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Intellisense Toll Management System: Automatic Vehicle Number Plate Recognition for Identity Based Transactions

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ABSTRACT: Toll collection booths represent some of the busiest spots across India, where vehicles consume significant amounts of fuel and travellers endure prolonged waiting times as they queue up behind others to pay tolls. This often results in traffic congestion and a notable loss of productivity. The proposed project Automatic Vehicle Number Plate Recognition for Identity Based Transactions, harnesses cutting-edge technologies like microcontrollers, sensors, and advanced image processing algorithms. This innovative system is designed to seamlessly recognize license plate numbers and streamline the toll collection process by recognizing the vehicle's owner and sending the Toll bill to his/her email id. By automating these tasks, the ANPR system effectively alleviates traffic congestion and enhances the efficiency of toll collection operations. With its capacity for scalability and expansion, this system holds immense potential for widespread adoption and further development.

KEYWORDS: ANPR, Toll collection, Google drive API, OpenCV, tesseract-OCR Node-mcu, esp32 cam, ultrasonic sensor.

I.INTRODUCTION

The length of national highways under toll across India amounted to nearly 30 thousand kilometres in financial year 2020. In an era marked by technological advancements, the optimization of transportation systems has become a crucial Endeavor. One key aspect of this optimization is the efficient collection of tolls on highways and expressways. Traditional toll collection methods often lead to traffic congestion and delays, which can result in decreased productivity and increased fuel consumption. FASTag has helped save 70,000 crore ($8.4 billion) in wasted fuel expenses in India, according to Road Transport and Highways Minister Nitin Gadkari. What if this system too can be optimized further by reducing the waiting time such that vehicles are allowed to move without stopping at the toll plazas. To address these challenges, this paper proposes a system that aims to introduce a solution that leverages image processing techniques to streamline the toll collection process. At the heart of this project is the implementation of License Plate Recognition (LPR) systems. These systems utilize sophisticated image processing algorithms to accurately detect and identify vehicle license plates as they approach toll booths. The project provides a reliable means to automate the collection of tolls, minimizing human intervention and reducing the potential for errors in the process. Moreover, the project will employ smart toll collection methods, ensuring a seamless experience for commuters. This project initiative not only promises to alleviate traffic congestion but reduces the fuel consumption too. The Automatic Number Plate Recognition (ANPR) system represents a pioneering solution in the realm of intelligent transportation systems, aiming to revolutionize the management of vehicular traffic and toll collection processes. In today's increasingly congested roadways, the need for efficient and accurate methods of identifying vehicles and processing their information has become paramount. The ANPR system, leveraging advanced technologies such as microcontrollers, sensors, and image processing algorithms, seeks to address this need by automating the identification and processing of license plate information with unparalleled efficiency and accuracy.

At the heart of the ANPR system lies the NodeMCU microcontroller, serving as the central processing unit orchestrating communication between various components. This includes an ultrasonic sensor tasked with detecting approaching vehicles and triggering image capture by the ESP32 camera module. The captured images of vehicle license plates are sent to a data processing server which is then subjected to rigorous image processing using OpenCV and Optical Character Recognition (OCR) algorithms from Tesseract OCR. Through this process, license plate numbers are accurately extracted from the captured images. The data collected by the ANPR system, comprising license plate

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numbers and relevant vehicle information, is used to identify the vehicle owners email address to which the generated toll bill is sent. This centralized approach to data management facilitates efficient analysis and utilization of the captured information, empowering authorities with valuable insights for traffic management, toll collection, and vehicle tracking purposes.

II. SYSTEM MODEL AND ASSUMPTIONS

This paper presents an innovative approach to automate toll collection processes utilizing advanced technologies including ESP32-CAM, Ultrasonic sensor, NodeMCU, OpenCV, Pytesseract, and Google Drive API. The proposed system aims to enhance efficiency, accuracy, and transparency in toll gate operations by automating vehicle detection, number plate recognition, and billing processes. The system integrates real-time image acquisition, cloud storage, server-side image processing, and OCR techniques to achieve seamless toll collection. Experimental results demonstrate the effectiveness of the proposed solution in improving toll gate operations, reducing manual. Toll collection at transportation facilities is a critical aspect of modern infrastructure management. Traditional toll collection methods often involve manual processes, leading to inefficiencies, errors, and delays. To address these challenges, this paper proposes an automated toll collection system leveraging cutting-edge technologies to streamline toll gate operations.

System Architecture:

The proposed system comprises several key components:

ESP32-CAM: Responsible for capturing real-time images of approaching vehicles.

Ultrasonic sensor and NodeMCU: Detects vehicle presence and triggers image capture.

Google Drive API: Facilitates seamless upload of captured images to a designated Google Drive folder for centralized storage.

Server environment equipped with OpenCV and Pytesseract: Performs image processing and optical character recognition (OCR) for number plate recognition.

Billing system: Generates toll bills based on extracted number plate information and predefined criteria.

Implementation:

Vehicle Detection & Imaging: The Ultrasonic sensor integrated with NodeMCU detects approaching vehicles and signals the ESP32-CAM to capture images in real-time.

Cloud Integration: Captured images are uploaded to a designated Google Drive folder using the Google Drive API, ensuring centralized storage and easy access to data.

Server-Side Operations: The server environment equipped with OpenCV and Pytesseract processes captured images, performs contour detection algorithms to isolate number plates, and utilizes Pytesseract OCR for accurate extraction of number plate information.

Billing System: Integrated functionalities for generating toll bills with date timestamps and calculated amounts based on predefined criteria ensure accurate toll collection.

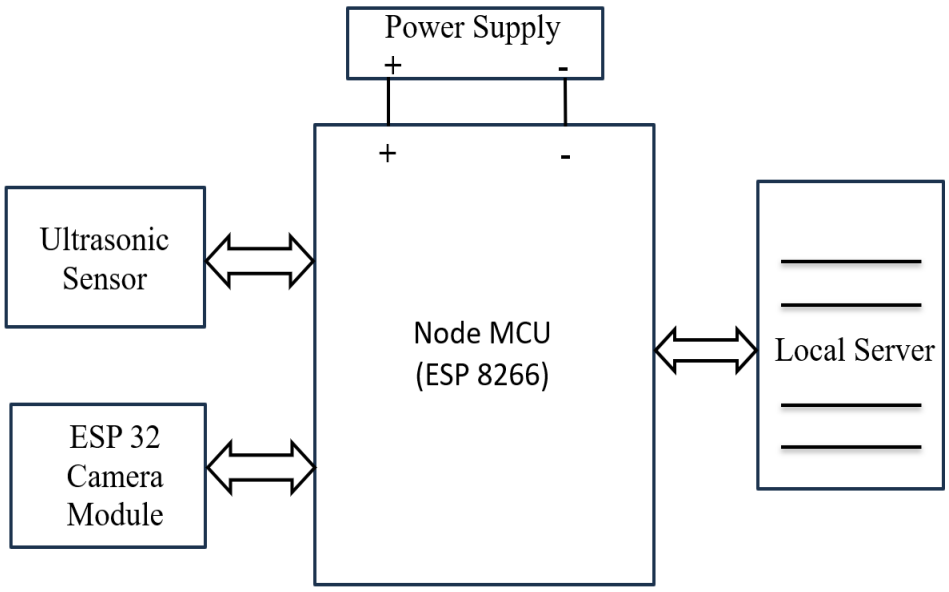

Fig. 1 System Model

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III.METHODOLOGY

The suggested approach for recognizing number plate using automatic number plate recognition and toll collection includes the following components:

System Components and Technologies: The ANPR project utilizes a combination of hardware and software components to achieve its objectives. The hardware components include the NodeMCU microcontroller, ultrasonic sensor (HC-SR04), and ESP32 camera module. Software tools such as Arduino IDE for programming the microcontroller, OpenCV for image processing, and Tesseract OCR for optical character recognition are employed. These components and technologies are carefully selected to ensure compatibility, functionality, and performance in the ANPR system.

ANPR System Architecture: The ANPR system is designed to automate the process of identifying and processing license plate information from vehicles. The system architecture encompasses the flow of data and interactions between the hardware components, image processing algorithms, and data transmission mechanisms. This architecture is conceptualized to optimize efficiency, accuracy, and reliability in license plate recognition and data processing.

Data Collection and Preprocessing: The first step in the methodology involves collecting a dataset of images containing vehicle license plates. These images are captured by the ESP32 camera module upon detection of approaching vehicles by the ultrasonic sensor. The captured images are sent to a server in which the image undergoes preprocessing techniques, including noise reduction, image enhancement, and resolution adjustment, to prepare them for further analysis.

Image Processing and License Plate Recognition: The preprocessed images are subjected to image processing algorithms implemented using OpenCV. These algorithms extract license plate regions from the images and enhance the clarity of the text characters. Subsequently, optical character recognition (OCR) techniques from Tesseract OCR are applied to accurately identify and extract the license plate numbers from the images.

Data storage: Once the license plat numbers are extracted. The server stores the captured license text in a database.

Toll Bill generation: The extracted text from the number plate is used to identify the owner and their email address to which the bill amount of the toll along with UPI QR code (to which the payment is to be made) is sent

The user can view and download the bill pdf and pay the bill at his comfort within the specified period of time. The users can make use of QR code to pay the bill seamlessly through UPI.

Integration with External Systems: In the final phase of the methodology, the ANPR system is integrated with external systems or platforms to enhance its functionality and interoperability. This integration may involve connecting the ANPR system with existing traffic management infrastructure, law enforcement databases, or smart city initiatives to leverage additional data sources and enhance overall system capabilities.

IV.SURVEY DESCRIPTION

Jin Yeong Tan, Pin Jern Ker, Dineis Mani, and Puvanesan Arumugam's "GPS-based highway toll collection system: Novel design and operation" developed a GPS-based highway toll collection system using Raspberry Pi 2 as the microcontroller. The system utilized GPS coordinates to track vehicles and incurring toll fees at specific points. Additional electronic modules included a GPS module, LCD module, speaker, wireless Wi-Fi router modem, and wireless Wi-Fi adapter. The system aimed to provide motorists with a smooth travel experience and eliminate the need for expensive toll booths. The authors also implemented an automatic delay time adjustment system to reduce power consumption without compromising accuracy. Furthermore, the system featured internet and GPS connection availability detection to enhance reliability. SQL databases were established to store toll destination information and user travel history , . The authors highlighted the importance of a structured approach to developing a GPS-based toll collection system, emphasizing the ease of commercialization with a microcontroller featuring 3G and GPS connectivity .In terms of system configuration, Raspberry Pi 2 was chosen as the microcontroller due to its processing speed and communication capabilities. The system ran on Raspbian OS, which was optimized for Raspberry Pi hardware. The authors flashed the Raspbian image into a 32 GB micro-SD card for system operation. Overall, the developed GPS-based highway toll collection system aimed to streamline toll fee payment processes, enhance travel efficiency, and reduce congestion on highways.

Shridevi Soma's "an intelligent toll-gate system for toll collection based on distance and pollution control using internet of things" presents an innovative Intelligent Toll-Gate System designed to revolutionize toll collection processes by incorporating advanced technologies such as RFID and Internet of Things (IoT). This system aims to tackle two major

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challenges faced at toll highways: congestion and pollution. By automating toll collection through RFID tags and prepaid accounts linked to vehicles, the system streamlines the payment process and reduces waiting times at toll booths. Furthermore, the integration of GPS technology enables the calculation of toll fees based on the distance traveled by each vehicle, ensuring a fair and accurate billing system. In addition to toll collection, the system also focuses on pollution control by implementing wireless sensor networks for monitoring vehicle emissions. A smoke sensor installed in vehicles detects harmful emissions, and the data is transmitted to a central monitoring station at the toll booth. If emission levels exceed predefined thresholds, alerts are sent to vehicle owners via GSM technology, prompting them to take necessary actions to reduce emissions. This proactive approach not only promotes environmental sustainability but also holds vehicle owners accountable for their emissions, thereby encouraging compliance with emission regulations.

Dr. Rajeev Kumar Chauhan and Dr. Kalpana Chauhan's "Intelligent Toll Collection System for Moving Vehicles in India" discusses the development of an Intelligent Toll Collection System for Moving Vehicles in India by Dr. Rajeev Kumar Chauhan and Dr. Kalpana Chauhan. The system aims to automate toll collection processes at toll plazas by utilizing automatic license plate recognition (ALPR) technology. This approach involves capturing images of moving vehicles, extracting license plate information, and recognizing the license plates. The use of LABVIEW software, along with morphological filters and optical character readers, enables efficient processing of captured images for accurate license plate identification. The proposed system architecture includes components such as a vehicle detector, camera, MyRIO hardware module, computer, and vehicle barrier system. By integrating ALPR technology with LABVIEW and MyRIO, the system can automatically identify vehicles, process transactions, and enforce toll collection regulations. The implementation of morphological filters and optical character readers enhances the system's ability to extract license plate information in real-time, contributing to faster and more accurate toll collection processes. Furthermore, the system incorporates a database created using Microsoft SQL Server Management Studio to store and manage information related to vehicle owners, their unique identification numbers, mobile numbers, and linked bank account balances. This database integration allows for testing the performance of the toll collection system with a comprehensive dataset of vehicles. The results demonstrate a significant reduction in vehicle waiting times, queue lengths, fuel wastage, and pollution emissions at toll plazas, highlighting the system's effectiveness in improving overall operational efficiency.

Sheenam Naaz, Suraiya Parveen, and Jawed Ahmed's "An Artificial Intelligence Based Toll Collection System" presents a comprehensive overview of an innovative toll collection system that leverages artificial intelligence (AI) technology to enhance efficiency and reduce congestion at toll gates. The system incorporates radio frequency identification (RFID) technology to automate the toll collection process, addressing the challenges faced by traditional manual ticketing systems. By utilizing RFID tags that store vehicle and account details electronically, the system enables seamless transmission of data to the main office in real-time, eliminating the need for vehicles to stop at toll gates and significantly reducing manpower requirements. Furthermore, the paper highlights the advantages of RFID tags over traditional paper-based ticketing systems, emphasizing their reusability and convenience. The implementation of an AI-based toll collection system not only streamlines the toll payment process for users but also contributes to a more efficient and organized toll management system. The integration of an infrared scanner at toll stations ensures accurate validation of incoming and outgoing vehicles, while the RFID scanner facilitates data retrieval from vehicle tags for toll processing. This approach creates a rapid and reliable ecosystem for automated toll collection, enhancing the overall user experience and operational efficiency. Additionally, the authors emphasize the role of AI in revolutionizing toll collection systems and enhancing transportation infrastructure. The paper underscores the significance of adopting innovative technologies like RFID and AI to modernize toll operations, reduce manual interventions, and optimize resource utilization. By presenting a detailed analysis of the proposed RFID-based toll collection system and its benefits, the authors advocate for the adoption of AI-driven solutions to address the evolving needs of toll management and urban mobility. Overall, the PDF provides valuable insights into the potential of AI technology in transforming toll collection processes and improving the overall efficiency of transportation systems.

V. FUTURE SCOPE AND DISCUSSION

1. Advanced Image Processing Techniques: The future potential of the ANPR system lies in the exploration of advanced image processing techniques to enhance its accuracy and efficiency. Research and development efforts could focus on incorporating deep learning algorithms and convolutional neural networks (CNNs) to improve license plate recognition capabilities, particularly in challenging lighting and weather conditions.

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2. Cloud-Based Solutions: The scalability and flexibility of the ANPR system could be further enhanced through the adoption of cloud-based solutions. By leveraging cloud computing resources, the system can handle large volumes of data processing and storage, enabling seamless integration with existing traffic management infrastructure and facilitating real-time decision-making.
3. Enhanced Security Measures: As the ANPR system plays a critical role in traffic management and law enforcement, future developments should prioritize enhancing security measures to prevent unauthorized access and tampering of data. Implementation of robust encryption protocols, secure data transmission mechanisms, and intrusion detection systems can fortify the system's defences against cyber threats and ensure data integrity.
4. Integration with Smart Cities Initiatives: The ANPR system holds significant potential for integration with smart cities initiatives aimed at improving urban mobility and sustainability. By partnering with municipal authorities and urban planners, the system can contribute to the development of smarter, more efficient transportation networks, reducing traffic congestion and emissions while enhancing overall quality of life for residents.
5. Continuous Improvement through Feedback Mechanisms: To ensure the effectiveness and relevance of the ANPR system in real-world scenarios, it is essential to establish feedback mechanisms for gathering user feedback and performance metrics. By soliciting input from stakeholders, including traffic management authorities, law enforcement agencies, and transportation providers, the system can undergo iterative improvements to address evolving needs and challenges.
6. Integration with IoT Platforms: Future iterations of the ANPR system could explore integration with Internet of Things (IoT) to enhance real-time monitoring and management capabilities. By integrating with IoT devices such as traffic cameras and sensors, this system can gather contextual data and improve its accuracy in identifying and processing license plate information

VI. RESULT AND DISCUSSION

The result of the project is a fully functional automated toll collection system that significantly enhances the efficiency, accuracy, and transparency of toll gate operations. By automating vehicle detection, image capture, number plate recognition, and billing processes, the system improves throughput at toll gates, reduces errors in toll collection, and enhances the overall user experience for drivers. Leveraging advanced technologies such as OpenCV and Pytesseract ensures accurate number plate recognition, while the integration of Google Drive API facilitates centralized storage and transparent record-keeping of toll transactions. With reduced manual intervention and streamlined procedures, the system offers cost savings for transportation authorities and scalability to accommodate future growth in traffic volumes and toll gate expansions, ultimately modernizing and optimizing toll collection operations.

VII.CONCLUSION

The IntelliSense Toll Management System proposes a novel and intelligent approach to automate toll collection, leveraging image recognition and wireless communication technologies. This project demonstrates the feasibility of a system that utilizes an ESP32 Cam module triggered by an ultrasonic sensor to capture vehicle license plates. Subsequent image processing on a server, employing OpenCV and Tesseract OCR, extracts the license plate text. By referencing a database linking license plates to owner email addresses, the system can generate and send toll bills with UPI QR codes, enabling contactless payment. The proposed system offers several advantages over traditional toll collection methods. Automation of license plate recognition and toll bill generation significantly improves efficiency by reducing manual intervention and processing time. Additionally, image recognition minimizes human error associated with manual license plate reading, leading to enhanced accuracy. This system also offers convenience for users by allowing remote toll payment within a specified timeframe, increasing flexibility. Finally, faster processing has the potential to reduce congestion at toll booths, improving overall traffic flow.

REFERENCES

[1] A Survey Of Methods And Strategies In Character Segmentation: A Survey, Richard G. Casey and Eric Lecolinet, Journal of Software, August 2020
[2] Automatic License Plate Recognition System for Vehicles Using a CNN by Parneet Kaur, Yogesh Kumar, Shakeel Ahmed, Abdulaziz Alhumam, Ruchi Singla, and Muhammad Fazal Ijaz Article published on November 2021
[3] Y. Lin, P. Wang, and M. Ma, “Intelligent transportation system (ITS): Concept, challenge, and opportunity in 2017 IEEE 3rd Int. Conf. on Big Data Security on Cloud, IEEE Int. Conf. on High Performance and Smart Computing, and IEEE Int. Conf. on Intelligent Data and Security, Beijing, China, vol. 2, pp. 167–172, 2017

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| DOI:10.15662/IJAREEIE.2024.1304050 |

[4] Y. Kumar, K. Kaur, and G. Singh, "Machine learning aspects and its applications towards different research areas," in 2020 Int. Conf. on Computation, Automation and Knowledge Management, Dubai, United Arab Emirates, vol. 3, pp. 150–156, 2020

[5] Image Processing Based Toll Automation Technique Using ANPR, Helix The Scientific Explorer by Dr. P. B. Mane, Gayatri Bade, and Varsha Patil, Journal Published on 30th June 2019

[6] Kavya.S, Mutturaj Hubballi, Priyanka. B.N, "IMAGE PROCESSING BASED TOLL AUTOMATION USING ANPR" International Journal of Emerging Technologies in Computational and Applied Sciences, 12(2), March-May 2015

[7] International Conference on Advances in Computing, Communication Control and Networking (ICACCCN2018) Automatic Number Plate Recognition Article by Abhishek Kashyap, B. Suresh, Anukul Patil, Saksham Sharma, Ankit Jaiswal, 2018

[8] A Roy and D.P Ghoshal, "Number Plate Recognition for use in different countries using an improved segmentation," in 2nd National Conference on Emerging Trends and Applications in Computer Science (NCETACS), 2011, pp. 1-5

[9] Ch. Jaya Lakshmi, Dr. A. Jhansi Rani, Dr. K. Sri Ramakrishna, and M. Kanti Kiran, "A Novel Approach for Indian License Recognition System," International Journal of Advanced Engineering Sciences and Technologies, vol. 6, no. 1, pp. 10-14, 2011

[10] Automatic Vehicle License Plate Recognition System based on Image Processing and Template Matching Approach by S.M.Mamduh, H.Jaafar, A.S.A.Nasir, K.Yogheedha published in IEEE 2018

[11] A. Goyal and R. Bhatia, "Various Techniques for Number Plate Recognition-A Review," International Journal of Computer Applications, vol. 143, 2016

[12] H. Karwal and A. Girdhar, "Vehicle number plate detection system for Indian vehicles," in the 2015 IEEE International Conference on Computational Intelligence & Communication Technology (CICT), pp. 8-12, 2015

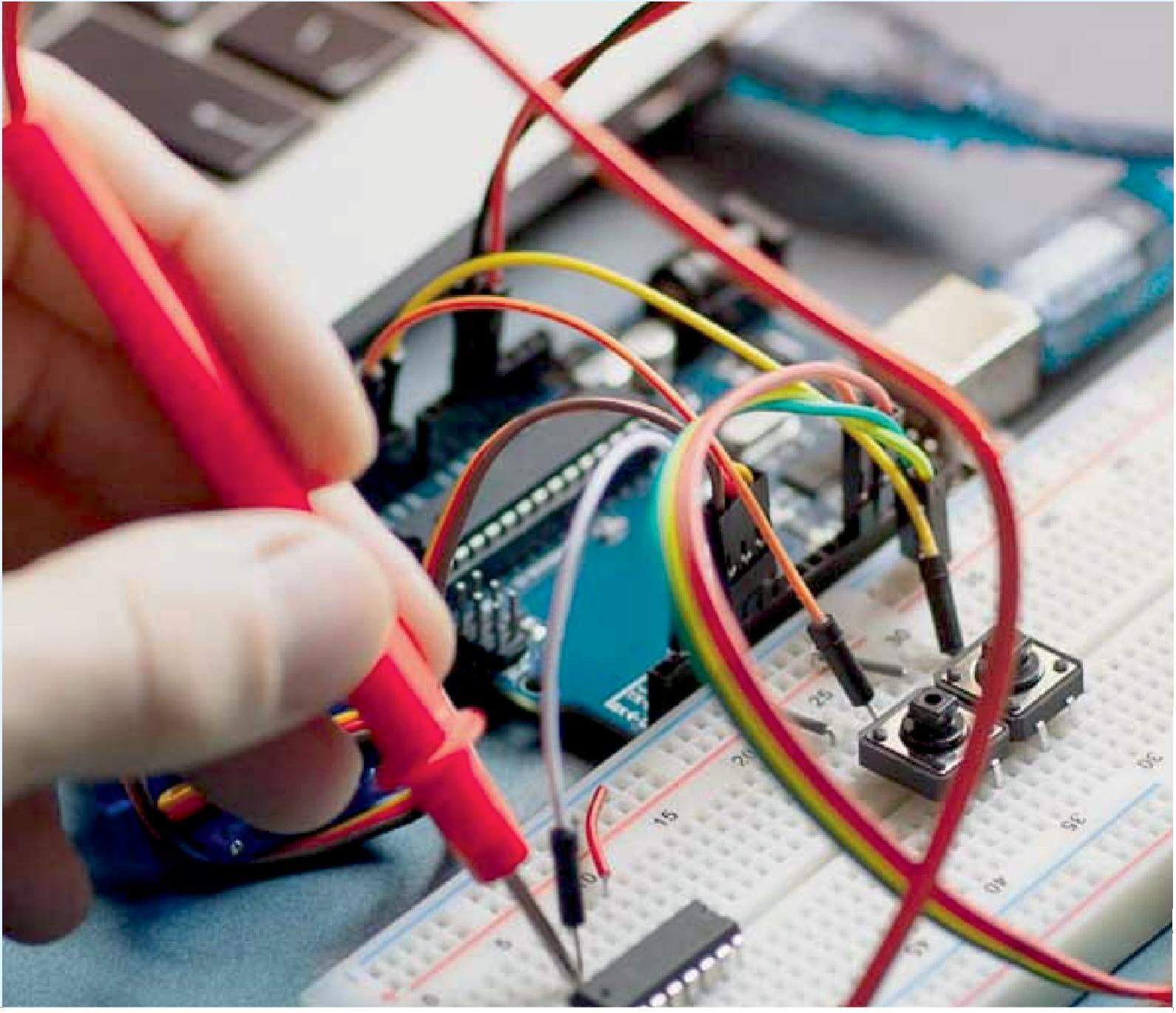
[13] Y. Tang, C. Zhang, R. Gu, P. Li and B. Yang, "Vehicle detection and recognition for intelligent traffic surveillance system," Multimedia tools and applications, vol. 76, pp. 5817-5832, 2017.

[14] IEEE 4th International Conference on Image Processing, Applications and Systems (IPAS) "Image-Preprocessing and Segmentation Techniques for Vehicle-Plate Recognition" by Mohamed Alkalai, Ahmed Lawgali in 2020

[15] W. Vandenberghe, E. Vanhauwaert, S. Verbrugge, I. Moerman, and P. Demeester. Feasibility of expanding traffic monitoring systems with floating car data technology. IET Intelligent Transport Systems, 6(4):347–354, December 2012

[16] Karez Abdulwahhab Hamad and Mehmet Kaya. A detailed analysis of optical character recognition technology. International Journal of Applied Mathematics, Electronics and Computers, 4(1):244–249, 2016

[17] A Novel Non-Payment Vehicle Searching Method For Multilane-Free-Flow Electronic-Toll-Collection Systems published by Ganesh Reddy, B.Naveen Kumar, B.Venkateswara Reddy in the International Journal of Research (IJR) Vol-1, Issue-11 December 2014 ISSN 2348-6848



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