

3.1 Overview:-

This chapter shows the overall design of a color sorting robot, sensor circuit, the operation concept with motor driver and the movement mechanism.

3.2 System Block Diagram:-

The following block diagram illustrates how the system's components interact with each other.

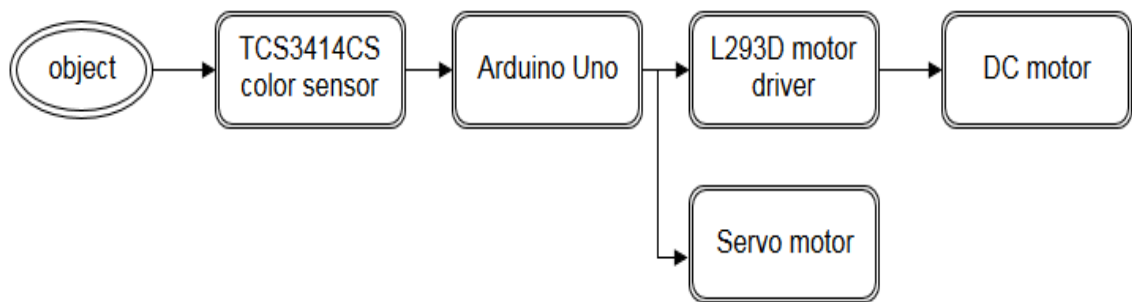


Figure 3.1: system block diagram.

The sensor detects the object's color and sends it to the Arduino Uno. The Arduino Uno tests whether the color is in the predefined ranges. Then sends signals to the servo motors and the DC motors through L293D driver. These motors are responsible for placing objects in their specified containers.

3.3 System Algorithm:-

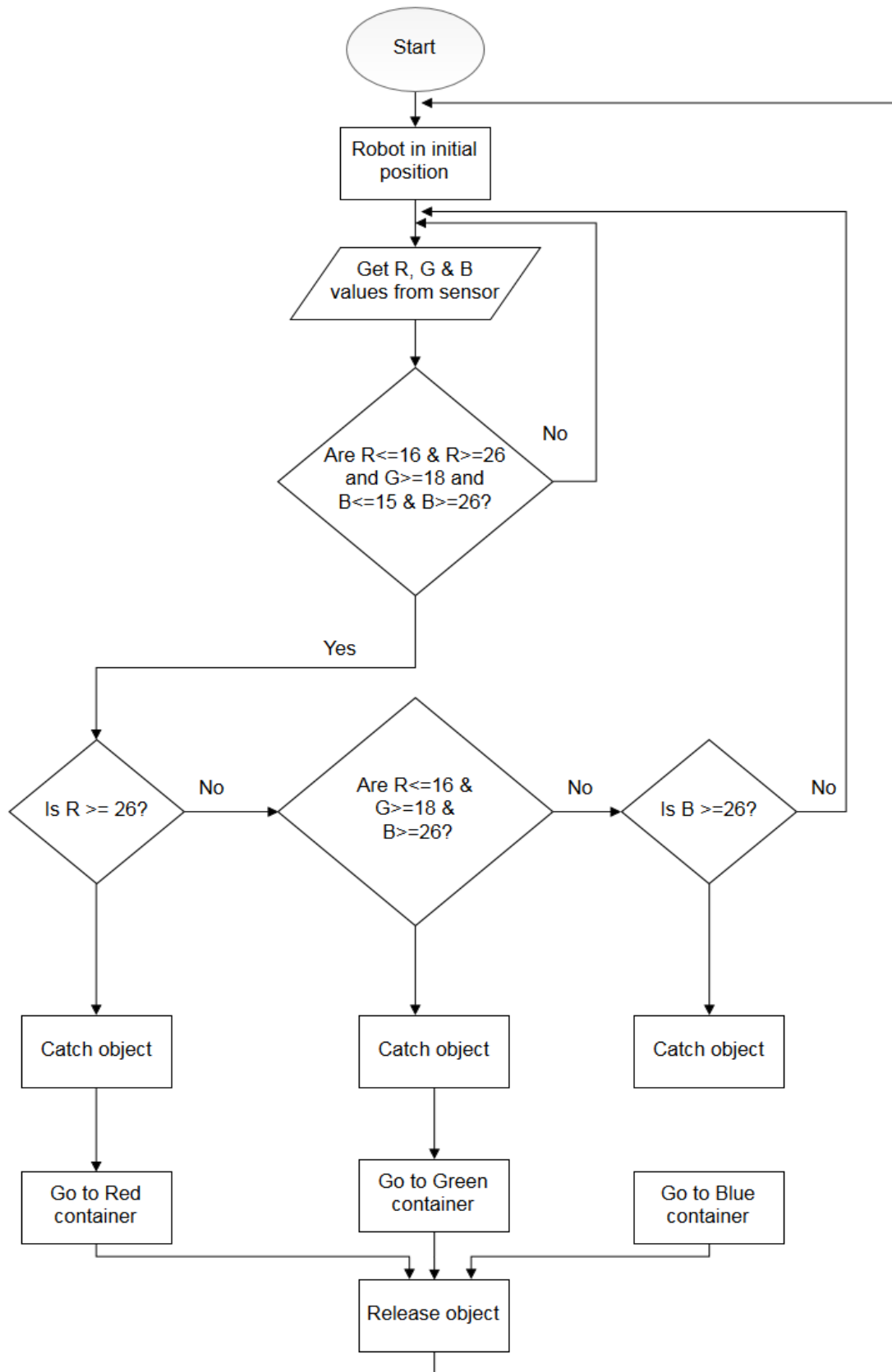


Figure 3.2: System Algorithm.

At the beginning, the robot must be in its initial position and the sensor detects the RGB component's values of the object's color and sends them to the Arduino Uno serially through I2C interface. The Arduino Uno is programmed to accept the ranges of the red component's values that are less than or equal to 16 and greater than or equal to 26, the green component's values that are greater than or equal to 18 and the blue component's values that are less than or equal to 15 and greater than or equal to 26. If the red component's value is greater than or equal to 26, Arduino Uno sends signals to the motors to catch the object and release it in the red container. To detect the green color three conditions must be conveyed. These conditions are: The red component's value is less than or equal to 16, the green component's value is greater than or equal to 18 and the blue component's value is less than or equal to 15. Then the robot catches the object and places it in the green container. If the blue component's value is greater than or equal to 26, the robot catches the object and releases it in the blue container.

Note: the robot returns to the initial position after releasing objects in their container.

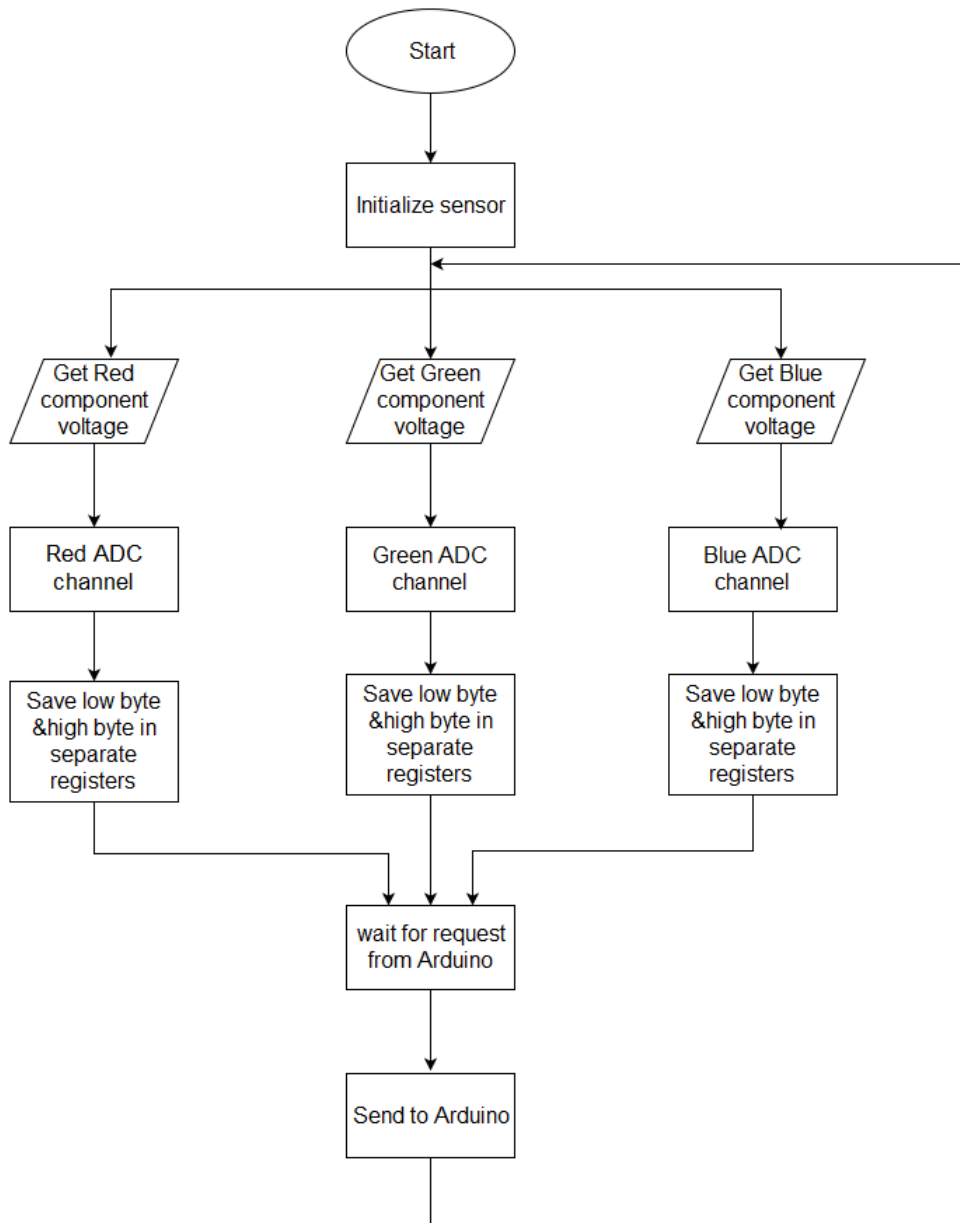


Figure 3.3: Sensor working algorithm.

The sensor is connected to Arduino Uno as slave through I2C connection with 0X39H address. To initialize this communication, the Arduino Uno provides a clock of 9600 bps to the sensor and sends a control word of 0X03H to the control register of the sensor to power it up and enable the ADCs.

After powering up, the sensor starts working and converts voltages from photodiodes into digital values at integration time of 12 ms and stores these values in two 8 bits registers.

To request a certain color component (Red, Green or Blue) the Arduino Uno sends a command with the address of the lower byte register of the specified color component, after receiving, it requests for the address of the high byte.

To shift the high byte up the following equation is used:

$$\text{Color Component} = (256 * \text{high byte of the color component}) + \text{low byte of the color component.}$$

3.4 Results and Discussion:-

Table 3.1: RGB values in high and low light conditions

Detected color	At high light conditions	At low light conditions
Red	R = 296 G = 98 B = 40	R = 26 G = 20 B = 17
Green	R = 103 G = 98 B = 48	R = 16 G = 18 B = 15
Blue	R = 74 G = 74 B = 98	R = 7 G = 10 B = 26

Discussion:-

The color sensor is calibrated in various environments and programmed according to these calibrations to be more flexible in detecting colors.

It calibrated to detect three colors; Red , Green and Blue color, but it has the ability to detect a large ranges of colors.

Obviously, the environments with high light exposure results in higher RGB values because the reflected light from the object disperses

in the white light so it becomes more closer to the white color which have the highest RGB components' among all colors. These environments give inaccurate values.

On the other side, the values from environments with low light exposure are relatively low due to low dispersion, these environments gives the best color detection.

Most of operation environments have a medium amount of light and falls between the previous ones. These environments are considered to be normal. This project works in such environments.

In the detection of the green color, the Red, Green and Blue components need to be specified because, it can conflicts with red and blue colors.

3.5 Hardware Implementation:-

The following figure shows the hardware implementation of the system:

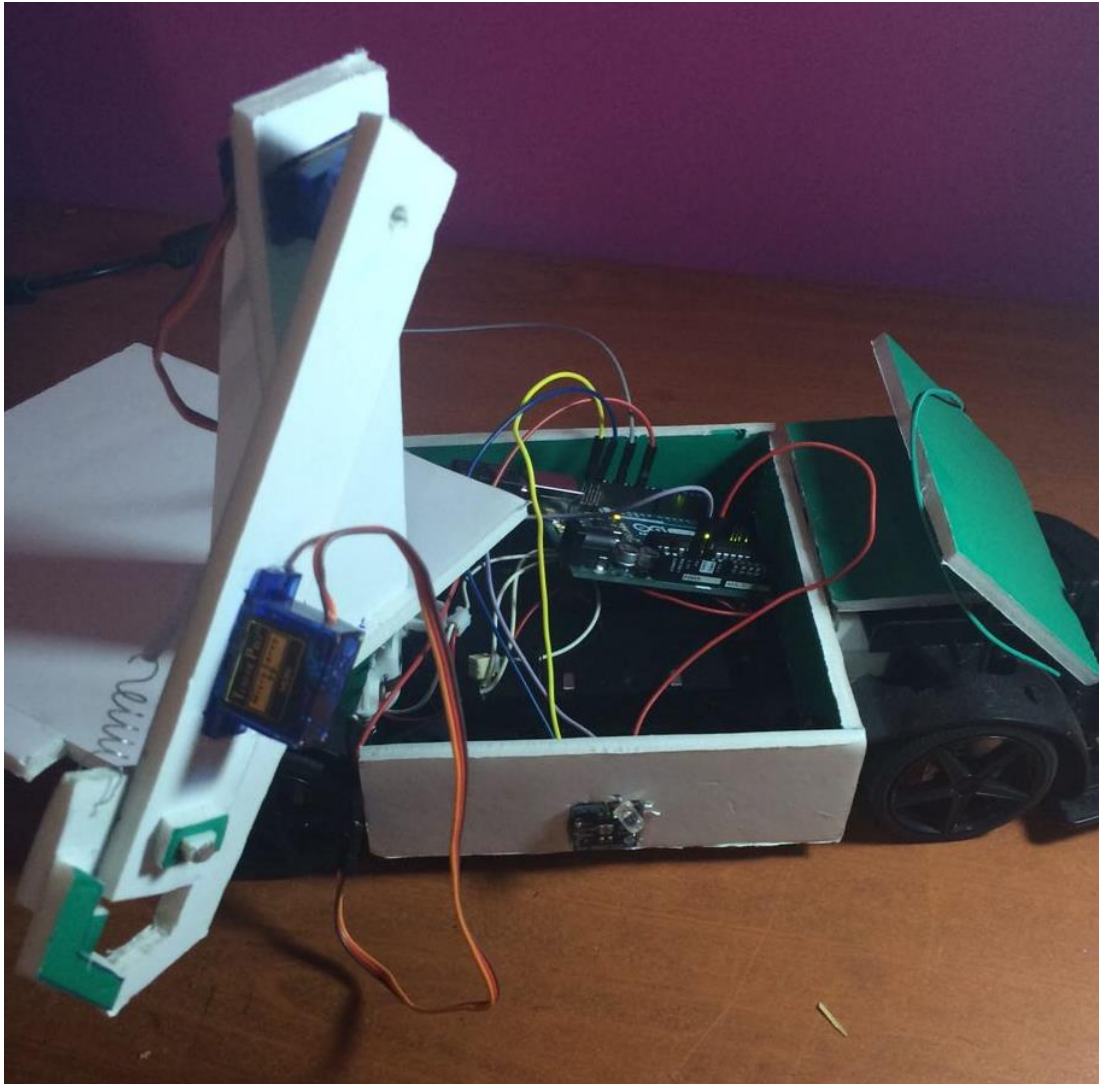


Figure 3.4: Hardware implementation.