IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1205259 |

Smart BRT (Bus Rapid Transit) using Image Processing

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ABSTRACT: In the context of Bus Rapid Transit (BRT) systems, ensuring efficient and secure entrance for authorized vehicles while maintaining a streamlined flow of public transportation is a challenging task. This abstract presents an innovative solution to address this challenge by leveraging image processing technology in a Smart BRT system. The proposed Smart BRT system integrates cutting-edge image processing techniques with an intelligent entrance control mechanism to enhance the security and efficiency of authorized vehicle access. The key components of this system include: 1. Vehicle Identification and Verification: Image processing algorithms are employed to capture and analyse vehicle license plates, identifying authorized vehicles from a predefined database. This allows for quick and accurate verification without manual intervention. 2. Real-time Monitoring and Analytics: Surveillance cameras are strategically placed at the entrance points to continuously monitor vehicle movement and maintain real-time situational awareness. Any suspicious activities or unauthorized entries are immediately flagged. 3. Access Control and Authentication: Authorized vehicles are granted access through an automated gate or barrier system based on the successful verification of their license plates. Non-authorized vehicles are denied entry. 4. Data Integration and Reporting: The system collects and stores data on vehicle entries and exits, allowing for comprehensive reporting and analytics. This data can be used to optimize traffic flow, enhance security protocols, and improve system performance. 5. User-Friendly Interface: A user-friendly interface for authorized vehicle owners and BRT authorities is implemented to manage access permissions, view historical data, and communicate with the system. The Smart BRT system using image processing for authorized vehicle entrance offers several advantages, including enhanced security, reduced manual interventions, improved traffic flow, and the ability to adapt to changing conditions. It aligns with the goals of modern urban transportation systems, promoting sustainability, efficiency, and security.

KEYWORDS: Smart BRT,Image Processing, Gate Automation, Emergency Services, Transit Efficiency, Intelligent Transportation System, Operational Efficiency, Advanced algorithms

I. INTRODUCTION

Implementing a Smart Bus Rapid Transit (BRT) system with image processing for the entrance of authorized vehicles is a multifaceted project with several key objectives. These objectives aim to enhance efficiency, safety, and security in public transportation. Here are some common objectives for such a system:1. **Enhance Security**: Improve security measures by using image processing to verify the identity and authorization of vehicles and their occupants before allowing access to the BRT lane. This helps in preventing unauthorized vehicles from entering and potentially endangering passengers.

2. **Reduce Congestion**: Mitigate traffic congestion and ensure the smooth flow of BRT buses by prioritizing their access to dedicated lanes. Authorized vehicles can also benefit from reduced travel times.3. **Improve Efficiency**: Increase the efficiency of the BRT system by reducing delays caused by unauthorized vehicles accessing the lanes. This can lead to more punctual and reliable services.4. **Enhance Passenger Safety**: Ensure the safety of BRT passengers by preventing unauthorized vehicles from encroaching on dedicated BRT lanes, which can lead to accidents or collisions.5. **Facilitate Data Collection**: Use image processing to collect data on authorized and unauthorized vehicles' movement patterns. This data can be valuable for future planning and optimizing the BRT system.6. **Promote Eco-Friendly Transportation**: Encourage the use of eco-friendly and authorized vehicles by providing incentives and access to dedicated lanes, thus contributing to a reduction in greenhouse gas emissions and pollution.

II. RELATED WORK

Automatic License Plate Recognition (ALPR): Studies have demonstrated the use of ALPR technology to automate gate operations. For instance, ALPR systems can be deployed to recognize emergency and BRT vehicles, allowing for

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seamless gate control. Example: A research paper on "Automatic License Plate Recognition for Access Control" discusses the integration of ALPR systems in urban settings for controlling access to restricted areas.

Real-time Object Detection and Tracking: Image processing techniques for detecting and tracking vehicles in real time are crucial for Smart BRT systems. These systems use cameras and machine learning algorithms to identify and track authorized vehicles. Example: "YOLO (You Only Look Once) for Real-Time Object Detection" is a widely referenced approach that can be adapted for identifying BRT buses and emergency vehicles.

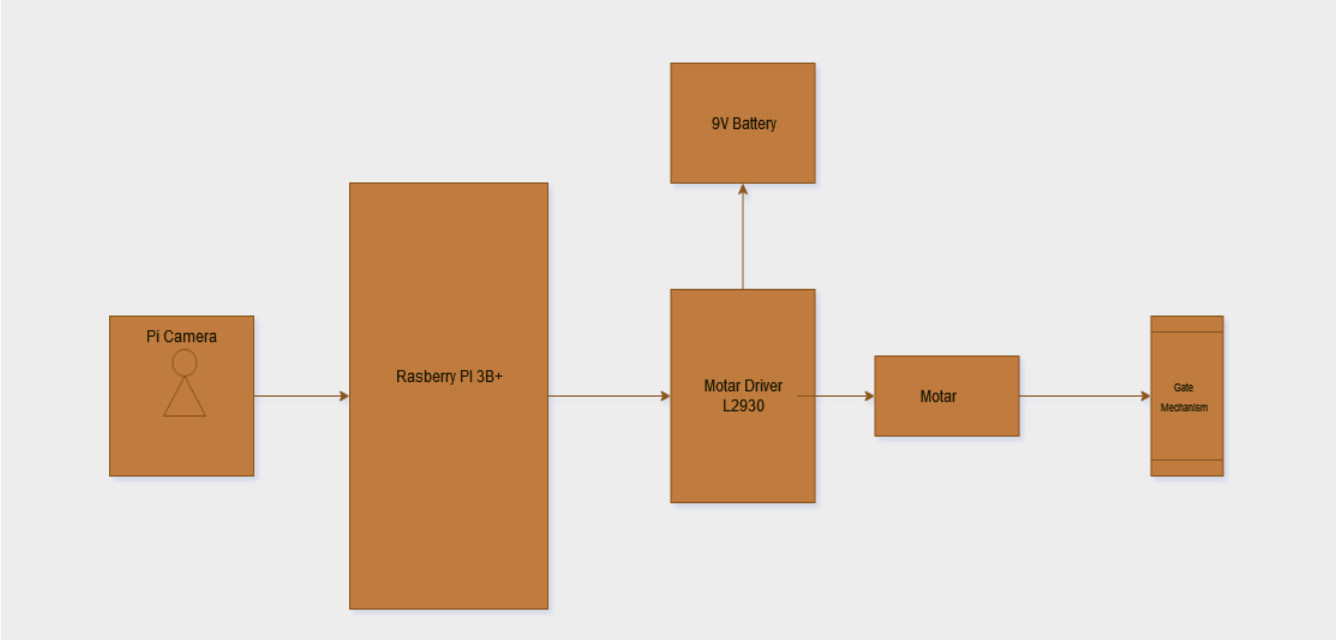
Smart Traffic Management Systems: Smart traffic management systems often incorporate image processing for various applications, including gate control. These systems improve traffic flow and reduce congestion by prioritizing certain vehicles. Example: Research on "Smart Traffic Control Systems Using Image Processing" explores the use of image processing for managing traffic signals and gates.

Surveillance and Security Systems: Security systems employing image processing are often used for monitoring and controlling access to sensitive areas. Techniques from this domain can be adapted for BRT gate control. Example: Studies on "CCTV-Based Automated Surveillance Systems" describe the use of image processing for real-time monitoring and access control.

Emergency Response Systems: Integration of image processing in emergency response systems can facilitate the rapid movement of emergency vehicles by automating gate operations. Example: Research on "Emergency Vehicle Detection Using Image Processing" highlights methods for identifying and prioritizing emergency vehicles in traffic systems.

Urban Mobility and Smart City Initiatives: Smart city projects frequently incorporate advanced technologies like image processing to improve urban mobility. These projects provide frameworks that can be adapted for Smart BRT systems. Example: The "Smart Cities: Foundations and Principles" book discusses various technologies, including image processing, that contribute to smart urban infrastructure.

III. BLOCK DIAGRAM



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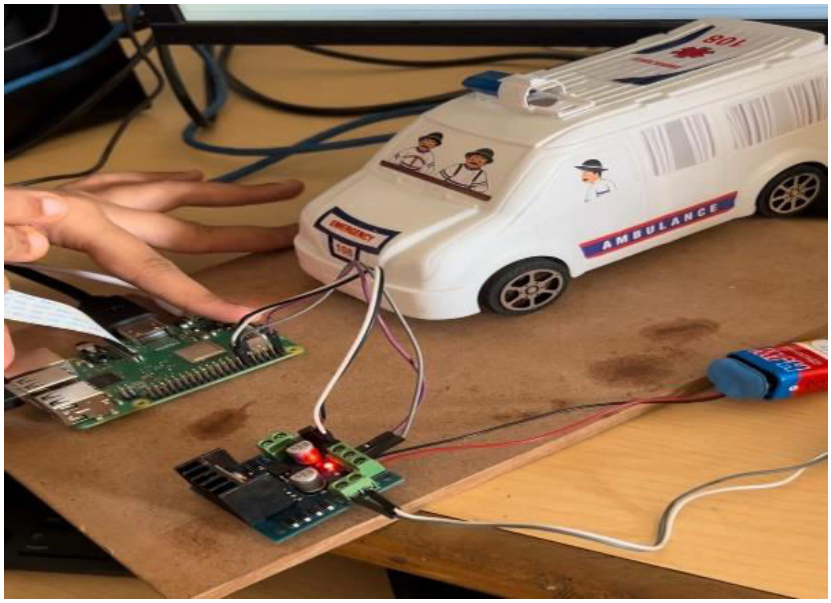
IV. CONNECTIONS AND WORK FLOW

1. Power Supply: Battery to Raspberry Pi: Connect the batteries positive and negative terminals to the respective power input pins on the Raspberry Pi.Battery to Motor Driver: Connect the battery to the motor driver's power input to ensure it can control the motor.
2. Raspberry Pi Setup: Pi Camera Connection: Connect the Pi Camera to the Raspberry Pi's camera interface (CSI) port. This port is specifically designed for camera modules. Motor Driver Control Pins: Connect the GPIO pins of the Raspberry Pi to the control pins of the motor driver. Typically, at least two GPIO pins are required to control the motor direction and speed.
3. Motor Driver to DC Motor: Motor Connections: Connect the motor terminals to the output pins of the motor driver. The motor driver will control the direction and speed of the motor based on the signals received from the Raspberry Pi.
4. Image Processing and Control Logic: Image Capture: The Pi Camera continuously captures images of the area where the BRT vehicle is expected. Processing: The Raspberry Pi processes these images using an object detection algorithm. Decision Making: If a BRT vehicle is detected, the Raspberry Pi sends a signal to the motor driver to open the gate. Gate Operation: The motor driver receives the signal and activates the motor to open the gate. After a set period or once the vehicle has passed, the Raspberry Pi sends another signal to close the gate.
5. Power Management: Ensure the battery has sufficient capacity to power the system for the required duration. If the system is to be used continuously, consider using a rechargeable battery with a solar panel for sustainable operation.

V. SIMULATION RESULTS



VI. CONCLUSION

The integration of image processing technology to regulate gate opening and closing in Smart Bus Rapid Transit (BRT) systems, specifically tailored for emergency services and BRT vehicles, heralds a transformative advancement in urban transportation infrastructure. By harnessing sophisticated image recognition algorithms, this innovation streamlines the transit process, ensuring seamless passage for authorized vehicles while upholding stringent security measures. The automatic identification of emergency service vehicles and BRT buses enables swift and efficient gate operations, significantly reducing response times during critical situations. Moreover, the implementation of such a system not only optimizes operational efficiency within the BRT network but also enhances overall traffic management in urban environments. By mitigating congestion and minimizing delays, this technology fosters smoother traffic flow, thereby bolstering commuter satisfaction and safety.In essence, the incorporation of image processing for gate control in Smart BRT systems represents a pivotal step towards the realization of a more intelligent, responsive, and sustainable urban transportation ecosystem, with profound implications for both emergency services and public transit infrastructure.

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INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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