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Pick and Place Robot for Sorting of Various Auto Components in Automobile Industry

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ABSTRACT

This paper shows how we made a new robot arm that can sort things by their color and shape. The arm can handle three colors and three shapes at once using smart ways to see and move things around. It works fast and gets things right, which is great for factories. The robot arm uses special tricks to spot colors and shapes, so it can sort stuff without any problems. It also uses smart computer programs to learn about different objects and places, so it can do a good job no matter what. We made sure it's easy to use too. People running the machine can tell it what to sort and keep an eye on how it's doing. One of the best things about this robot arm is that it can work with lots of different colors and shapes so it fits in well with other machines in a factory. We built it using new computer languages like Python and C++, so it can work on all kinds of systems and is easy to set up in different factories. We also followed all the rules for making good software, so it works really well and doesn't break down in factories.

Keyword : Robotic Arm, ESP32, C++ etc.

1. INTRODUCTION:

A color sensing robot is an intelligent robotic system designed to detect and respond to different colors using a color sensor. This type of robot plays an essential role in automation, sorting systems, educational tools, and quality control processes in industries. The core component of a color sensing robot is the color sensor, which can distinguish between colors such as red, green, blue, and others based on the light reflected from a surface. The robot processes input from the sensor and takes action accordingly, such as stopping at a specific color, following a colored path, or sorting objects based on color. This project combines electronics, programming, and sensor technology to build a robot capable of interacting intelligently with its environment based on color cues. It serves as an excellent demonstration of real-time embedded systems and robotics applications

1.1 Need For Automation

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics forms an attractive medium for low-cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production.

- To achieve mass production
- To reduce man power
- To increase the efficiency of the plant
- To reduce the work load
- To reduce the production cost
- To reduce the production time
- To reduce the material handling
- To reduce the fatigue of workers
- To achieve good product quality

1.2 Statement of Problem

In many industrial and manufacturing processes, the manual sorting of objects based on color is time-consuming, labor-intensive, and prone to human error. This inefficiency can reduce productivity, increase labor costs, and compromise product quality. A Color Sorting Robotic Arm is required to automate the process of identifying and sorting objects based on their color, improving accuracy, speed, and consistency while reducing the need for manual intervention.

1.3 Objectives

The primary objective of the Color Sorting Robotic Arm is to automatically detect, identify, and sort objects based on their color using sensors and robotic automation**.** This system aims to enhance operational efficiency by minimizing human effort, reducing sorting time, and ensuring greater accuracy and consistency in color-based classification of items.

2. LITERATURE SURVEY

3. COMPONENT OF PROJECT

3.1. Structure

The structure of a robot is usually mostly mechanical and can be called a kinematic chain. The chain is formed of links, actuators, and joints which can allow one or more degrees of freedom. Most contemporary robots use open serial chains in which each link connects the one before to the one after it. These robots are called serial robots and often resemble the human arm. Robots used as manipulators have an end effector mounted on the last link. This end effector can be anything from a welding device to a mechanical hand used to manipulate the environment.

3.2. Power Source

At present mostly (lead-acid) batteries are used, but potential power sources could be:

- Pneumatic (compressed gases)
- Hydraulics (compressed liquids)
- Flywheel energy storage
- Organic garbage (through anaerobic digestion)
- Still untested energy sources (e.g. Nuclear Fusion reactors)

3.3. Actuation

Actuators are like the "muscles" of a robot, the parts which convert stored energy into movement. By far the most popular actuators are electric motors that spin a wheel or gear, and linear actuators that control industrial robots in factors. But there are some recent advances in alternative types of actuators, powered by electricity, chemicals, or compressed air.

Actuators

3.4. Touch

Current robotic and prosthetic hands receive far less tactile information than the human hand. Recent research has developed a tactile sensor array that mimics the mechanical properties and touch receptors of human fingertips. The sensor array is constructed as a rigid core surrounded by conductive fluid contained by an elastomeric skin. Electrodes are mounted on the surface of the rigid core and are connected to an impedance-measuring device within the core. When the artificial skin touches an object the fluid path around the electrodes is deformed, producing impedance changes that map the forces received from the object.

Sensors

3.5. Vision

Computer vision is the science and technology of machines that see. As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences and views from cameras. In most practical computer vision applications, the computers are pre-programmed to solve a particular task, but methods based on learning are now becoming increasingly common. Computer vision systems rely on image sensors which detect electromagnetic radiation which is typically in the form of either visible light or infra-red light. The sensors are designed using solid-state physics. The process by which light propagates and reflects off surfaces is explained

using optics. Sophisticated image sensors even require quantum mechanics to provide a complete understanding of the image formation process.

3.6. Manipulation

Robots which must work in the real world require some way to manipulate objects; pick up, modify, destroy, or otherwise have an effect. Thus the 'hands' of a robot are often referred to as end effectors, while the arm is referred to as a manipulator. Most robot arms have replaceable effectors, each allowing them to perform some small range of tasks. Some have a fixed manipulator which cannot be replaced, while a few have one very general purpose manipulator, for example a humanoid hand.

3.6.1 Mechanical Grippers: One of the most common effectors is the gripper. In its simplest manifestation it consists of just two fingers which can open and close to pick up and let go of a range of small objects. Fingers can for example be made of a chain with a metal wire run trough it.

3.6.2 Vacuum Grippers: Pick and place robots for electronic components and for large objects like car windscreens, will often use very simple vacuum grippers. These are very simple astrictive devices, but can hold very large loads provided the pretension surface is smooth enough to ensure suction.

3.7 Power Supply (Battery/Charger)

The hydraulic jack may be powered by a rechargeable battery, especially if it's a mobile or portable unit. In the case of a remote-controlled jack, the remote control also requires a power source, typically batteries or a rechargeable pack.

Battery

A battery is a device that stores electrical energy in the form of chemical energy and converts it into electrical energy when needed. It consists of one or more electrochemical cells, each of which consists of two electrodes (an anode and a cathode) an electrolyte. Batteries are widely used to power a variety of devices, from portable electronics to electric vehicles and backup power systems. Batteries are essential for providing portable power to a wide range of devices, from electronics to vehicles and energy storage systems. They come in many different types, including primary and secondary (rechargeable) batteries, each with specific characteristics suitable for different applications. The performance, lifespan, and efficiency of a battery depend on its type, usage, and maintenance practices. Understanding how batteries work, how to maintain them, and how to safely dispose of or recycle them is essential for ensuring both effective performance and environmental safety.

Types of Batteries:

- Lithium-Ion (Li-ion) Batteries
- Nickel-Cadmium (NiCd) Batteries
- Nickel-Metal Hydride (NiMH) Batteries
- Lead-Acid Batteries

3.8 Colour sensing

Though while executing this project, there were many colour identification sensors available in the market place, sensor TCS3200 was selected because of its, price, speed and well formatted output. The output of TCS3200 is a square wave with frequency directly proportional to light intensity. This frequency was received by Atmega 2560 microcontroller for interpretation.

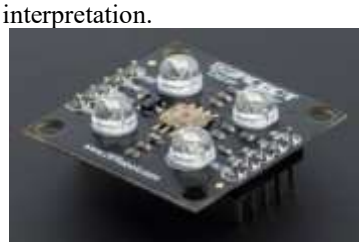


Fig 4.4 TCS3200 colour sensor for Arduino

Color Sensor is a complete color detector, including a TCS3200 RGB sensor chip and 4 white LEDs. The TCS3200 can detect and measure a nearly limitless range of visible colors. The TCS3200 has an array of photodetectors, each with either a red, green, or blue filter, or no filter (clear).

The filters of each color are distributed evenly throughout the array to eliminate location bias among the colors. Internal to the device is an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen color.

3.9 Wiring and Connectors

Cables and connectors are necessary to link the components, such as the power supply, motor, pump, valves, and the receiver unit. Proper insulation and weatherproofing are important for maintaining safety and reliability.

Wiring

Wiring and connectors are crucial components in electrical and electronic systems, enabling the transfer of power, signals, or data between different parts of a circuit or device. They play an essential role in ensuring the smooth, efficient, and safe operation of electrical systems, from small household gadgets to complex machinery like hydraulic jacks and remote control systems.

4. METHODOLOGY

4.1 Construction of Project

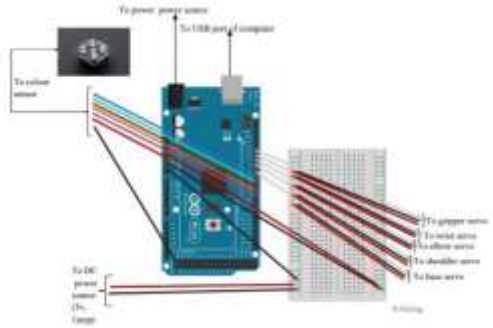
The methods used for construction of object sorting robotic arm based on colour sensing. Also, the materials used, the scientific and engineering characteristic properties that made those materials suitable, are explained in detail.

4.2 Material Selection

Building a robotic manipulator from scratch requires selection of material suitable for the job, and a suitable material is one that meets some design requirements. For this project, design requirements were: (i) Ease of machining (ii) Ease of shaping (iii) Durability (iv) Strength (v) Lightness (vi) Availability To prevent failure of each link of the arm when load is imposed, material with sufficient strength was used. Durability characteristic increases life span of robotic material. One-way cost minimization was achieved was by reducing torque requirement of the robot actuators through the use of light material. The material was also carefully selected to ensure ease of shaping because some components of the robotic arm required cutting of intricate shapes. Deep research shows that Perspex (polymethyl methacrylate or PMPA plastic) sheet features the above listed requirements as characteristics, so, the sheet was used for this project. Perspex sheet is easy to machine, of outstanding strength, cheap, and readily available. Density of Perspex is 1180kg/m3.

4.3 Implementation of Modeling:-

Figures below are block flow diagram (representing the entire implementation plan for the object sorting robotic arm) and circuit schematic diagram for the robot setup. Computer modelling is of great importance because it aids better understanding of a particular system and communicate ideas behind the system clearly. It helps visualize a system as it is, permits the specification of the structure and behavior of a system, and serves as template that direct the construction of system's prototype. Computer modelling also helps document decisions. As earlier mentioned in the introductory section of this report, the object sorting robotic arm has five degrees of freedom. A CAD model of the arm was designed with Autodesk® Inventor®. The modelling was sectioned into part modelling, assembly modelling and annotated drawing. During part modelling, all the components of the arm (the links, base, end-effector, turn table, actuators, colour sensor, controllers and joints) were designed separately. Then, the components were then imported to assembling workspace where coupling operation was performed. The output of assembly section was a full-scale model of the arm.



Circuit schematic diagram for the robot setup

4. CONCLUSIONS

The color sensing pick and place robot is an intelligent automation system that integrates color detection with robotic manipulation. It uses a color sensor to identify object colors, a microcontroller to process the data, and a robotic arm or gripper to physically move objects to their designated locations. This type of robot demonstrates the synergy between sensing, decision-making, and mechanical actuation key pillars of modern robotics. Such robots have practical applications in automated sorting, recycling, quality control, and manufacturing, offering improved efficiency, accuracy, and cost-effectiveness in various industries. Moreover, it serves as a valuable educational project for learning embedded systems, sensors, actuators, and programming.

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