DEPARTMENT OF MECHATRONICS ENGINEERING

Mechatronics System Integration (MCTA3203)

WEEK 9: Color Detection and Analysis

Section 1

(Group E)

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Abstract

This experiment focuses on the integration of image/video input with an Arduino and computer-based system to enable color detection and analysis. The setup involves connecting a Pixy camera to an Arduino for real-time image acquisition. Software algorithms are implemented on the Arduino to process the captured images, employing techniques like thresholding and color space transformations to detect specific colors. The processed color data is then transmitted to a computer where dedicated software applications receive the data, conduct in-depth analysis, and visualize the results. This experiment highlights the collaborative role of hardware and software components in identifying and analyzing colors from visual inputs, showcasing potential applications in fields like object recognition, manufacturing quality control, and computer vision-based tasks.

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1.1 Introduction

The integration of image and video inputs with microcontroller systems, coupled with computer-based analysis, stands as a pivotal field in modern technology. This experiment delves into the convergence of hardware and software methodologies, exploring their synergistic capabilities to detect and analyze colors from visual data streams. This experiment showcases the acquisition of real-time visual information by interfacing a camera or image sensor with a microcontroller. Through software algorithms implemented on the microcontroller, specific colors within the captured imagery are identified utilizing techniques like thresholding, image segmentation, and color space transformations. The subsequent transmission of processed color data to a computer system facilitates advanced analysis and visualization. This experiment illuminates the intricate relationship between hardware and software components, emphasizing their collaborative role in color detection and analysis, while also envisaging potential applications across diverse fields such as automated object recognition, manufacturing quality assurance, and advancements in computer vision technologies

Objectives

1. To design a color detection system using Arduino, Python, and either a color sensor or a USB camera. The experiment will involve hardware setup, programming Arduino and Python, and analyzing the accuracy and performance of color detection in different scenarios.

PART 1

1.2 Materials & Equipment

1. Arduino board
2. Color sensor (e.g., TCS3200 or TCS34725)
3. Jumper wires
4. Breadboard
5. Pixy camera
6. Computer with Arduino IDE and Python installed
7. USB cable for Arduino

1.3 Experimental setup

Hardware Setup:

1. Connect the Pixy camera to the Arduino Uno. If you're using the I2C interface, connect the GND, +5V, SDA, and SCL pins. If you're using UART, connect the GND, +5V, TX, and RX pins.
2. Ensure that the Arduino Uno is powered either via USB or an external power supply.
3. Open the PixyMon software on your computer, connect the Pixy camera, and configure color signatures for each of the three objects.

Arduino Programming:

1. Download and install the Pixy library for ArduinoRGB color data was read from the sensor and converted to a format that can be sent to the computer.
2. Open the Arduino IDE and create a new sketch.

PART 2

1.2 Materials & Equipment

1. Arduino board
2. USB camera
3. Jumper wires
4. Breadboard
5. Computer with Python installed
6. USB cable for Arduino

1.3 Experimental Setup

Hardware Setup:

1. The USB camera was connected to the computer using a USB cable.

Python Programming:

1. A Python program was written to capture video from the USB camera using the OpenCV library.
2. Color detection logic was implemented using HSV color space.
3. The video feed and detected colors were displayed on the computer screen.

1.4 Methodology

1. Pixy Camera was connected to Arduino Uno.
2. Arduino Uno is powered via a laptop.
3. The Pixy camera was calibrated for three different colored objects which were red, green, and blue.
4. Pixy library for Arduino was installed and included in Arduino IDE.
5. Arduino code was written to detect objects.
6. The code was uploaded to Arduino.
7. Serial Monitor was opened in the Arduino IDE to view the output and debug any issues.
8. Color signatures and threshold values were adjusted in the PixyMon software and the Arduino code to improve object detection.

Part 1

1.5 Data Collection

1. The system with 3 different colored objects was tested.
2. The data on the detected colors and their accuracy.

1.6 Data Analysis

1. The accuracy of color detection by showing the reading in Arduino.
2. How the system performs in 3 different colors was analyzed.

Part 2

1.5 Data Collection

1. The system with different colored objects was tested.
2. The data on the detected colors, their accuracy, and how the system performs in various lighting conditions was collected.

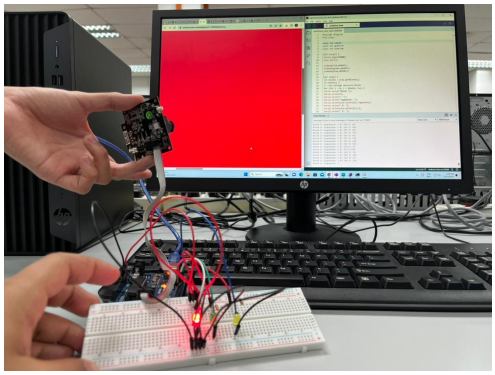
1.6 Data Analysis

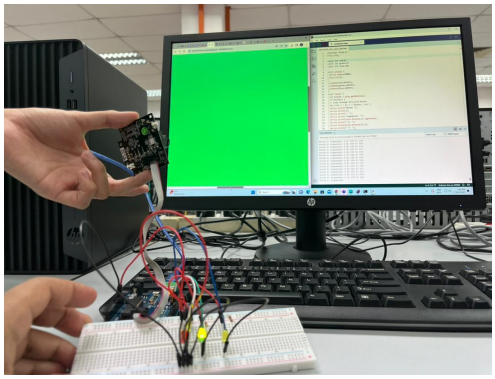
1. The accuracy of color detection by comparing detected colors with actual colors was evaluated.
2. How the system performs in different lighting conditions was analyzed.
3. The performance of the USB camera-based system with the color sensor-based system was compared.

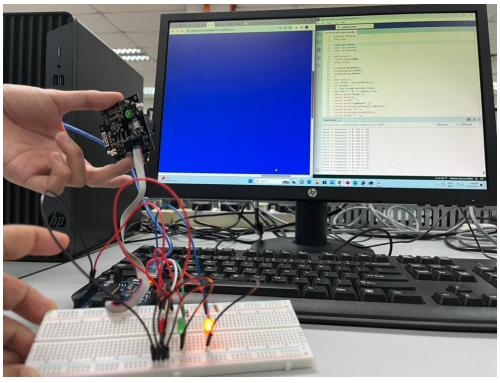
1.7 Result

For both parts, we managed to do the tasks successfully by detecting the three different colored objects, and analyzing the accuracy and performance of color detection in different scenarios.

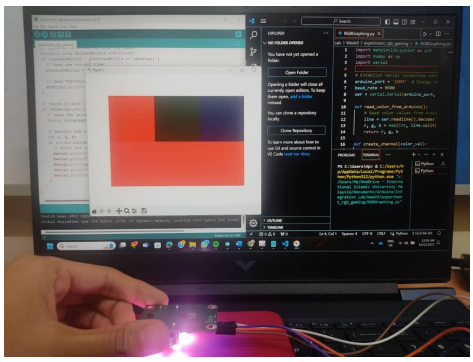
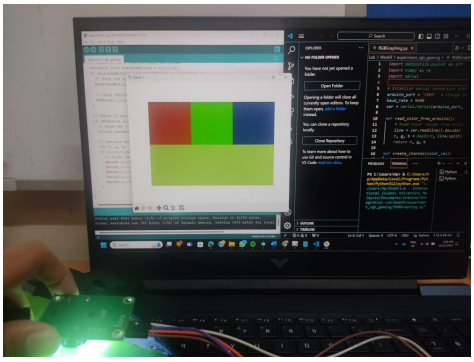
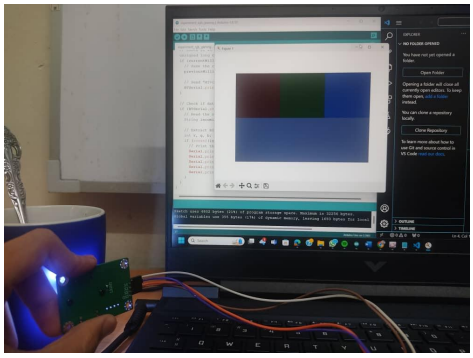
Part 1







Part 2

1.8 Discussion

Part 1

- To test the functionality of a pixy camera by detecting a color difference on the objects.
- When three different color objects shown, the pixy camera can detect the difference and sent the data to arduino
- Arduino then integrated the data and led lights lightened up based on the color shown.

Part 2

- To test the functionality of a USB camera by detecting the colors on objects.
- When USB camera is pointed at any objects, the USB camera collected the color data of the object then sent to arduino
- Arduino read the data and evaluated the accuracy of color detection by comparing detected colors with actual colors.

1.9 Conclusion

In conclusion, this experiment highlights the mutually beneficial relationship between hardware and software components in the field of image/video input-based color detection and analysis. This study effectively illustrates the real-time processing and transmission of color data to a computer-based system by integrating a camera or image sensor with a microcontroller in a seamless manner and utilizing software algorithms for color identification. The joint efforts of software implementation and hardware integration demonstrate the potential for a wide range of

applications, such as object recognition, manufacturing process quality control, and computer vision technology development. This experiment opens the door for novel advancements in visual data processing and analysis systems by illuminating the value of multidisciplinary approaches and emphasizing the synergy between hardware interfacing, algorithmic processing, and computer-based analysis.

1.10 Recommendations

Using the current setup, for the experiment in part 1, even though the Pixy camera could detect the colors that it is calibrated to detect, it could only detect that specific shade of color. To widen the range of shades it could detect and label correctly, a fuzzy logic system could be implemented so that the Pixy camera and the color detection system can be more flexible in detecting colors.

A recommendation for the experiment in part 2 is to do the experiment in a well lit environment so that the colors displayed and detected by the Arduino and camera can be accurate.

1.11 Acknowledgements

We would like to acknowledge our instructor, Dr. Wahju Sediono for your expert guidance, encouragement, and unwavering support throughout the project and also for your invaluable support and provision of resources crucial to the successful execution of the experiment on color detection using a microcontroller and the Pixy camera. We hope to learn more from such a talented instructor if the opportunity arises.

We would also like to give thanks to Allah S.W.T. for guiding us in demonstrating this experiment successfully.

1.14 Student's Declaration
Declaration:

We certify that this project/assignment is entirely our own work, except where we have given fully documented references to the work of others, and that the material in this assignment has not previously been submitted for assessment in any formal course of study.

_adam_____ Date: 20/12/2023

Name: Adam Mikhail Bin Khairul Effendy

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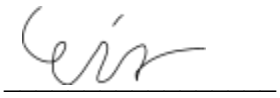

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