KULLIYYAH OF ENGINEERING
DEPARTMENT OF MECHATRONICS ENGINEERING

Lab Report 9A:

Image/Video input interfacing with microcontroller and computer based system: Software and hardware

GROUP E

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Abstract

This lab report details the development of a color detection system using an Arduino Uno microcontroller and a Pixy camera. The primary goal of this project is to build a system capable of identifying three distinct colored objects through a series of structured steps. The process begins with the hardware setup, where the Pixy camera is configured to communicate with the Arduino Uno via the UART interface, and the necessary power supply connections are established. Following the hardware setup, the Pixy library is installed to enable seamless integration between the camera and the microcontroller.

The next step involves writing the Arduino code to process the color data received from the Pixy camera. This code is then uploaded to the Arduino Uno, enabling the system to recognize and differentiate the pre-defined color signatures of the target objects. Finally, the system undergoes rigorous testing and debugging to ensure accurate color detection and reliable performance under various conditions.

This step-by-step approach provides a clear and systematic methodology for constructing a robust color detection system. The results demonstrate the effectiveness of using the Arduino Uno and Pixy camera in mechatronics applications, highlighting the practical applications and potential improvements for similar projects in the field.

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Introduction

In this experiment, we will interface an Arduino UNO R3 and Python with a Pixy camera to capture picture and video input. This experiment's main goal is to construct a system that can recognise three distinct colors—red, green, and blue—in things using an Arduino Uno and a Pixy camera. The Pixy camera is connected via I2C and an Arduino UNO R3. We learn that there is a specific colour signature for every colour that exists in this world and that there are numerous ways to use colour detection techniques because the Pixy camera can detect colours. We use Python to code the configuration and we also use PixyMon software to configure colour signatures for each of the three objects.

Material and Equipment

1. Pixy camera

2. Arduino UNO R3

3. I2C module

4. Servo motor

5. Breadboard

6. USB cable for Arduino UNO R3

7. Computer with Arduino IDE and Python installed

8. RGB LED

9. Arduino board

10. Jumper wires

Hardware setup

1. The Arduino Uno was interfaced with the Pixy camera.
2. Connections were established for the I2C interface, comprising the GND, +5V, SDA, and SCL pins.
3. The Arduino Uno was integrated with the servo motor.
4. All connections were securely established and insulated.
5. The Arduino Uno was powered using either an external power supply or USB.

Methodology

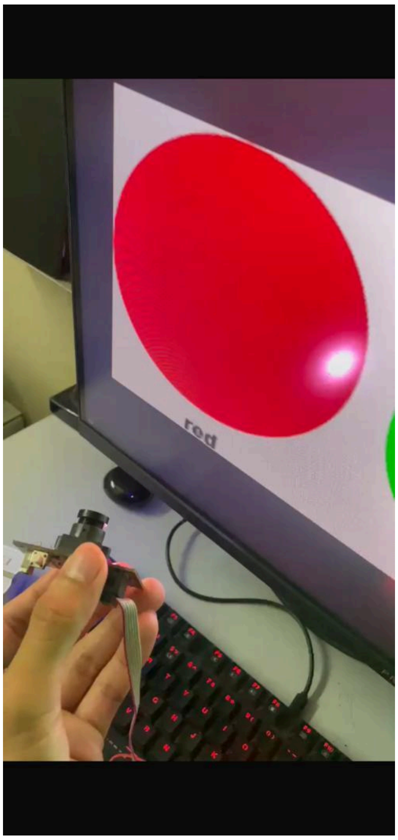
1. Research was conducted on the RGB color spectrum via online resources to configure the desired color settings within the Pixy camera.
2. The camera orientation was adjusted to capture the RGB color displayed on the screen, and corresponding colors were meticulously selected and assigned as variables utilizing PixyMon software.
3. The Pixy camera was interfaced with the laptop to facilitate the uploading of the Arduino code.
4. The Arduino Integrated Development Environment (IDE) was utilized to compile and upload the code onto the microcontroller housed within the Arduino board.

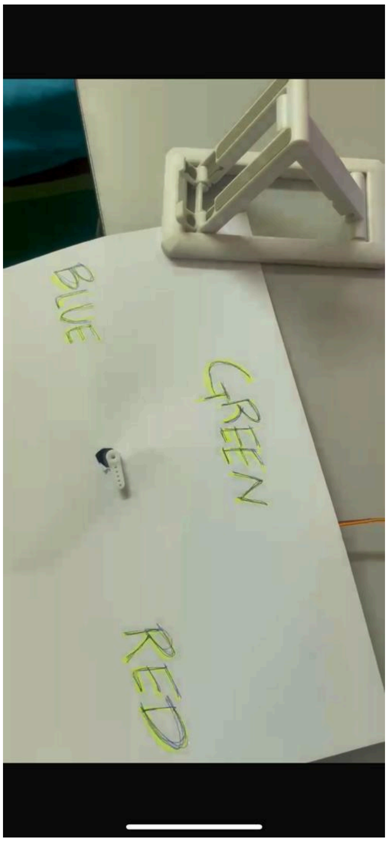
Coding used

```
#include <Pixy.h>
Pixy pixy;

#include <Servo.h>
Servo myservo;

void setup() {
  Serial.begin(9600);
  pixy.init();
  myservo.attach(8);
}
void loop() {
  int blocks = pixy.getBlocks();
  if (blocks) {
    for (int i = 0; i < blocks; i++) {
      Serial.print("Block ");
      Serial.print(i);
      Serial.print(": ");
      Serial.print("Signature: ");
      Serial.print(pixy.blocks[i].signature);
      Serial.print(" X: ");
      Serial.print(pixy.blocks[i].x);
      Serial.print(" Y: ");
      Serial.println(pixy.blocks[i].y);

      if (pixy.blocks[i].signature == 1) {
        myservo.write(0);
      } else if (pixy.blocks[i].signature == 2) {
          myservo.write(90);
      } else if (pixy.blocks[i].signature == 3) {
          myservo.write(180);
      }
      delay(100);
    }
```

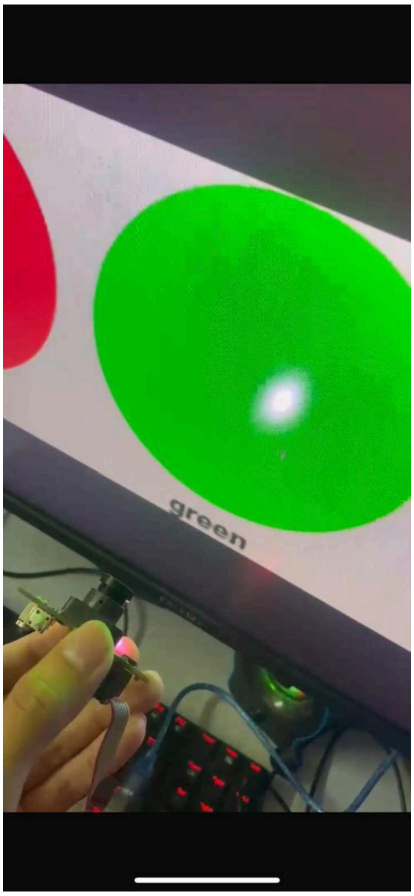
Result

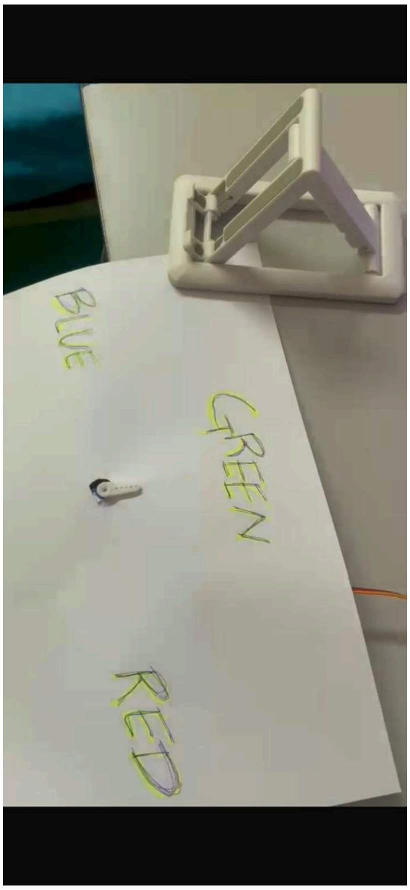
1. When detected colour **RED**



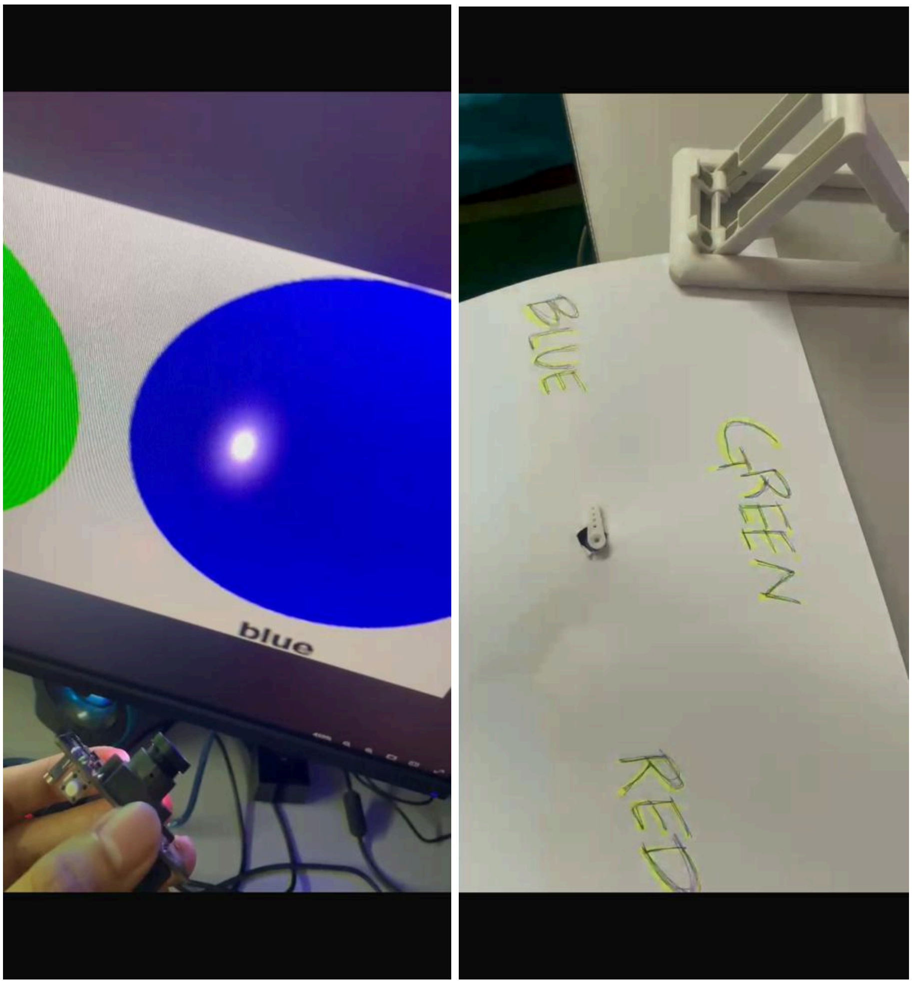


2. When detected colour **GREEN**





3. When detected colour **BLUE**



Discussion

During testing, the Pixy camera successfully distinguished and identified colors, namely green, blue, and red, in accordance with our expectations. Verification of the camera's accuracy was conducted through observation of the correct data displayed on the serial interface of the Arduino IDE upon color detection. Notably, color recognition exhibited swift responsiveness, promptly reflecting results on the serial monitor.

To enhance precision in color recognition, adjustments were made to the color pattern ranges within the PixyMon software settings. Specifically, the range for blue hues was contracted while those for red and green were expanded. This optimization was necessitated by the camera's tendency to detect a blue background hue. Experimentation across varying lighting conditions demonstrated consistent color detection capabilities under normal, bright, and dim lighting. However, in low-light conditions, the Pixy camera failed to detect any colors, underscoring its sensitivity to environmental factors.

The experiment further involved configuring the Pixy camera's output to control the movement of a servo motor. Upon detection of red, the servo was oriented at 0 degrees. Conversely, detection of green prompted the servo to pivot to 90 degrees, while blue elicited a 180-degree rotation. The output exhibited precise control over servo motor positioning.

Recommendation

Initiating further research, an exploration into the integration of machine learning methodologies presents an avenue to augment the adaptability and recognition capabilities of the system. The implementation of a trained model tailored for specific object recognition holds promise in bolstering detection accuracy, particularly when encountering diverse object characteristics such as shape, size, or orientation. Investigating machine learning libraries compatible with the Arduino platform will facilitate the seamless incorporation of these advanced techniques.

Subsequently, deliberation on the development of an intuitive and user-friendly interface emerges as a crucial consideration to enhance the system's usability. The conceptualization of a graphical user interface (GUI) stands to furnish users with a visual representation of detected objects alongside pertinent information, thereby fostering enhanced user engagement and expediting troubleshooting processes. Such an interface would also streamline system monitoring efforts, contributing to overall operational efficiency.

Concluding the proposed avenues for system enhancement, an expansion of the scope of objects and scenarios tested is imperative to validate the system's efficacy across diverse conditions. Incorporating objects exhibiting varied textures, shapes, and colors beyond the initial selection of three is essential. Rigorous testing encompassing scenarios characterized by intricate backgrounds, dynamic lighting conditions, and varied object arrangements will ascertain the system's reliability and versatility in real-world applications. This comprehensive approach to testing ensures the system's robust performance and underscores its potential for deployment in a myriad of practical contexts.

Conclusion

In conclusion, the successful integration and testing of the Pixy camera system with the Arduino Uno platform have yielded valuable insights into its capabilities and applications. Through meticulous calibration and experimentation, we have demonstrated the Pixy camera's proficiency in color recognition and its adaptability to diverse lighting conditions. The system's responsiveness and precision in detecting and distinguishing between colors underscore its utility in various real-world scenarios. Moreover, the seamless control of servo motor movement based on color detection showcases the potential for practical implementation in automated systems and robotics. This project not only highlights the effectiveness of the Pixy camera in color-based sensing tasks but also underscores the significance of meticulous calibration and optimization for achieving optimal performance in such applications.

Student’s declaration

Certificate of Originality and Authenticity

This is to certify that we are responsible for the work submitted in this report, that the original work is our own except as specified in the references and acknowledgment, and that the original work contained herein has not been untaken or done by unspecified sources or persons.

We hereby certify that this report has not been done by only one individual and all of us have contributed to the report. The length of contribution to the reports by Each individual is noted within this certificate.

We also hereby certify that we have read and understand the content of the total report and no further improvement on the reports is needed from any of the individual contributor to the report.

We, therefore, agreed unanimously that this report shall be submitted for marking and this final printed report has been verified by us

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