Traffic Light Control at a Four-Way Intersection Using Image Processing

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***Abstract*—This undergraduate thesis focuses on the design and implementation of a traffic light control system at a four-way intersection using image processing techniques. The author describes the system's development, including the use of Python and OpenCV for algorithm implementation, and the Raspberry Pi 3 as the hardware platform. The system processes images from a Pi camera to control traffic lights, employing techniques such as noise reduction, edge detection, and color space conversion. The system was tested in a simulated environment and demonstrated stability and ease of use, but faced challenges with power supply and processing time. The author proposed future improvements, including multi-threading and real-time video processing.**

***Index Terms*—traffic light control, image processing, Raspberry Pi, OpenCV, Python, color space**

I. Introduction

The thesis provides an overview of image processing techniques, including color spaces, morphological operations, and edge detection methods. It also discusses the application of deep learning and neural networks in image processing. The author explains the system's design and implementation, highlighting the use of Raspbian, Python, and OpenCV. The system aims to control traffic lights at a four-way intersection by processing images from a camera, addressing issues such as image processing, noise reduction, and edge detection. The author also discusses the limitations of the hardware platform, such as the Raspberry Pi 3, which is suitable for small-scale projects but may be insufficient for larger systems [1]. Related earlier ICTU undergraduate theses provide context for this English summary [5]. Published articles on the methods and subject of this project provide context for this English summary [6], [7], [8], [9], [10].

II. Methods

The author implemented the system using Python and the OpenCV library on a Raspberry Pi 3. The system processes images from a Pi camera to control traffic lights, employing techniques such as noise reduction, edge detection, and color space conversion. The system was tested in a simulated environment, where it demonstrated stability and ease of use. The author noted that the system could be improved by implementing multi-threading and real-time video processing. The system's design and implementation involved setting up the Raspberry Pi 3, installing Raspbian, and configuring the necessary software and libraries. The author also discussed the use of color spaces, such as RGB, HSV, CMYK, and CIE LAB, and morphological operations like erosion, dilation, opening, and closing. The system's algorithms were developed to handle various image processing tasks, including noise reduction and edge detection [1].

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III. Results

The system was tested and demonstrated stability and ease of use in a simulated environment. However, it faced challenges with power supply and processing time. The author noted that the system could be improved by implementing multi-threading and real-time video processing. The system's algorithms were developed to handle various image processing tasks, including noise reduction and edge detection. The author also discussed the limitations of the hardware platform, such as the Raspberry Pi 3, which is suitable for small-scale projects but may be insufficient for larger systems. The system's performance was evaluated based on its ability to process images and control traffic lights, but no specific metrics or measurements were provided [1].

IV. Discussion

The author discussed the advantages and limitations of the system, including its stability, user-friendliness, and ease of research and expansion. However, it lacks an independent power source and requires further improvements in processing time and efficiency. The author proposed future improvements, including multi-threading and real-time video processing. The system's algorithms were developed to handle various image processing tasks, including noise reduction and edge detection. The author also discussed the limitations of the hardware platform, such as the Raspberry Pi 3, which is suitable for small-scale projects but may be insufficient for larger systems. The system's performance was evaluated based on its ability to process images and control traffic lights, but no specific metrics or measurements were provided [1]. Earlier ICTU undergraduate work addressed control of intersection traffic lights [4].

V. Conclusion

The system was designed to control traffic lights at a four-way intersection using image processing techniques. While it demonstrated stability and ease of use, it faced limitations

such as power supply issues and processing time. The author proposed future improvements, including multi-threading and real-time video processing. The system's algorithms were developed to handle various image processing tasks, including noise reduction and edge detection. The author also discussed the limitations of the hardware platform, such as the Raspberry Pi 3, which is suitable for small-scale projects but may be insufficient for larger systems. The system's performance was evaluated based on its ability to process images and control traffic lights, but no specific metrics or measurements were provided [1].

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