanth J.S, Kiran J, Harish S, & Linga Kumar T, Traffic jams have grown to be a major issue worldwide in recent years. According to current figures, the average person lives for four to six months by merely standing in traffic and waiting for the green light. Additionally, as delays grow, commuters arrive at their destination much later, which has serious daily repercussions. In general, automated traffic light control systems or manned traffic police intervention can be used to manage traffic at a number of major intersections [2]. Usikalu, M. R., Adagunodo, T. A., Okere, A., Ayanbisi, O., & Babarimisa, I. O. One of the main causes of congestion is vehicle has no bearing on the hard-coded modifications to traffic signals. Traffic control needs to be simulated and refined to better manage density-based traffic as opposed to time-based traffic. This strategy seeks to lessen the possibility of traffic jams brought on by traffic lights to a significant degree. To address this issue, a density-based traffic control system has been put into place [3]. M. Suresh Kumar, S. Sindhuja, R. Padmavathy, P. Jayabharathi, and K. Bagya Lakshmi1, the project's objective is to develop a density-based dynamic traffic signal system that can recognize changes in traffic density at any intersection and automatically modify its timing. Moving from human or set timer modes to automated systems with decision-making capabilities

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is crucial since traffic congestion is a significant problem in most cities across the world. One lane being open longer than the others could render the current time-based traffic signaling system inefficient [4].

3. Design:

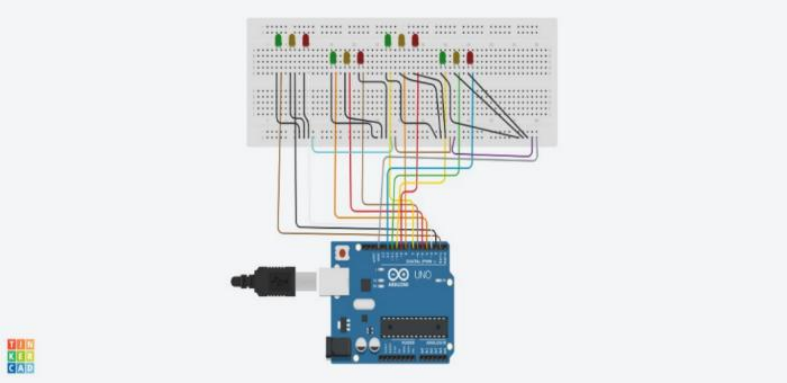

Figure1**:** Design of Arduino Based Traffic Control System

An Arduino-based adaptive traffic control system according to real-time traffic conditions. This project, designed using Arduino and simulated in Proteus software, focuses on creating a cost-effective and scalable solution for traffic management. The primary components include an Arduino microcontroller, ultrasonic sensors, LEDs (to represent traffic lights), and jumper wires. Each intersection is equipped with ultrasonic sensors placed at designated points to measure the density of traffic. The sensors continuously monitor vehicle presence and communicate the data to the Arduino, which acts as the system's central control unit. The Arduino uses this information to make decisions about the timing of traffic lights at each intersection. When traffic density increases on a particular lane, the Arduino extends the green light duration for that lane to allow more vehicles to pass. If the traffic is minimal, the system reduces the green light time to allocate more time to other lanes. This adaptive approach ensures smoother traffic flow, reducing congestion and waiting time for drivers. Proteus software is used to simulate the circuit and visualize the system’s performance without needing physical components. In Proteus, ultrasonic sensors are simulated using virtual buttons or potentiometers

to emulate traffic density changes. LEDs simulate traffic lights, showing changes in signal timing as per the Arduino's program.

4. Algorithm:

Define arrays `Lane1`, `Lane2`, `Lane3`, `Lane4` for Red, Yellow, and Green LEDs with their respective pin numbers. For each lane and each LED (Red, Yellow, Green). Set the pin as an output using `pin Mode'. Turn all LEDs off using `digital write`. Green for Lane 1, Red for Lanes 2, 3, and 4. Turn on Green LED for Lane 1 and Red LEDs for Lanes 2, 3, and 4. Wait for 7 seconds (`delay`). Yellow for Lane 1: Turn off Green LED for Lane 1 and turn on Yellow LED for Lane 1. Wait for 3 seconds. Red for Lane 1, Green for Lane 3:Turn off Yellow LED for Lane 1.Turn on Red LED for Lane 1 and Green LED for Lane 3.Wait for 7 seconds. Yellow for Lane 3: Turn off Green LED for Lane 3 and turn on Yellow LED for Lane 3. Wait for 3 seconds. Red for Lane 3, Green for Lane 4. Turn off Yellow LED for Lane 3. Turn on Red LED for Lane 3 and Green LED for Lane 4. Wait for 7 seconds. Yellow for Lane 4: Turn off Green LED for Lane 4 and turn on Yellow LED for Lane 4. Wait for 3 seconds for Lane 4, Green for Lane 2: Turn off Yellow LED for Lane 4. Turn on Red LED for Lane 4 and Green LED for Lane 2. Wait for 7 seconds. Yellow for Lane 2:Turn off Green LED for Lane 2 and turn on Yellow LED for Lane 2.Wait for 3 seconds. Red for Lane 2, Green for Lane 1:Turn off Yellow LED for Lane 2.Turn on Red LED for Lane 2 and Green LED for Lane 1.Wait for 7 seconds. Loop back to Step 1 and repeat the sequence indefinitely.

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5. Result Analysis:

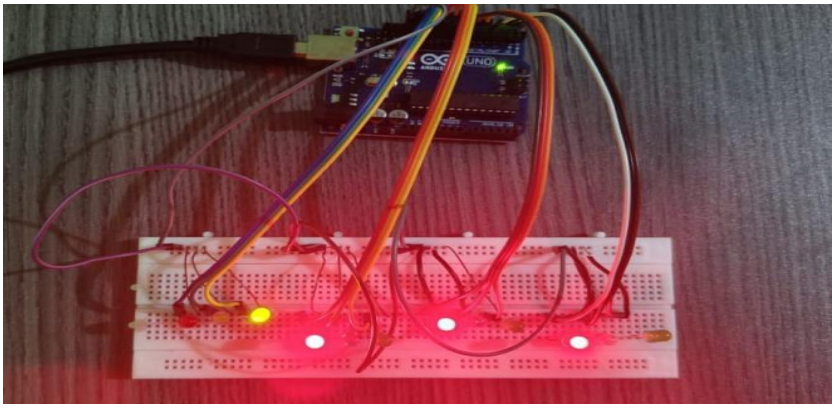

Figure 2: Result Analysis of Arduino Based Traffic Control System

The Arduino-Based Adaptive Traffic Control System, which was developed using an Arduino UNO, a breadboard, LEDs, and male-to-male jumper cables, demonstrates an effective technique for dynamic traffic control. By altering traffic signal cycles in response to real-time vehicle recognition. In this setup, the Arduino UNO serves as the primary controller, processing information from ultrasonic sensors placed at strategic locations to detect the presence of cars. A flexible and reusable circuit design is ensured by the breadboard, which acts as a foundation for connecting various components. The traffic lights that are red, yellow, and green, which stand to the various traffic control statuses for the two primary directions of East-West and North-South, are simulated by the LEDs. All things considered, the system's output demonstrates an effective traffic control mechanism that enhances traffic flow and reduces wait times. This project shows how an inexpensive and scalable solution can be created for real-world traffic control issues utilizing basic components like the Arduino UNO, LEDs, and jumper wires. Additional enhancements may involve expanding to multi-intersection control, incorporating additional sensors, or introducing wireless connection.

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6. Conclusion:

The Arduino-based adaptive traffic control system is an innovative and efficient solution to address increasing urban traffic challenges. By using real-time data from sensors to adjust traffic signal timings, this system can significantly reduce congestion, lower vehicle waits times, and optimize traffic flow. The Arduino microcontroller, acting as the central processor, enables flexible and precise control over traffic signals based on actual road conditions. One of the primary advantages of this system is its cost-effectiveness. Arduino and basic sensors like ultrasonic or infrared are affordable and accessible, making this solution feasible for deployment in smaller cities or regions with limited budgets. This reduces the risk of errors, cuts development costs, and speeds up the implementation process. Overall, the Arduino-based adaptive traffic control system showcases how technology can be leveraged to create smarter cities. By reducing traffic delays and improving road efficiency, it has the potential to reduce fuel consumption and environmental pollution while enhancing commuter satisfaction. This project demonstrates that even simple, affordable technologies can make a meaningful impact on modern urban issues, providing a promising solution for sustainable traffic management.

7. References:

1. M.B Jensen, M.P.Phillpsen A. Magelmose, T.B.Moestund, “Vision for looking at traffic lights Issues, and perspectives,”IEEE Transactions on Intelligent Transportation system.

2. Kaushik Mandal, Arindam Sem, Abhijnan Chakraborty and siuli Roy “Road traffic Congestion Monioring & measurment using RFID & GSM Technology”.

3. Manoj Kante Mainali & Shings Mabu [2010]”Evolution Approach for the Traffic Volume Extimation of road section”,

4. Rotake, Dinesh & Karmore, Swapnil [2012] .inteligent Traffic Siganl Control System Using Embedded System.

5. Saiba P A, Afeefa M U, Aruna T S, Clincy Jose, & Radhika V M. “Density Based Traffic Signal System using PIC Microcontroller”. International Journal of Computer Trends and Technology (IJCTT). ISSN: 2231-2803,2017.

6 . Sakshi Pandey, Mittal Jethva, Sailee Jangam, & Yash Panwar. “Density based Traffic Control System”. International Journal for Scientific Research & Development (IJSRD),2017.

7. Ghazal, B., ElKhatib, K., Chahine, K., & Kherfan, M.. “Smart traffic light control system”. Third International Conference on Electrical, Electronics, Computer Engineering and Their Applications (EECEA),2016.

8. K. Vidhya, & A. Bazila Banu . “Density Based Traffic Signal System”. International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET). ISSN: 2319 – 8753,2014.

9. D. D. Pukale1, Palak Chauhan, Adhikari Siddhi Satish, Preeti Nawal, & Neha Kumari. “Density Based Traffic Control System Using Video Processing”. Imperial Journal of Interdisciplinary Research (IJIR). Vol-2. Issue-6, 2012..