PROGRAMMING A COLOR-BASED SORTING SYSTEM AND ITS UTILITY IN THE INDUSTRY

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ABSTRACT: We live in a time covered by technology, and it is not news that it is spreading day by day, from simple objects that we use in everyday life in our homes, to devices that save lives, ships space, and many other revolutionary inventions. The technology we use nowadays is also widespread in the field of machine tools. They are becoming more and more independent through automation and artificial intelligence, evolving so quickly that there is a great possibility that they will replace the human job itself. The equipment used in the machine tool industry provides evidence of reduced productivity costs, optimized processes, and increased efficiency. All in all, automated systems and artificial intelligence bring a great advantage to companies, even if they require greater investment.

KEYWORDS: industrial engineering, technology, robots, efficiency, productivity

1. Introduction

Software and hardware developments in machine tools aim at the principles of Industry 4.0. They continuously enhance their intelligence and communication capabilities, establishing connections with other devices or production lines. In the world of Industry 4.0, this equipment brings significant results, leading to smooth production and processes.

Intelligent manufacturing technology increases efficiency and eliminates weak points within the system. It is characterized by highly interconnected industrial enterprises with advanced knowledge, where all organizations and operating systems are connected. As a result, productivity, sustainability, and economic performance are improved.

2. Project presentation

This research paper presents color sorting equipment used in various industries such as machine tools, food industry, and textile industry. This particular configuration is primarily dedicated to the machine tool industry, specifically in the field of 3D printers. The equipment works with different materials, such as resin, plastic with varying hardness, metal infusion, conductive material, magnetic material, etc. The system described in this paper is designed for sorting filaments with specific hardness but different colors.

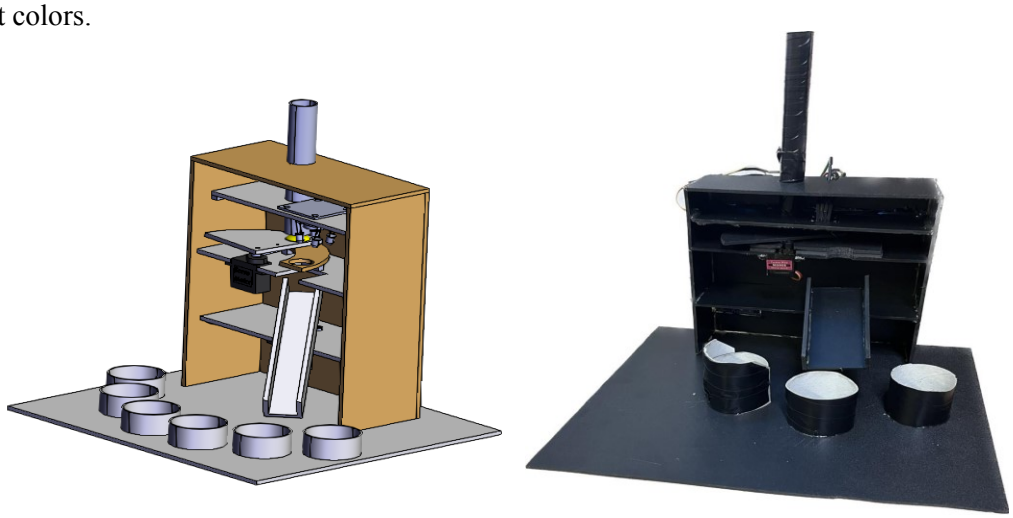

Fig. 1 3D Model and Physical Prototype

With the help of a conveyor, the filament roll reaches the storage container, and the servo takes them one by one, passing them in front of the color sensor. When the sensor detects a different color, the second servo moves the ramp towards the specific color container [1, 3].

3. Design and Connectivity

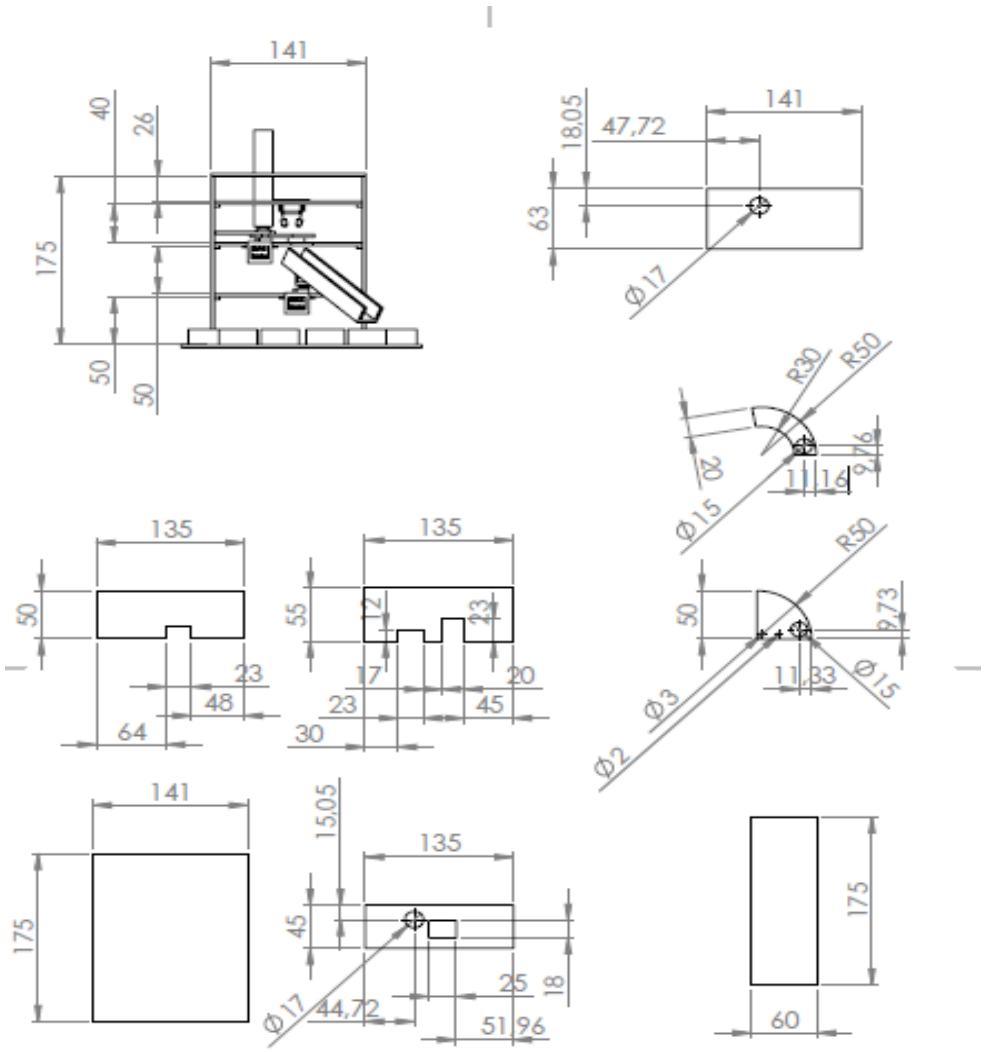

Fig. 1 Technical Drawing of the Parts

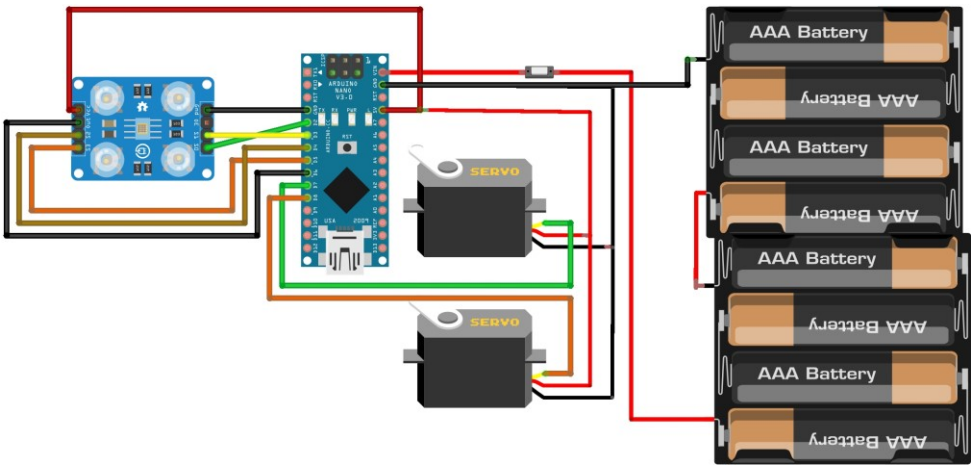

Fig. 2 Connection diagram

4. Advantages

• High Quality: Digitizing processes reduce the risk of human error and failure. This enables process monitoring and performance tracking, leading to increased efficiency and more effective resource utilization.

• Reduced Operational Costs and Predictive Maintenance: Smart factories can anticipate and resolve maintenance issues more rapidly, resulting in reduced equipment repair costs and minimized production disruptions.

• Enhanced Customer Satisfaction: Intelligent manufacturing provides managers with more accurate data and better measurement of key performance indicators, enabling them to serve customers more effectively and meet their requirements in real-time.

• Significant Cost Reductions: Improved access to supply chain and production data and analytics increases forecasting accuracy and reduces losses, contributing to cost reduction through proper demand management.

• Increased Productivity: Autonomous machines communicate with each other, generating vast amounts of data and enabling new analysis scenarios. Real-time insights into production processes help managers adjust efficiency planning and improve productivity.

• Higher Employee Satisfaction: Access to cutting-edge technology can attract and retain new talent. Additionally, modern technology reduces human errors, resulting in employees facing fewer issues related to dissatisfied customers.

• Energy Efficiency: All manufacturers can reduce their carbon footprint by minimizing waste. However, energy-intensive industries stand to gain the most in terms of energy savings, resulting not only in reduced energy waste but also increased product accessibility.

5. Programming/Code

```
int getRosuPW() {
  digitalWrite(S2,LOW);
  digitalWrite(S3,LOW);
  int PW;
  PW = pulseIn(sensorOut, LOW);
  return PW;
}


int getVerdePW() {
  digitalWrite(S2,HIGH);
  digitalWrite(S3,HIGH);
  int PW;
  PW = pulseIn(sensorOut, LOW);
  return PW;
}

int getAlbastruPW() {
  digitalWrite(S2,LOW);
  digitalWrite(S3,HIGH);
  int PW;
  PW = pulseIn(sensorOut, LOW);
return PW;
}
```

Fig. 3 Setting the Sensor for Color Frequencies

```
// Intervalele pentru fiecare culoare

int rosuMin = 14;
int rosuMax = 132;
int verdeMin = 17;
int verdeMax = 169;
int albastruMin = 15;
int albastruMax = 144;


int rosuPW = 0;
int verdePW = 0;
int albastruPW = 0;

int RV;
int GV;
int BV;
int rosuValue;
int verdeValue;
int albastruValue;
int color=0;
```

Fig. 4 Calibration of the Color Sensor

From the entire code, I have attached the most important parts of the program. In Figure 3, we have a set of instructions for each color that sets the frequency. The most crucial element in this equipment is the TCS230 color sensor [2]. It consists of 4 white LEDs directed towards the scanned element and a photodiode that captures the color reflection sent by the light. In Figure 4, we have the intervals for each color. To find the correct minimum and maximum values, we used a white sheet, which allowed the sensor to display the maximum value, and for the minimum value, we used the black color of the casing.

In addition to sorting, we also have two servos that are very useful. The first servo, which takes the elements and passes them in front of the sensor, has two possibilities programmed. When the color of

the element is recognized, it sends it to the sorting ramp. The second possibility is when the color is not found, the servo repeats the movement and passes in front of the scanner again. The second servo is responsible for moving the ramp towards the respective color container.

```
  Serial.print("Rosu = ");
  Serial.print(rosuValue);
  Serial.print(" - Verde = ");
  Serial.print(verdeValue);
  Serial.print(" - Albastru = ");
  Serial.println(albastruValue);
delay(500);


  color = readColor();
  delay(10);
  switch (color) {
    case 1:
    bottomServo.write(85);
    break;
    case 2:
    bottomServo.write(105);
    break;
    case 3:
    bottomServo.write(125);
    break;

    case 0:
    break;
  }
  delay(300);
```

Fig. 5 Positions for the Sorting Ramp

6. Conclusions

Industry 4.0 is an industrial paradigm that refers to the digital transformation of production processes and the integration of digital technologies in factories and other industrial units. The term was first used in 2011 in a research project funded by the German government [4]. Since then, the term has been adopted by the international community and is used to describe a new era of smart factories, automated production, and the integration of advanced digital technologies into the manufacturing process. In recent years, the concept of Industry 4.0 has evolved and expanded to include technologies such as the Internet of Things (IoT), artificial intelligence (AI), collaborative robots, augmented reality (AR), and others.

Since the introduction of this industry, productivity has increased by 20%, the production cycle time has been reduced by 45%, documentation volume has decreased by 50%, manufacturing defects have decreased by 18%, and order preparation time has been reduced by 27% [5]. Additionally, it enhances competition among companies, pushing them to raise their quality standards. There are numerous factors that position our country in a very favorable position for transitioning to Industry 4.0. Although there are voices claiming that we cannot make the leap from 2.0 to 4.0, Romania will benefit significantly and attract numerous investments. Automated systems are among the few innovative elements that Industry 4.0 brings.

In conclusion, improving equipment with automated systems is optimal even if their cost is higher. In the future, companies will recover these costs in a very short time.

7. Bibliography

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