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MP-9S Industrial Manipulator Handling and Scrapping Tasks in Industrial Environments

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Abstract

The main goal of the project was to carry out a handling task using a color sensor and thermal sensor, as well as an industrial robotic unit. The selection by color made it possible to represent the sub-process of the production of a sample, where each color can be matched to the corresponding or rejected product. The function of the thermal sensor is to show the delay function for the pro-cess, which occurs when the product does not reach a point in the process at the wrong tempera-ture and needs cooling between the two workflows. The thermal sensor and color sensor were pro-grammed using the ATmega microprocessor, while the manipulator was controlled with industrial PLC. The completed project will serve educational purposes in training for students.

Keywords*: RTT, industrial manipulator, handling, colour sensor, heat sensor, PLC, ATmega328P, MP-9S.*

1. Introduction

Handling tasks have become part of our daily lives thus, it is worthwhile to deal with errors that occur during mass production. Since the representation of the task is complex, the problem had to be implemented in an industrial environment, for which the Cyber-Physical & Intelligent Robot Systems Laboratory lab provided us with a basis in the Department of Mechatronics of the University of Debrecen, Faculty of Technology [1]

2. Choosing a suitable technology

During the project an industry robotic unit, PLC and Atmega microcontroller as well as a color and thermal sensor were involved to develop a sorting and fault-debugging system for educational purposes. The MP-9S manipulator, which is the main part of the task, was originally used in automotive factories [2]. The MP-9S was renovated and made possible in line with Industry 4.0 requirements, including PLC and microcontroller-based control, as well as HMI for network control [3].

3. MP-9S manipulator

The MP-9S manipulator (Figure 1) pneumatic and has 3 degrees of freedom. The front part of the metal housing has a handle that provides the move-

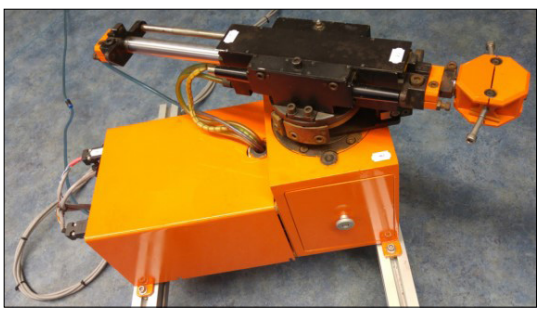

Figure 1. *The MP-9S manipulator.*

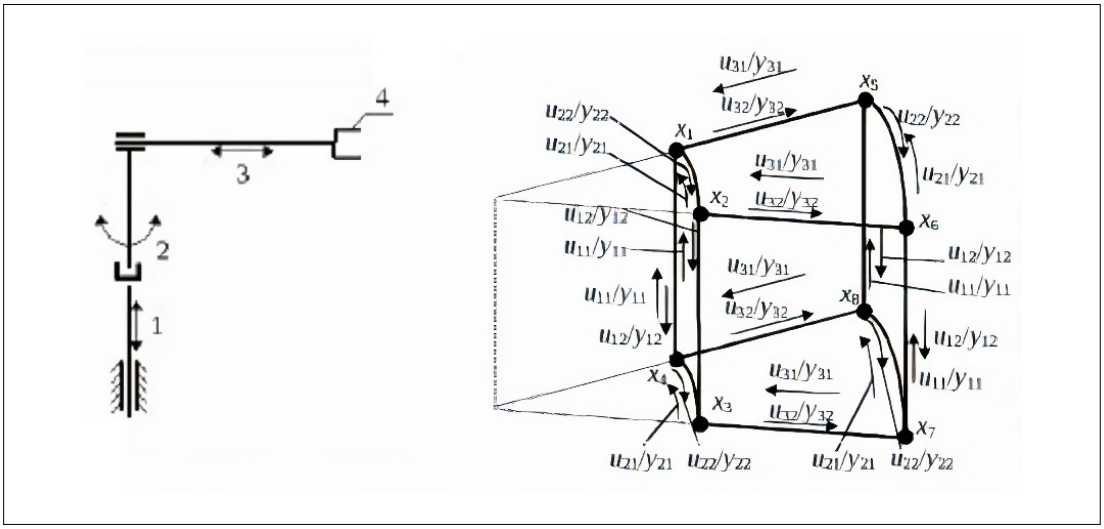

Figure 2. *Kinematic chain and manipulator work area.* [5]

ment of the gripper head. In the rear, there are 8 electro pneumatic valves with 2 connectors that collect the wires.

The MP-9S robot's kinematic chain (shown in Figure 2) clearly represents a three-axis RTT machine unit. All axes are operated with pneumatic auxiliary energy.

4. Used sensors and their programming

4.1. TCS230-M Colour sensor module

The TCS230 sensor is used to measure the colour of the area illuminated by the 4 white LEDs (Figure 3). The light sensor can measure RGBW colours, which it converts into frequencies.

Arduino NANO has been used for the control. Arduino is an open source development platform that is part of the ATmega microcontroller family [4]. The main part of Arduino NANO is the ATmega328P microcontroller, which is 8-bit and RISC based (Table 1).

The first step of the program written for the sensor (detail in Figure 4) is to declare the foot allocation and then the pins running into the PLC. Then variables containing the frequency of the colours were declared.

4.2. MLX90615 Infrared Thermal Sensor

The thermal sensor is replaced by the INFRARED temperature sensor MLX90614 (Figure 5). It has dimensions of 10,5 × 13 × 9,6 mm. Its data are shown in Tabel 2.

The previously written colour detection program (Figure 6) has been added in order to be

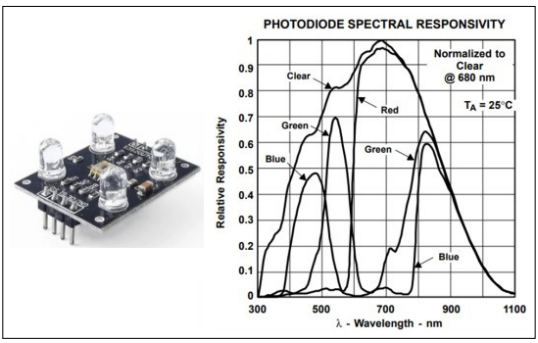

Figure 3. *TCS230-M Color sensor module.* [6, 7]

Table 1. *ATmega328P chip characteristics.* [4]

Program memory type	Flash
Program memory	32 KB
CPU speed	20 MIPS
Digital PWM pins	6 PWM
Temperature range	-40 +85 °C
Operating range	1.8 – 5.5V
Number of legs	32

Table 2. *MLX90615 thermal sensor data.* [8]

Temperature [°C]	**Temperature of device**	-40+85
	Object temperature to measure	-40+115
Measurement standard deviation [°C]		0.5 (0+50)
Read-out accuracy [°C]		0.02
Operating voltage range [V]		3.3

```
if (redFrequency < 400 && greenFrequency > 850 && 150 < blueFrequency) {
  Serial.println(" - Piros kocka észlelve!");
  digitalWrite(dig0, HIGH);
  digitalWrite(dig1, LOW);
  digitalWrite(dig2, LOW);
}
else if (500 < redFrequency && greenFrequency < 500 && blueFrequency < 200) {
  Serial.println(" - Zöld kocka észlelve!");
  digitalWrite(dig0, LOW);
  digitalWrite(dig1, HIGH);
  digitalWrite(dig2, LOW);
}
else if (1100 <  redFrequency && 800 < greenFrequency && blueFrequency < 250) {
  Serial.println(" - Kék kocka észlelve!");
  digitalWrite(dig0, LOW);
  digitalWrite(dig1, LOW);
  digitalWrite(dig2, HIGH);
}
else if(redFrequency < 550 && 650 < greenFrequency && blueFrequency < 160){
  Serial.println(" - Hibás termék!");
  digitalWrite(dig0, HIGH);
  digitalWrite(dig1, HIGH);
  digitalWrite(dig2, HIGH);
}
else {
  Serial.println(" - Nem látható kocka!");
  digitalWrite(dig0, LOW);
  digitalWrite(dig1, LOW);
  digitalWrite(dig2, LOW);
}
```

Figure 4. *Program snippet: Comparing frequencies.*

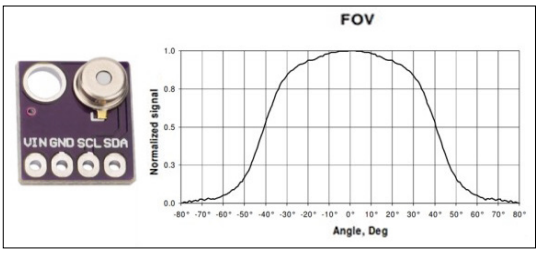

Figure 5. *MLX90615 infra heat sensor & Field of view values.* [8]

```
if (mlx.get_object_temp() < 25){

    digitalWrite(ho1, LOW);
    digitalWrite(ho2, HIGH);
    Serial.println("Object Is Too Cold");
}
else if (mlx.get_object_temp() > 30){

    digitalWrite(ho1, HIGH);
    digitalWrite(ho2, LOW);
    Serial.println("Object Is Too Hot");
}
else {
    digitalWrite(ho1, HIGH);
    digitalWrite(ho2, HIGH);
    Serial.println("Adequate Object");
}
    Serial.print("Ambient = ");
    Serial.print(mlx.get_ambient_temp());
    Serial.print(" *C\tObject = ");
    Serial.print(mlx.get_object_temp());
    Serial.println(" *C");
```

Figure 6. *Heat sensor program detail.*

able to use the MLX90615 thermal sensor. In the first step, the finished file itself was scanned and pins running into the PLC were declared, and the outputs were eventually named.

4.3. PLC & ATmega328P sensor wiring diagram

The circuit wiring diagram is shown in **Figure 7.**

5. Cube Holder

The detection distance of the colour sensor is up to 10 mm, so it was necessary to manufacture a cube holder that surrounds the sensor (**Figure 8**).

6. MP-9S Control with Industrial Modicon M340 PLC-vel

The robotic unit is controlled using a Schneider Modicon M340 modular PLC **[9]**. The PLC program was written in an LD, or ladder diagram (**Figure 9**) for the MP-9S, for which the Unity Pro XL development environment was used.

7. Conclusions

The above objectives have been achieved. The MP-9S industrial robot unit is capable of distin-

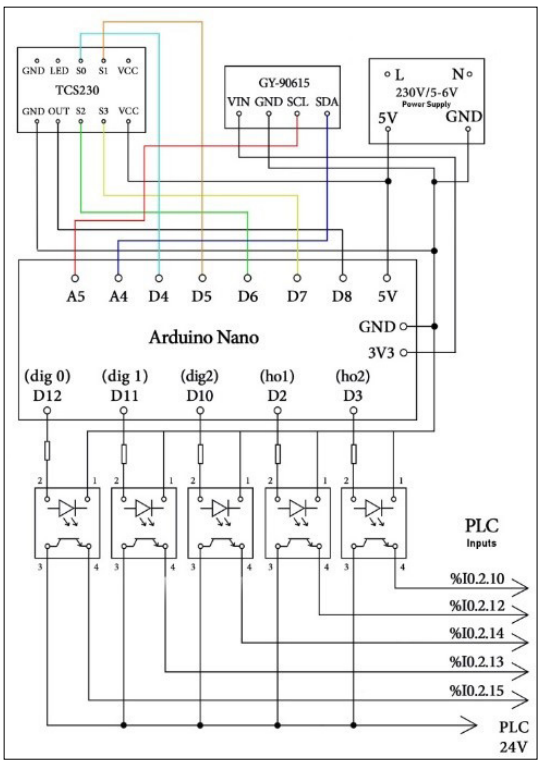

Figure 7. *Wiring diagram.*

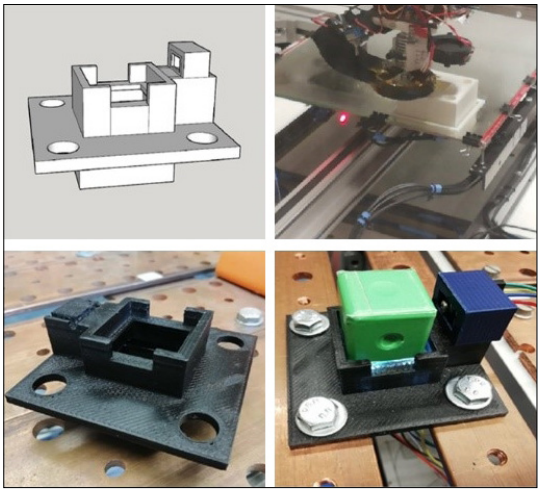

Figure 8. *Cube Holder model and 3D printing.*

guishing and sorting specific elements by using heat and colour sensors, according to whether or not the workpiece represented by the cube is defective.

Acknowledgments

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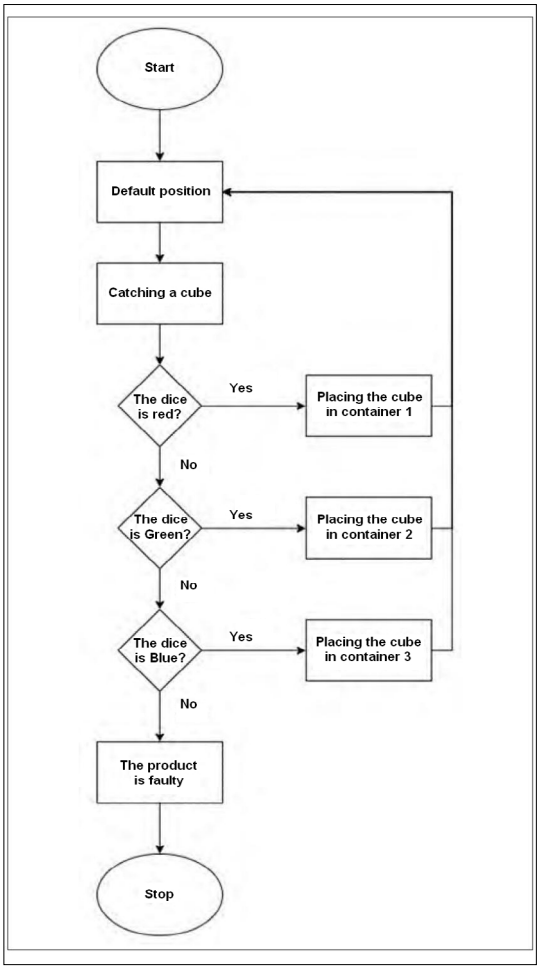

Figure 9. *Flowchart of the PLC programme.*

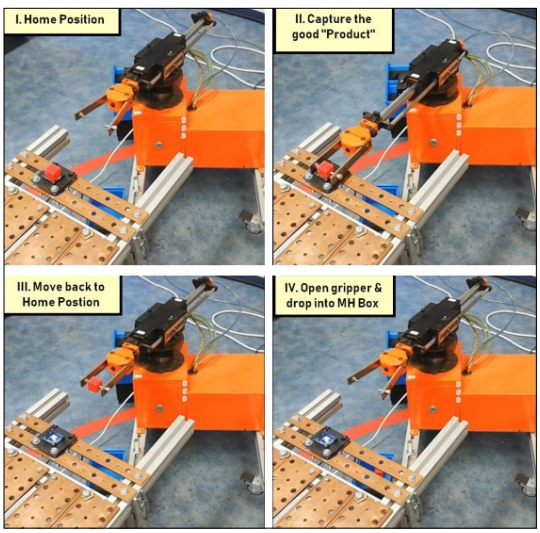

Figure 10. *The MP-9S manipulator in action.*

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