International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 14 Issue 4, April-2025

Dynamic IoT - Enabled Road Divider for Smart Traffic Management

Venu Babu Inala[1], Reshmi Pindi[2], Naga Sai Preethi Dokku[3], Yaswanth Kumar Chikati[4], Naga Venkata Satyanarayana Bochhula[5]

[1,2,3,4,5] Department of IoT, SR Gudlavalleru Engineering College Gudlavalleru, India

ABSTRACT

Using Arduino Uno and IoT sensors, the Dynamic IoT-Enabled Road Divider is an intelligent traffic management system that optimizes lane distribution in real-time. Road dividers are dynamically adjusted to alleviate congestion by monitoring vehicle density and environmental factors. Remote monitoring is made possible by Thing Speak cloud for data privacy and real-time responsiveness. In order to detect vehicles, the system uses ultrasonic and infrared sensors. Low-latency decision-making is ensured by edge processing on Arduino. For the best flow Management, AI-driven object detection improves traffic analysis. Future developments will include deeper cloud integration, AI-driven traffic prediction, and scalability for urban deployment. Adaptability will be further enhanced by improved communication with autonomous vehicles and traffic lights, making it an essential part of smart city infrastructure.

Index Terms— Arduino Uno, IoT, Real-Time Monitoring, Smart traffic, Thing Speak Cloud.

INTRODUCTION

Through real-time lane adjustments, the Dynamic IoT-Enabled Road Divider for Smart Traffic Management is an inventive way to improve road safety and optimize traffic flow. The system prioritizes emergency vehicles and dynamically reallocates lanes based on traffic density by combining motorized dividers, RFID technology, IR sensors, and Arduino Uno. This solves the drawbacks of static road dividers, which cause congestion and inefficiencies because they are unable to adjust to shifting traffic-conditions. Through the ESP8266 module, the system makes use of IoT connectivity to allow for remote monitoring and control via the Thing Speak Cloud. In the event of an accident or the detection of an unauthorized vehicle, traffic authorities can react quickly, make well-informed decisions, and access real-time traffic data. By integrating RFID technology, emergency vehicles are given priority right away.

In addition to traffic control, the system uses DHT11 temperature and humidity sensors and gas sensors for environmental monitoring. By monitoring weather and air quality, the project helps with sustainability initiatives by cutting emissions and fuel waste. Smart city initiatives are further supported by data logging and analytics, which offer insightful information for infrastructure development and urban-planning. By dynamically reacting to conditions in real time, this scalable and flexible traffic management system is intended to enhance urban mobility. It provides authorities with useful information while improving environmental sustainability, emergency response, and traffic efficiency. The project provides a data-driven, futuristic solution to today's traffic problems by combining automation, cloud computing, and the Internet of Things. This system's scalability and adaptability to various urban environments are two of its main advantages. The dynamic road divider can be tailored to meet particular traffic demands, whether it is used in large metropolitan cities with high traffic volumes or in smaller towns that are urbanizing quickly. The technology continuously analyses traffic patterns in real time, producing insightful data that can help transportation authorities and city planners make well-informed decisions regarding urban mobility planning and infrastructure-development.

All things considered, this project integrates cloud computing, automation, and the Internet of Things to offer a revolutionary approach to traffic management. Through clever monitoring and optimization, it not only increases road safety and traffic efficiency but also promotes environmental sustainability. By giving emergency vehicles priority access, easing traffic, and providing traffic police with real-time Monitoring of Vehicle count, Lane adjustments and user interface to monitor smart traffic systems.

LITERATURE ANALYSIS

An Arduino-based IoT-enabled dynamic road divider system enhances real-time traffic management through automation and cloud computing. [1]. Intelligent Road Divider That Can Be Moved Lane distribution is dynamically changed by an IoT system in response to traffic flow in real time. [2]. Road Divider That Can Be Moved Real-time traffic density measurements are used by an IoT-based system to modify lanes. It updates traffic data to the cloud for remote monitoring by using RFID and infrared sensors to identify traffic jams and emergency vehicles. [3]. IoT Cloud-Based Smart Mobile Road Divider and Clearance Ambulance Path Control An IoT system driven by deep learning that detects traffic and ambulances using RFID and camera vision. In order to maximize traffic lanes and give priority to emergency vehicles, it dynamically moves the road divider. [4]. System for Dynamic Lane Management IoT-based traffic optimization uses motorized dividers, ESP8266 wireless transmission, and ultrasonic sensors to dynamically change lanes. To help authorities make data-driven decisions, real-time traffic data is uploaded to the cloud. [5]. An Adaptive Traffic Management System Based on IoT Using servo motors, RFID, infrared sensors, and smart dividers, the system reallocates lanes to prioritize emergency vehicles and identify traffic density. Remote monitoring and improved emergency access during peak hours are made possible by cloud integration. [6]. An Internet of Things-based dynamic road traffic management system dynamically modifies lanes based on real-time traffic density measurements. With the aid of data analysis tools and cloud connectivity, it can identify patterns in traffic, and visual cues help drivers change lanes [7]. IoT and Infrared-Based Dynamic Traffic Management System This system monitors traffic density and dynamically modifies road lanes using infrared sensors and cloud-based analytics. It uses machine learning models to forecast traffic patterns, allowing for better decision-making and more efficient traffic flow. [8] IoT-Based Intelligent Traffic Signaling System driven by the Internet of Things that automatically modifies traffic signals in response to the current traffic density. In order to improve urban traffic efficiency and sustainability, it incorporates environmental sensors for air quality monitoring and cloud-based data transmission.

METHODOLOGY

In order to maximize traffic flow in real time, the Dynamic IoT-Enabled Road Divider for Smart Traffic Management combines cutting-edge hardware and software. To ensure effective lane allocation and road safety, the system makes use of an Arduino Uno microcontroller, IR sensors, RFID modules, motorized dividers, the ESP8266 Wi-Fi module, and environmental sensors. While RFID modules prioritize emergency vehicles and initiate dynamic lane adjustments, infrared sensors measure vehicle density. Based on real-time data, motorized dividers that are managed by the Arduino reallocate lanes. Neo-Pixel LEDs and LCD screens reduce confusion during transitions by giving drivers visual direction. The Arduino IDE is used to program the system, guaranteeing smooth communication between sensor inputs and actuator outputs.

By using the ESP8266 module to transmit traffic data, ThingSpeak Cloud integration allows for remote monitoring and data analytics. To reduce congestion, authorities can remotely operate dividers and access real-time traffic insights. System integrity is safeguarded by security measures like cloud-based logging and RF communication protocols. By supporting weather and air quality monitoring, environmental sensors help to advance sustainability. The system provides a scalable and intelligent traffic management solution by utilizing IoT, cloud computing, and automation to optimize urban mobility, alleviate traffic, and support smart city initiatives.

COMPONENTS

A. Arduino Uno

The Arduino Uno, a popular microcontroller board with a wide range of uses from embedded systems to prototyping, is a significant advancement in the Arduino series. The ATmega328P microcontroller, an 8-bit AVR processor running at 16 MHz, is the brains behind the Arduino Uno. It offers dependable performance for a variety of embedded computing tasks. For data storage, the board has 1KB of EEPROM, 32KB of Flash memory, and 2KB of SRAM. It has six analog input pins and fourteen digital input/output pins, six of which support PWM output, enabling flexible interface with sensors and actuators. This facilitates smooth integration with a variety of peripherals by supporting UART, SPI, and I2C communication protocols.

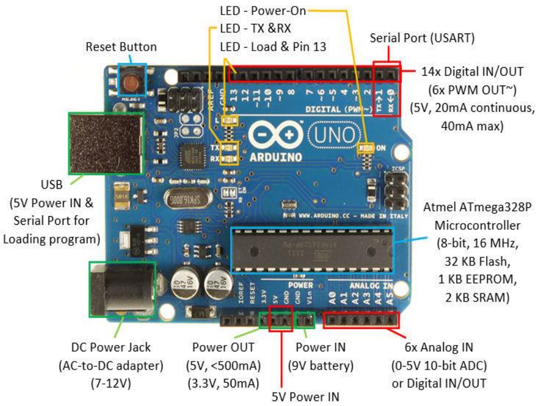

Fig. 1. Arduino Uno

It has a USB Type-B port for connectivity and programming, and users can connect to a computer serially and upload code using the Arduino IDE. As seen in Figure 1, the Arduino Uno has an integrated voltage regulator that supports inputs ranging from 7V to 12V for steady power delivery. It has onboard LED indicators for debugging and a reset button for simple program restarts. A detachable microcontroller allows for simple upgrades or replacement in certain models.

B. Neo-pixel LEDs

Lane reallocation is visually indicated by neo-pixel LEDs, as seen in Fig. 4. These LEDs warn drivers of changing lanes and emergency vehicle prioritization by changing color in response to lane changes. High visibility is ensured by their dynamic and bright illumination, which lessens confusion when changing lanes.

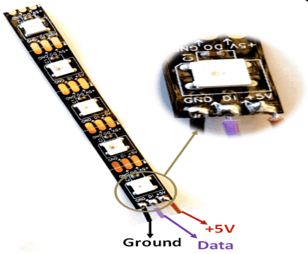

Fig. 2. Neo-pixel LEDs

ACCOMPLISHMENT

A. Block Diagram

With an Arduino Uno serving as the primary controller, the block diagram depicts an intelligent traffic management system. Sensors and other parts driven by a steady power source are used by the system to collect traffic data in real time.

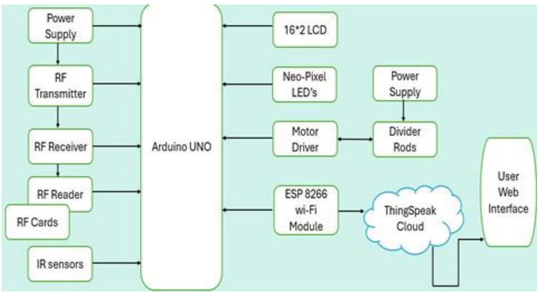

Fig. 3. block diagram.

While emergency vehicles are identified by an RFID reader and RFID cards, IR sensors measure the density of vehicles, enabling the divider to be adjusted appropriately. Wireless communication is made possible by RF transmitters and receivers, which guarantee efficient system functioning. An LCD screen shows traffic information, and LED indicators show lane changes visually. For dynamic lane changes, divider rod movement is managed by a motor driver. The system is connected to the cloud via the Wi-Fi module, which transmits data to ThingSpeak for remote monitoring. Traffic authorities can analyze traffic, get real-time insights, and effectively optimize road usage through a web interface.

B. Experimental setup of the proposed system

The Dynamic IoT-enabled road divider's hardware implementation for smart traffic control. An Arduino Uno serves as the setup's main controller, interacting with a number of sensors and actuators to dynamically control traffic lanes. The divider rod is moved by a motor-driven gear mechanism in response to real-time traffic data gathered by infrared sensors that measure the number of vehicles on either side. By modifying the divider position, an RFID reader verifies emergency vehicles and guarantees priority access. A Wi-Fi module allows cloud connectivity through Thing Speak for remote monitoring, and the system also has an LCD display for real-time status updates. Additional environmental sensors, such as a DHT11 temperature and humidity sensor, help collect data for the best possible urban traffic management, while neo-pixel LEDs offer indications to drivers. The interdependent parts cooperate to guarantee enhanced road efficiency and real-time traffic optimization.

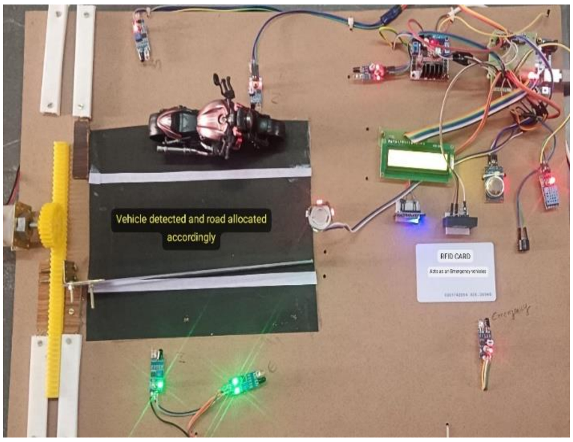

Fig. 4. Experimental setup of the proposed system

C. Software

For real-time monitoring and lane allocation for vehicles and emergency vehicles, the Dynamic IoT-Enabled Road Divider System makes use of Arduino IDE Software and Thing Speak cloud, The Arduino loop () function is used to run the entire system continuously, guaranteeing real-time responsiveness to shifting traffic patterns. The accuracy of sensor data, actuator responsiveness, and cloud communication are all verified through extensive testing and optimization processes. Algorithms for making decisions are improved to guarantee smooth urban mobility, reduce congestion, and improve traffic flow efficiency. This integrated approach is a scalable and efficient solution for contemporary traffic management since it integrates automation, IoT connectivity, and human supervision. By combining real-time sensor data, microcontroller processing, cloud-based monitoring, and automated actuator control, the dynamic IoT-enabled road divider system is intended to maximize traffic flow. To ensure precise traffic assessment, infrared sensors continuously measure the number of vehicles on either side of the divider. While environmental sensors, such as gas and DHT11, monitor temperature and air quality, RFID modules authenticate emergency vehicles and grant priority access when necessary. In order to dynamically modify lane allocations based on current traffic conditions, the Arduino Uno microcontroller, which is programmed in Arduino C/C++, processes the gathered data and runs decision-making tools. Motor drivers move the physical divider rod to effectively re-distribute lanes when congestion is detected on one side. While a 16x2 LCD display provides real-time traffic density, lane reallocation updates, and environmental parameters, Neo-Pixel LEDs act as visual indicators, alerting drivers about lane changes. Using an ESP8266 Wi-Fi module, the system connects to the cloud and uploads environmental and traffic data to the Thing Speak Cloud for analytics and visualization. Authorized staff can manually override lane changes when needed and remotely monitor traffic conditions via a web-based interface.

FLOW CHART

The Dynamic IoT-Enabled Road Divider for Smart Traffic Management combines automated decision-making, microcontroller processing, and sensor data collection in a methodical manner as mentioned in Fig 11. In order to track vehicle density, emergency vehicle authentication, and environmental conditions, the system first collects real-time data from IR sensors, RFID modules, and environmental sensors.

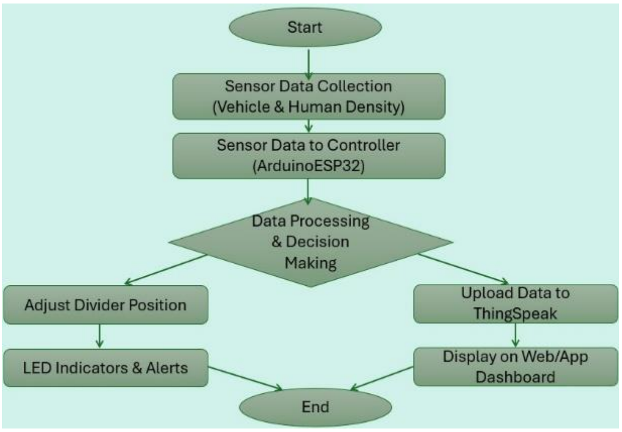

Fig. 5. flow chart

The Arduino/ESP32 microcontroller receives the gathered data, processes it, and decides if lane reallocation is required. The motor driver modifies the road divider to maximize lane distribution if traffic congestion is detected.

Real-time traffic updates are shown on a 16x2 LCD display, and Neo-Pixel LEDs provide visual alerts to ensure safety. Additionally, the system uploads data to Thing Speak Cloud via an ESP8266 Wi-Fi module, allowing traffic authorities to monitor and analyze data remotely.

FINAL RESULTS

A. Automated Traffic Management system

In order to dynamically modify road dividers, the Fig 12, Automated Traffic Management system uses motor drivers and infrared sensors to measure vehicle density.Neo-Pixel LEDs serve as visual alerts for smart indicators,

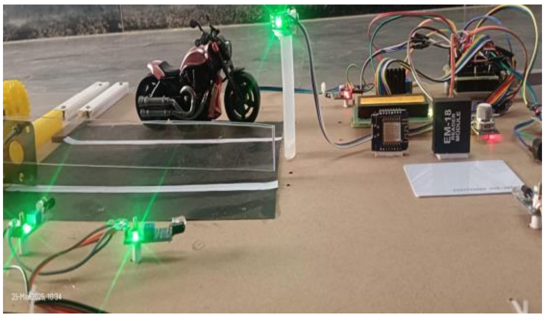

Fig. 6. ***automated traffic management system***

while a 16x2 LCD display provides real-time traffic data. By raising driver awareness, these features increase road safety and efficiency. This guarantees the best possible lane distribution, which lowers traffic and enhances real-time traffic-flow.

B. Real-Time Monitoring

The ESP8266 Wi-Fi module provides real-time monitoring by uploading environmental and traffic data to the Thing Speak Cloud observe in Fig 13. This makes it possible for traffic authorities to monitor and manage traffic remotely through a web-based dashboard. The system has environmental sensing capabilities that use DHT11 and gas sensors to track temperature and air quality. The solution is more sustainable thanks to this data, which aids in evaluating pollution levels and the overall impact on the environment.

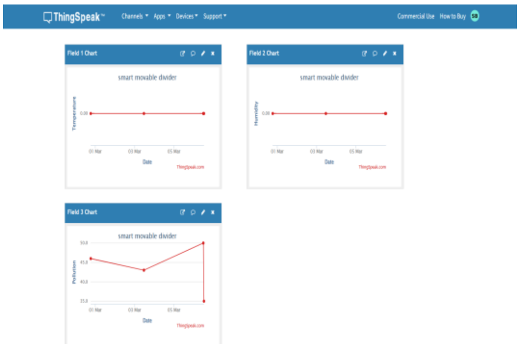

Fig. 7. real-time temperature, humidity and air pollution monitoring

CONCLUSION

Using IoT sensors and the Thing Speak cloud, the Dynamic IoT-Enabled Road Divider optimizes traffic flow by modifying lane allocation based on real-time vehicle density. This system guarantees cost-effective, data-driven traffic management while improving road safety and reducing congestion. Because it dynamically allocates lanes for efficient travel, it is especially helpful in urban areas, highways, toll booths, and emergency routes. Although the system is energy-efficient and scalable, it requires consistent internet connectivity, has a high initial setup cost, and requires frequent maintenance. Challenges also include system failures and public adaptability. Notwithstanding these drawbacks, it has the potential to revolutionize smart city design by guaranteeing better emergency response and lane utilization. This innovation has the potential to revolutionize urban mobility by incorporating AI-based traffic prediction, which will make roads safer, smarter, and more efficient.

DECLARATION

We would like to express our gratitude to all of the individuals who participated for their insightful suggestions, rapid support and help, all of which enabled us to finish the project on schedule. We would like to express our sincere gratitude to Mr. I. Venu Babu Assistant Professor for his crucial assistance, encouragement, and direction as well as his insightful criticism during the project's growth. Last but not least, we want to express our gratitude to each and every group member for their unwavering support in completing our project.

REFERENCES

[1] S. Agrawal and P. Maheshwari, "Controlling of Smart Movable Road Divider and Clearance Ambulance Path Using IOT Cloud", 2021 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, January 27-29 2021, Doi: 10.1109/ICCCI50826.2021.9402497..

[2] Martina Benini, Silvia Gallucci, Marta Bonato, Marta Parazzini, And Gabriella Tognola, "Evaluation of Road User Radio-Frequency Exposure Levels in an Urban Environment From Vehicular Antennas and the Infrastructure in ITS-G 55.9GHz Communication" IEEE Access, Volume 12,2024, date of current version 16 April 2024, Digital Object Identifier: 10.1109/ACCESS.2024.3385664.

[3] B. D. Sri, K. Nirosha and S. Gouse, "Design and implementation of smart movable road divider using IOT," 2017 International Conference on Intelligent Sustainable Systems (ICISS), Palladam, India, 2017, pp. 1145-1148, Doi : 10.1109/ISS1.2017.8389364

[4] R. S. Shinde and A. S. Pande, "IoT-Based Intelligent Traffic Management System for Smart Cities," 2020 International Conference on IoT in Social, Mobile, Analytics, and Cloud (ISMAC), 2020, pp. 214-219, DOI: 10.1109/ISMAC49090.2020.9243316.

[5] M. Kumar and S. Sharma, "Adaptive Traffic Signal Management System Using IoT and AI," 2021 International Journal of Advanced Research in Computer Science, DOI: 10.5120/ijarcce20211678.

[6] Gupta and K. Verma, "Design of a Smart City Traffic Management System Using IoT and Edge Computing," 2022 IEEE Transactions on Industrial Electronics, DOI: 10.1109/TIE.2022.3122564.

[7] S. Pradhan and A. Tiwari, "Real-Time Traffic Flow Analysis Using IoT and Deep Learning," 2020 International Journal of Intelligent Transportation Systems, DOI: 10.1109/IJITS202033214.

[8] P. N. Rao and L. R. Devi, "IoT-Based Traffic Density Estimation for Smart Road Infrastructure," IEEE Access, 2021, DOI: 10.1109/ACCESS.2021.3051208.

[9] C. Zhang and B. Li, "5G-Enabled IoT for Intelligent Road Traffic Management," IEEE Transactions on Vehicular Technology, 2021, DOI: 10.1109/TVT.2021.3131205.

[10] N. Ahmed and F. Hossain, "AI-Powered IoT-Based Adaptive Traffic Management System," 2022 International Journal of Transportation Science and Technology, DOI: 10.1016/j.ijtst.2022.06.014.