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Design and experimental study of Automatic Colour Sorting by a Robotic arm System

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ABSTRACT

In many industries there is a need of sorting of the manufacturing products. Sorting process is a difficult task faced by many industries. Automatic sorting using a proposed system overcomes the difficulties caused by the manual sorting. This proposed system design is a robotic system which comprises of colour object detection and sorting them according to colour. The three colours objects viz. Red, Green and Blue are identified by a sensor. The robotic arm based on three motors is used to separate them. The TCS3200 programmable module based on light to frequency converter technology is used to detect different coloured objects. This type of self-intelligent robotics system performs all the activity automatically by its own. This paper discusses about the proposed robotic system that is required in different industrial work where automated and self-intelligence is highly recommended. The experimental study assures perfect automation by fulfilling the higher production requirement with proper quality.

Keywords: Arduino Uno Micro controller, colour sensing, robotic arm, DC motor, sorting objects.

INTRODUCTION

Robot is computer-generated machine-driven equipment. It is typically an electro-mechanical apparatus in which it is directed by the workstation or microelectronic software design, therefore capable of doing jobs on its individual. Alternative collective characteristics are that by its presence of actions, the robot frequently delivers a logic that it has determined of action of its own. The robot directs three separate functions called processing, action, and sensing. The attached sensor on the robot is preceptors, the onboard microcontroller or processors are the main units for processing and action is performed by using motor or additional mechanical elements.

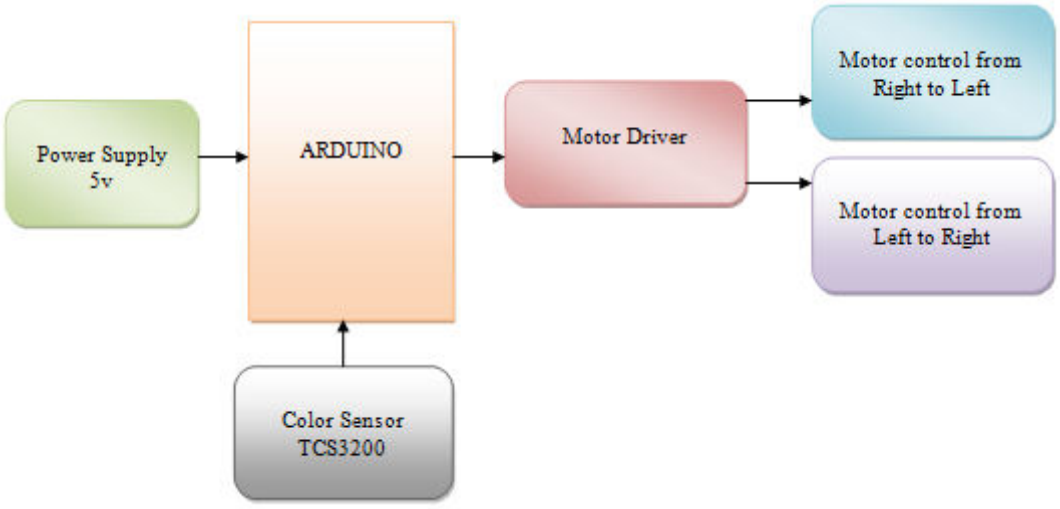
PROPOSED SYSTEM

The proposed system is a colour sorting robot by recognizing the different colours of the object, and collecting the object that are moving on the conveyer belt and distributes it in correct location according to colour. It is mainly used in

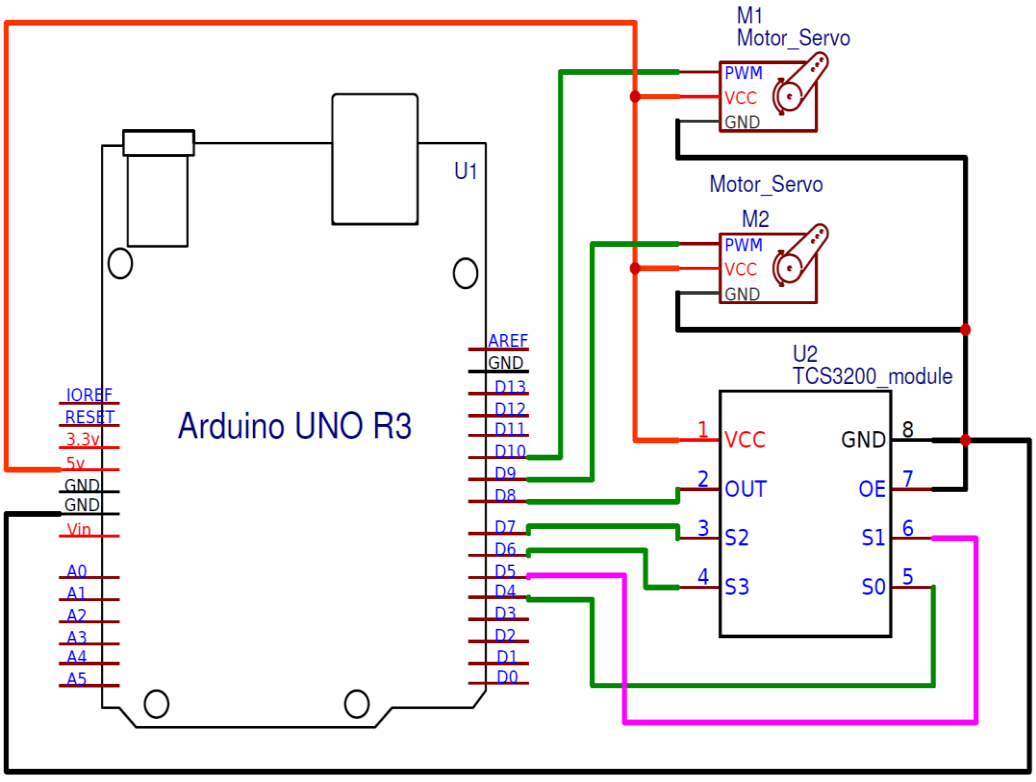
the risky or unknown environments where a person cannot do his job by reducing the risky work, time consumption and labour limitation. It is built by using the simple electronic devices like microcontroller for processing, DC motors for actions and colour sensor for recognizing different coloured objects.

DIAGRAMS OF THE WORKING MODEL

BLOCK DIAGRAM



CIRCUIT DIAGRAM



TOOLS REQUIRED

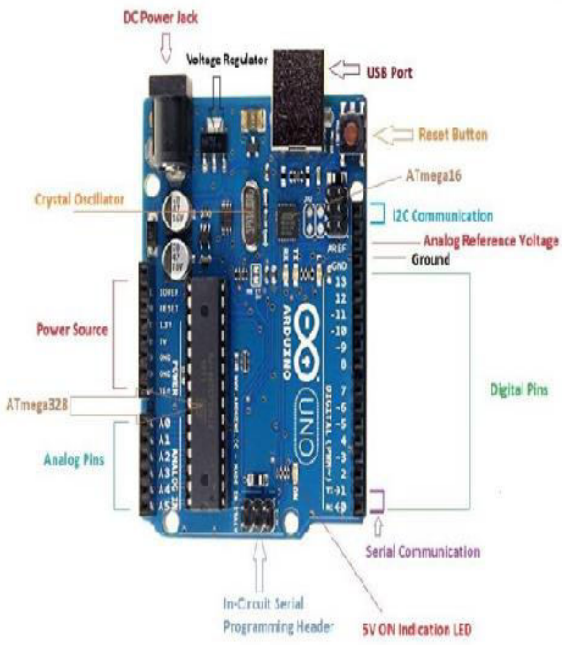
Hardware Requirements

- ARDUINO UNO
- COLOR SENSOR-TCS3200
- IR PHOTOTRANSISTOR
- STEPPER MOTOR
- COMPARATOR LM324
- MOTOR –DRIVER IC,L293D

Software Requirements

Arduino is a single-board microcontroller. The Arduino provides an integrated development environment (IDE) based on the Processing language.

Arduino Uno



Programming in Arduino

Arduino programs are written in the Arduino Integrated Development Environment (IDE). The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution.

Every Arduino sketch has two main parts to the program:

void setup () – Sets things up that have to be done once and then don't happen again.

void loop () – Contains the instructions that get repeated over and over until the board is turned off.

POWER SUPPLY

The Arduino board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

COLOUR SENSOR (TCS3200)

This **Arduino compatible colour sensor TCS3200 module** consists of a RGB sensor chip and 4 white LEDs. The main part is a Colour Light-to-Frequency Converter. The white LEDs are used for providing proper lighting for the sensor to detect the object colour correctly. It senses colours and gives the output in the form of corresponding frequency This chip consists of an 8 x 8 array of photodiodes. Each photodiode has either a red, green, or blue filter, or no filter. The filters of each colour are distributed evenly throughout the array to eliminate location bias

among the colours. Internal circuits include an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen colour. By selectively choosing the photodiode filter's readings, it is possible to detect the intensity of the different colours. The sensor has a current-to-frequency converter that converts the photodiodes' readings into a square wave with a frequency that is proportional to the light intensity of the chosen colour. This frequency is then, read by the Arduino.

FILTER SELECTION

To select the colour read by the photodiode, the control pins S2 and S3 is used. As the photodiodes are connected in parallel, setting the S2 and S3 LOW and HIGH in different combinations allows selecting different photodiodes.

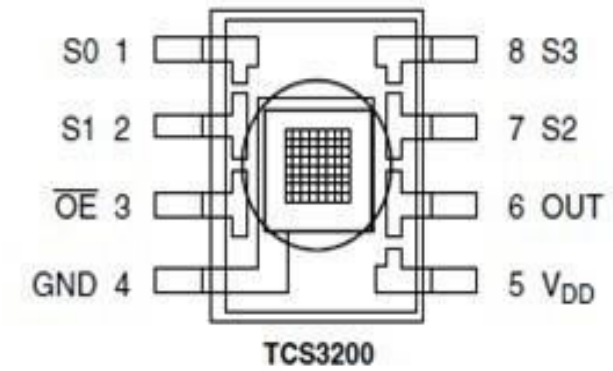
PROGRAMMING LOGIC

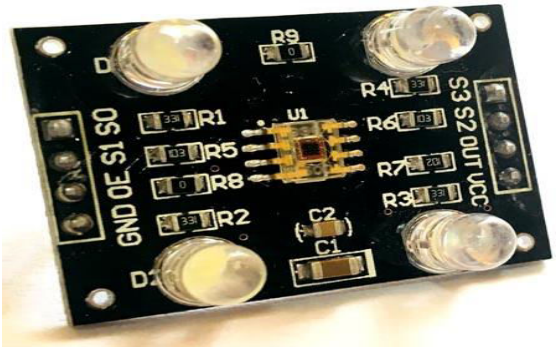
1) First set the input pins as input and output pins as output. No need to use analog pins.

2) Set S0 and S1 to high or low to set desired frequency scaling.

3) In loop, activate each filters by setting S2 and S3 to HIGH or LOW and measure frequency 'fo' from 6th pin to get corresponding color intensity. Compare frequencies of each color to determine the color of the object.

PIN CONFIGURATION OF THE SENSOR





L293D MOTOR DRIVER IC

The L293D is a 16-pin Motor Driver IC which can control a set of two DC motors simultaneously in any direction. The L293D is designed to provide bidirectional drive currents of up to 600 am (per channel) at voltages from 4.5 V to 36 V (at pin 8!).

DESCRIPTION OF THE SYSTEM WORKING

The colour sensors identify the colour of the object and it sends the data to a microcontroller which controls the arm motion of the robot according to the colour of the object. The motion of the servo motors are controlled in a manner so that each object is dropped into a respective boxes place in a predetermined position. The

time taken by the robotic arm for a single motion is set to approximately 0.5 seconds. Eight steps of motion of robotic arm are required for a object to be picked up and to be dropped in the correct basket. That includes motion of arm from the default position, picking a object, motion to the correct basket, dropping the object to the basket and return to the default position. The number of steps taken by the arm to pick the object and drop the object counts to seven steps and from there to back to default position needed one step. Approximate time needed for the microcontroller to identify colour of the object is around one second. Therefore the total time needed for picking and dropping the object including identifying the colour is around five seconds. Four motors are used in the robotic arm. One to control the rotational motion of the base, one to control the angle at the elbow, one to control the wrist movement and last one to control the gripper, that is to hold and drop the object. A lever mechanism is used for opening and closing the gripper. So a single motor is enough for the gripper control. Fingers come closer to pick and hold the object and move apart when it drops the object. Two positions are designed for the fingers by using a single servo motor, one in close position and the other in open position. Two motions are permitted for the motors at wrist and elbow that is to move up and down. Then by controlling the finger motion the object is picked. After picking the object arm return back to initial position by rotating motor at the wrist and elbow to default degrees. Here only one position of servo motor at finger varies from default position and the position of the motor. The motion of the motor at the base is controlled as per the colour of the object. The base motor is made to rotate to four different positions. One is the default position which keeps the arm directly above the sensor module. Other three motions keep the arm above the appropriate colour boxes. Two boxes are placed left to the base, one at extreme left and the other one located between extreme left and default position and one box at the right.

The connection between the TCS3200 and the Arduino is as follows:

- S0: digital pin 5
- S1: digital pin 6
- VCC: 5V
- S3: digital pin 7
- S4: digital pin 8
- OUT: digital pin 9

Colour Sensing requires Two Major Steps:

- Reading and displaying the output frequency on the serial monitor.
- Distinguish between different colours.

READING THE OUTPUT FREQUENCY

The Output Frequency of the desired colour is detected by placing a colour object in front of the sensor and the sensor in return gives various RGB values according to the colour that is being sensed.

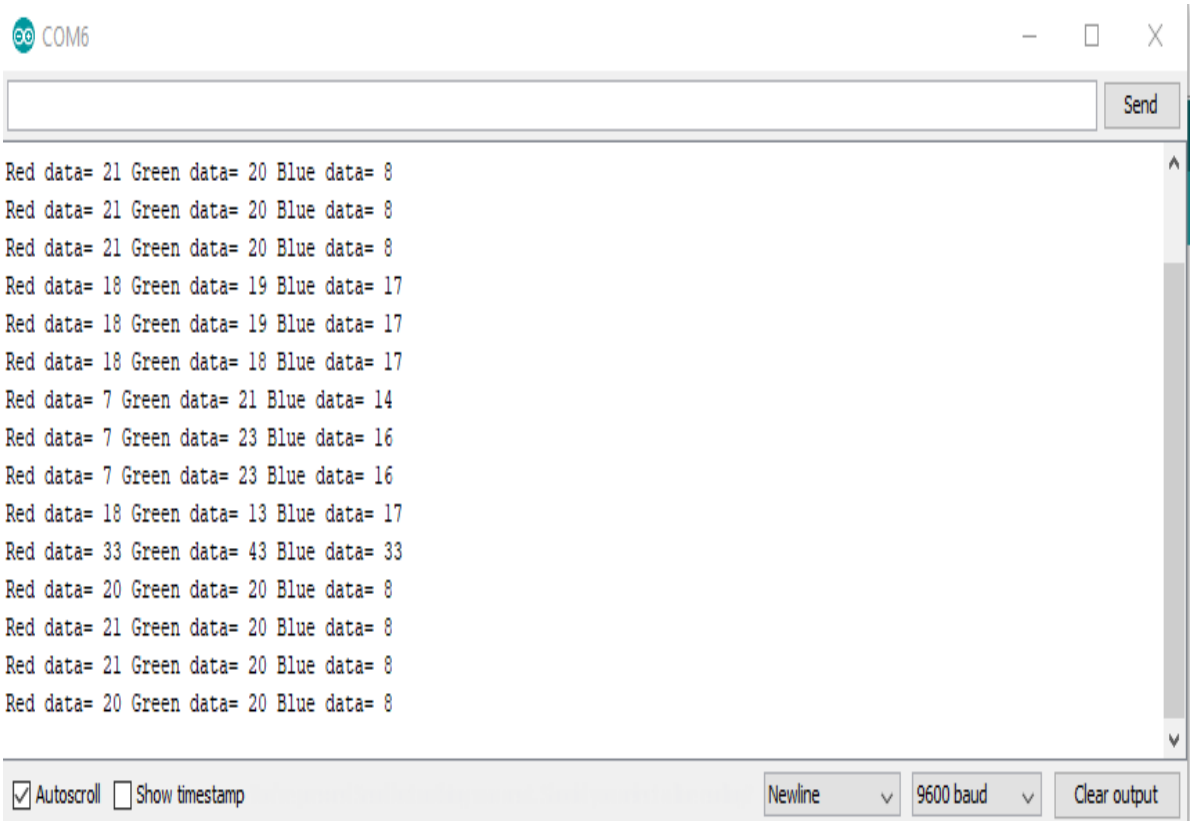
DISTINGUISHING COLOURS

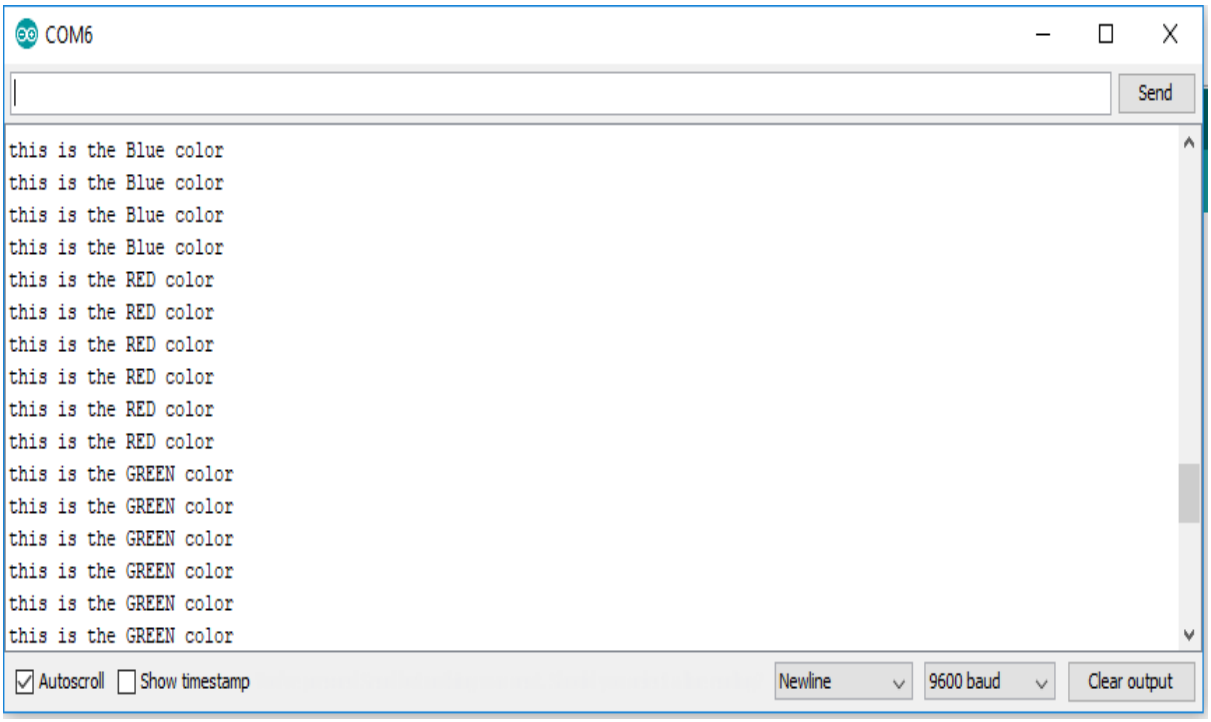
When the RGB value matches the red colour, then the monitor displays RED colour

- When RGB value matches green colour, display to be GREEN.
- When RGB value matches blue colour, then the object placed is a blue object.

COLOUR	R	G	B
RED	5-10	16-31	12-21
BLUE	12-29	14-28	7-13
GREEN	12-24	15-25	13-21

FREQUENCY TABLE





Sensed Colour output of the monitor

CONCLUSION

This proposed system has been effectively designed to handle the required task. It can identify the specific color of the object and grab it and place it in a required area as the user wants with the help of RGB color sensor by sensing the color of the object.

The two main tasks performed by the sensing section.

- Detection of objects.
- Recognition of color.

This system is fully controlled by the control unit and capable of picking objects and places it to the respective area. This sorting device is very much useful in production areas and different types of household activities. Thus the robot with select and insertion automation with color detection and distinction property is achieved successfully. The system could be used in industries for selecting and inserting objects efficiently and also for surveillance. The interfacing of all the components on a single board, the system could be made compact reducing the size and making it more compact.

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