A

MINI PROJECT REPORT

ON

"COLOR AND WEIGHT BASED SORTING MECHANISM"

FOR PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE
MINI PROJECT SUBJECT
OF T.E. E&TC – 2019 COURSE, SPPU, PUNE

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CERTIFICATE

This is to certify that the Mini Project report entitled

Title of project

has been successfully completed by

Omkar Navalgundkar	Exam no. T190053201
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Is a bona fide work carried out by them under the supervision of Mr. V. B. Vaijapurkar and it is approved for the partial fulfillment of the requirements for the Mini Project subject of T.E. E&TC – 2019 Course of the Savitribai Phule Pune University, Pune.

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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my supervisor, colleagues, faculty, and staff for their unwavering support and invaluable contributions that helped shape this project. Their guidance, expertise, and encouragement were instrumental in its completion. I extend my sincere appreciation to Mr. V. B. Vaijapurkar for providing essential resources that enhanced the quality of this work. Furthermore, I acknowledge and attribute all external sources referenced, honoring their intellectual contributions and ensuring ethical use of information. Their work has significantly enriched the content of this report, and I am thankful for their valuable contributions to my research journey.

Omkar Navalgundkar
Prajwal Padwal
Pravin Gurjar

ABSTRACT

This report presents the development and implementation of an industrial sorting mechanism that combines color and weight parameters for accurate and efficient object sorting. The system consists of a conveyor driven by a DC motor, an IR sensor to detect objects and stop the conveyor, and stepper motors to sort objects into four categories. It incorporates a TCS 3200 color sensor for color detection and a limit switch to distinguish between lightweight and heavyweight objects.

The primary goal of this project was to design a high-capacity sorting mechanism suitable for industrial environments. The conveyor system ensures continuous material flow, while the IR sensor enables precise object detection and conveyor control.

The industrial color and weight-based sorting mechanism offers numerous benefits across industries such as manufacturing, recycling, and logistics. It enhances productivity, reduces manual labor, and minimizes errors, resulting in improved overall efficiency and cost-effectiveness.

In conclusion, this project presents a comprehensive solution for industrial object sorting using color and weight parameters. The integrated conveyor, IR sensor, color sensor, limit switch, and stepper motors enable precise and efficient sorting. The successful implementation of the system in an industrial setting validates its practicality and effectiveness.

Omkar Navalgundkar

Prajwal Padwal

Pravin Gurjar

List of figures:

Feasibility report

Title: Color and weight-based sorting mechanism

Group members:

1) Omkar Navalgundkar 2) Prajwal Padwal 3) Pravin Gurjar

Tools required	**Testing possibility**	**Controller**	**Cost**
Hardware/components Stepper Motor 28byj-48 DC Motor 10 rpm L293D ULN2003 Color sensor TCS3200 Limit switch LM358 LM317 Miscellaneous	**Hardware** Yes	PIC 18F4550	450 90 x3 120 60 49 450 10 20 25 600 Total=2050
Software Proteus Design Blender MP Lab	**Software** Yes	—	
Tools available within campus or outside	**Sensors required**	**Signal conditioning if any**	
PCB printing Soldering gun PIC kit 3	Color Sensor TCS 3200 IR sensor	—	
Applications if any	**PCB design and fabrication**	**Datasheets/ application notes available**	
Sorting objects based on color and weight	Yes, we require PCB printing in college and from external sources	Yes available	
Mechanical design	**Enclosure design**	**Demonstration**	
Wooden base for conveyor, Rollers and conveyor belt of 1 meter length	Yes		540

Title of project: Color and weight based sorting mechanism

Electric specification

IC LM317
Input voltage range: 4.2V to 40V
Output voltage range: 1.25V to 37V

IR sensor
Input voltage range: 3.3V to 5V
Output Voltage range: 3.3V to 4.5V

Motor Driver
Input voltage range: 4.5V to 36 V
Output voltage range: 12V

Mechanical specification

The conveyor system is designed with the following specifications:
Base: 120cm x 20cm
Conveyor: 100cm x 10cm x 10cm
Material: Wood

Conveyor Belt
Dimensions: 200cm x 8.9cm
Material: Leather

Total cost of the project = 2540/-

Group members:

32128	Omkar Navalgundkar
32133	Prajwal Padwal
32139	Pravin Gurjar

CONTENTS

CHAPTER 1: Introduction

1.1 Background

Conveyor sorting systems—also sometimes referred to as sortation systems—are material handling technologies designed to increase the efficiency and accuracy of manufacturing and shipping operations. The project focuses on designing and implementing a conveyor sorting system for a manufacturing facility, with the aim of improving efficiency and reducing labor costs.

The history of conveyor sorting mechanisms dates to the early 20th century when the first conveyor belts were developed for use in the mining industry. Since then, conveyor sorting mechanisms have continued to evolve, with the introduction of more advanced sensors, motors, and control software. Today, these systems are widely used in a range of industries, including manufacturing, distribution, and logistics.

1.2 Relevance

In today's highly competitive business environment, manufacturing companies are under pressure to increase efficiency, reduce costs, and improve product quality. The conveyor sorting mechanism is a critical tool in achieving these objectives.

The conveyor sorting mechanism is highly relevant to electronics engineering because it provides a way to automate the sorting process, making it more accurate and efficient. The conveyor sorting mechanism incorporates advanced sensors, motors, and control software. The study of sensors and motors is highly relevant to Electronics.

1.2 Literature Survey

There are several types of conveyors sorting mechanisms, including diverters, pushers, and pop-up wheels. Each type of mechanism has its own advantages and disadvantages, depending on the application.

A range of sensor technologies are used in conveyor sorting mechanisms, including proximity sensors, vision systems, barcode scanners etc. These sensors are critical in detecting and sorting products accurately and efficiently.

Control systems are used to manage the sorting process and ensure that products are sorted accurately and efficiently. These systems can be programmed to sort products based on various attributes, such as size, shape, and color

S. Huang and S. S. Zhang, "Design and Control of a Conveyor-Based Sorting System," in IEEE Transactions on Automation Science and Engineering, vol. 10, no. 3, pp. 728-736, July 2013, Doi: 10.1109/TASE.2012.2236971. The paper provides insights into the design and control aspects of a conveyor-based sorting system. It focuses on the development and implementation of a sorting system that utilizes conveyors to efficiently sort objects based on specific criteria. One of the key contributions of the article is the proposed control algorithm for the sorting system. It provides practical insights into the implementation of intelligent control algorithms for optimizing object sorting processes.

N. S. A. Ali, A. R. A. Rahman, A. F. M. Asib and A. F. M. Hidayatullah, "Design and Development of Conveyor Sorting Mechanism for Industrial Applications," in 2018 IEEE Conference on Sustainable Utilization and Development in Engineering and Technology (CSUDET), Kuala Lumpur, Malaysia, 2018, pp. 1-5, Doi: 10.1109/CSUDET.2018.8644758. The conference paper focuses on the design and development of a conveyor sorting mechanism for industrial applications. The design and implementation of a sorting mechanism is described that utilizes conveyors to efficiently sort objects in an industrial setting. The paper presents the design considerations and components of the conveyor sorting mechanism, including sensors, actuators, and conveyor belts. The authors explain the integration of these elements to achieve effective object sorting based on predefined criteria.

1.4 Motivation

The project on color and weight-based sorting is motivated by several factors. Firstly, these sorting techniques have widespread industrial applications, such as in agriculture, food processing, recycling, and manufacturing. Exploring these applications can provide insights into their efficiency and productivity benefits.

Secondly, color and weight-based sorting contribute to quality control efforts in manufacturing, ensuring that only products meeting specific criteria are delivered. The integration of these techniques with automation and robotics can further enhance accuracy, speed, and scalability in sorting processes.

Thirdly, the environmental sustainability aspect of color and weight-based sorting is significant. By separating recyclable materials based on color and weight, valuable resources can be recovered, and waste sent to landfills can be minimized.

Overall, the project aims to contribute to the understanding of color and weight-based sorting techniques, their applications, and their impact on various industries. It provides valuable insights for businesses, researchers, and policymakers looking to enhance sorting processes and improve overall efficiency.

1.5 Aim and Objectives

To design a sorting mechanism to sort objects based on color and weight.

Objectives:

1. To study existing sorting techniques.
2. To develop a conveyor belt for the model using various motors.
3. To implement and verify the designed sorting system.

1.6 Technical Approach

1. **Overview of the system:**

- The installation includes conveyor driven by DC motor, IR sensor and stepper motors for flap installation.
- Includes a TCS 3200 color sensor to determine the color of the object and a limit switch to determine its weight.

2. **Conveyor use:**

- The DC motor is controlled using an L293D motor driver [4] circuit and PIC 18F4550 microcontroller.
- The microcontroller receives input from the IR sensor to detect an object on the conveyor belt. When the object is detected, the microcontroller stops the Conveyor belt for color and weight detection.
- After detection, the microcontroller releases the carrier to start the installation.

3. **Object Color Detection:**

- The TCS 3200 color sensor [6] is placed along the conveyor to detect the object's color once detected.
- The sensor provides color data to the microcontroller, which analyzes the values to determine the color of the object (red or blue).

4. How to determine weight:

- The limit switch is strategically placed under the conveyor belt to determine the weight category of the product (lightweight or heavyweight).
- If the switch is pressed, it means the object is lightweight.
- If the switch is not pressed, the item is heavyweight.

5. Sequence of Implementation:

- The object moving on the conveyor belt is detected by the IR sensor and the conveyor is stopped.
- The microcontroller receives information about the color and weight of the object and determines the appropriate category to which the object belongs.
- If the object is lightweight, the microcontroller controls the stepper motors to position the flaps accordingly.
- After the flaps are adjusted, the conveyor is started.
- The stepper motors move the flaps to direct the object into the available class bins (red light, blue light).
- If the object is heavyweight, the conveyor belt is started and the Jaw at the end of the conveyor belt is rotated once the object reaches the end of the conveyor belt and is dropped into the appropriate colored bins (red heavy, blue heavy).

6. Design and testing:

- The system requires calibration to ensure accurate color detection and weight distribution.
- Introduce calibration to set the limit switch sensitivity for weight detection by setting threshold values for color detection.
- The IR sensor requires accurate calibration every time to adjust to the ambient light in the room.
- Comprehensive testing is done to verify the system's effectiveness, including detection accuracy, conveyor control, movement of flaps and sorting accuracy.

CHAPTER 2: Block Schematic and Requirements

2.1 Introduction

The primary goal of this project was to design a high-capacity sorting mechanism suitable for industrial environments. By integrating color and weight parameters, the system offers several benefits across industries such as manufacturing, recycling, and logistics. These benefits include improved productivity, reduced manual labor, and minimized errors, resulting in enhanced overall efficiency and cost-effectiveness.

The key components of the system work together seamlessly to enable precise and efficient sorting. The conveyor system ensures continuous material flow, while the IR sensor detects objects and controls the conveyor's operation. The color sensor accurately identifies the color of objects, allowing for color-based sorting, and the limit switch provides an additional parameter for distinguishing between lightweight and heavyweight objects.

The successful implementation of this sorting mechanism in an industrial setting validates its practicality and effectiveness. It represents a comprehensive solution for industrial object sorting, offering a reliable and efficient method for optimizing productivity and minimizing errors. Overall, this sorting mechanism is a significant advancement in sorting technology, with wide-ranging applications across various industries.

2.2 Block Diagram

As shown in figure 2.2.1, the sorting mechanism consists of a power supply to power the main circuit. A microcontroller to interface between sensors and motor. Sensors to detect color and measure weight of object and a motor driver circuit to drive a motor.

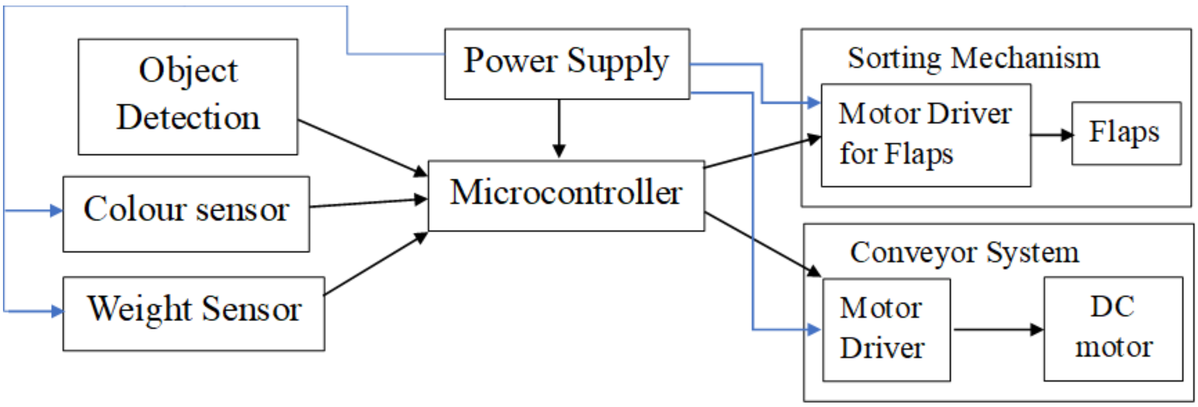

Figure. 2.2.1 Block diagram of the proposed sorting mechanism

Object Detection Sensor: The object detection sensor detects objects on the conveyor system. It can be an infrared sensor, ultrasonic sensor, or any other suitable sensor that can detect the presence or absence of objects.

Color Sensor: The color sensor [6] is connected to the microcontroller through suitable interfaces, such as analog or digital communication protocols. The microcontroller receives the color information from the sensor and can analyze it using algorithms or predefined color libraries. The microcontroller can then make decisions based on the detected colors, such as sorting objects into various categories.

Weight sensor: A weight sensor measures the weight or force exerted on it. The microcontroller reads the electrical signal from the weight sensor and performs necessary calculations. It can determine if the object's weight is above or below the threshold set by the user.

Microcontroller: The microcontroller serves as the control unit of the system. It receives inputs from the object detection sensor and color and weight sensor, processes the data, and generates control signals accordingly. The microcontroller can be programmed to interpret the sensor data, make decisions for sorting, and control the operation of the conveyor system and flaps.

Conveyor System: The conveyor system is responsible for moving objects from one point to another. It can consist of a conveyor belt, roller conveyor, or any other suitable mechanism to transport the objects along a predefined path.

Flaps for Sorting: The flaps are actuated devices that divert objects into different paths based on the sorting decision made by the microcontroller. The flaps can be pneumatic or motor-driven, and they are positioned strategically along the conveyor system to direct the objects into the appropriate bins or destinations.

Motor Drivers: The motor drivers [4] interface between the microcontroller and the motors that control the conveyor system and flaps. They amplify the control signals from the microcontroller and provide the necessary power and current to drive the motors.

Power Supply: The power supply provides the required electrical power to operate the entire system. It can be a regulated power supply that converts the input voltage to the suitable voltage levels required by the microcontroller, sensors, motor drivers, and motors.

Figure 2.2.2 shows the block diagram for IR sensor. It consists of an IR transmitter, an IR Receiver and a comparator circuit which compares received voltage level and threshold voltage.

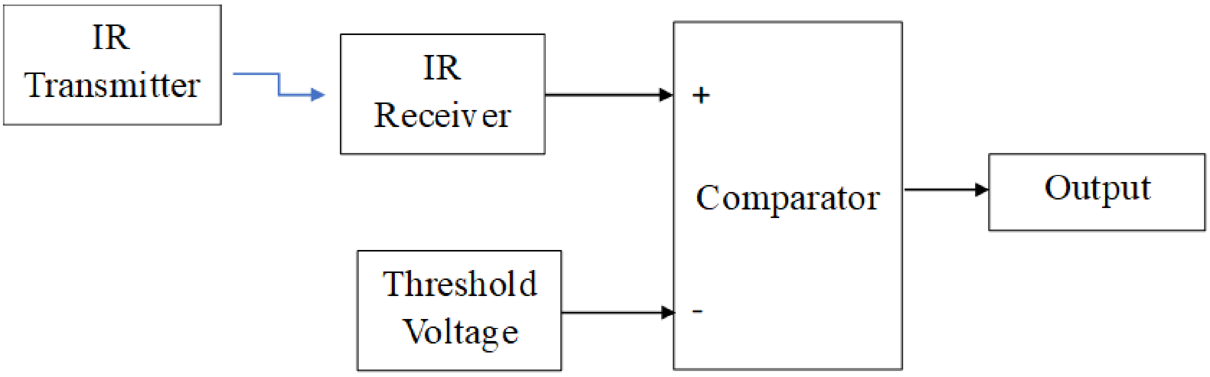

Figure. 2.2.2 Block diagram of IR Sensor

IR Transmitter: The IR transmitter emits infrared light signals. It typically consists of an IR LED that converts electrical signals into infrared light pulses.

IR Receiver: The IR receiver detects the infrared light signals reflected or emitted by objects in its vicinity. It consists of a photodiode or phototransistor that converts the received light into electrical signals.

Comparator: The comparator is an electronic component that compares two input voltages and provides a digital output based on the comparison result. In this configuration, the comparator is used to compare the output voltage of the IR receiver with a reference voltage.

Threshold Voltage Potentiometer: The threshold voltage potentiometer is an adjustable resistor used to set the reference voltage for the comparator. By adjusting the potentiometer, the threshold voltage can be varied, allowing the sensitivity or detection range of the IR receiver to be adjusted.

Figure 2.2.3 shows the block diagram of a variable power supply. Ac voltage is rectified using a rectifier and filtered to get a DC voltage and its value is regulated using a Regulator and a potentiometer.

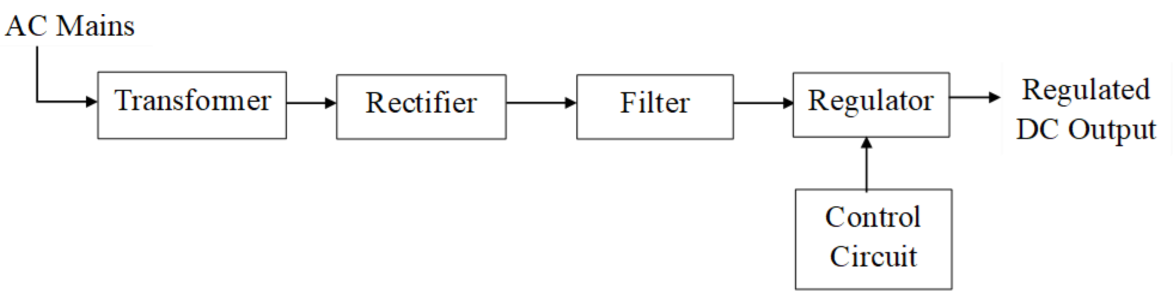

Figure. 2.2.3 Block diagram of Power Supply

AC Input: The power supply is typically connected to an AC mains source. The AC input block includes a fuse and power switch for safety and control.

Transformer: The AC input is connected to a transformer, which steps down the voltage from the mains source to a lower voltage level suitable for further processing.

Rectifier: The rectifier block converts the AC voltage from the transformer into a pulsating DC voltage. It usually consists of diodes arranged in a bridge configuration to rectify the alternating current into a unidirectional flow.

Filter: The filter block follows the rectifier and consists of capacitors and inductors. Its purpose is to smooth the pulsating DC voltage by reducing the ripple and providing a constant DC output.

Voltage Regulator LM317: The voltage regulator [5] block is responsible for maintaining a stable output voltage despite changes in input voltage and load conditions. It typically includes an operational amplifier (op-amp) and feedback circuitry to compare the output voltage with a reference voltage and adjust the control element, such as a transistor or integrated circuit, to regulate the output voltage.

Control Circuit: The control circuit block enables the user to adjust the output voltage and current levels. It typically includes potentiometers or digital controls to set the desired voltage and current values.

2.3 Requirements

Hardware:

- Microcontroller: PIC 18F4550: PIC 18F4550 microcontroller has more GPIO ports required for the project and has a faster clock speed.
- L293D Motor Driver: The L293D motor driver [4] is a versatile integrated circuit designed for motor control applications. It offers precise control over motor speed and direction, with a high current capability of up to 1.2A.
- DC Motor: DC motor provides increased torque, allowing for higher load capacity and better performance, all of which is required in our project.
- Color Sensor TCS3200 [6]: The microcontroller receives the color information from the sensor and can analyze it using algorithms or predefined color libraries. The microcontroller can then make decisions based on the detected color.

Software:

MPLAB

Proteus software used for PCB layout.

Blender for Conveyor design

2.4 Selection of sensors and major components

Following is the table for comparison of color sensor modules TCS-3200 and TCS-34725

Table 2.4.1. Color sensor selection table

Parameter	**Models**		**Units**
	TCS 3200	TCS 34725	
Datasheet	[6]	[7]	
V_{DD} (Supply)	2.7 to 5.5	2.7 to 3.8	V
I_{DD} (Supply)	1.4 to 2	0.235 to 0.330	mA
Output	Analog	Digital	--
Sensing Range	400-700	380-950	nm
Resolution	256 discrete steps	65536 discrete steps	--
Manufacturer	Texas Instruments	AMS	--

The TCS 3200 color sensor was chosen because it was the best fit for the project's needs. The project only needed to detect two colors (red and blue), and the TCS 3200 is able to measure the frequency component of each color separately (R,G,B). The TCS 34725 has much higher resolution than the TCS 3200, but this was beyond the project's requirements and would have increased the cost.

Table 2.4.2 compares the 3 different comparator modules used in the IR sensor module

Table 2.4.2. Comparator IC selection table

Parameter	**LM393**	**LM358**	**LM741**	**Units**
Datasheet	**[10]**	**[11]**	**[12]**	
Package Type	DIP, SOIC	DIP, SOIC	DIP, TO-99	-
Number of Op-Amps	Dual	Dual	Single	-
Supply Voltage Range	3 to 36	3 to 36	±5 to ±22	V
Input Offset Voltage	4	7	15	mV
Input Bias Current	-50	20	80	nA
Gain Bandwidth Product	10	1.2	1	MHz
Slew Rate	0.5	0.5	0.5	V/µs

The LM358 operational amplifier was chosen due to its high gain-bandwidth product. The project required an operational amplifier that could effectively amplify the signal, as the HIGH input for the PIC 18F4550 is at +5 Volts. The LM358 has a high gain-bandwidth product so that it can amplify signals with a high frequency without distorting the signal.

Table 2.4.3 show the comparison of microcontrollers PIC18F4550 and ATmega328P.

Table 2.4.3. Microcontroller selection table

Feature	**PIC18F4550**	**ATmega328P**	**Units**
Datasheet	[8]	[9]	
Architecture	8-bit Harvard	8-bit Modified Harvard	-
Clock Speed	Up to 48 MHz	Up to 16 MHz	MHz
Flash Memory	32 KB	32 KB	KB
RAM	2 KB	2 KB	KB
GPIO Pins	33	23	-
ADC	10-bit, 13 channels	10-bit, 6 channels	-
Communication Interfaces	USB 2.0, UART, SPI, I2C	UART, SPI, I2C	-
Peripherals	Timers, PWM, Interrupt Controller	Timers, PWM, Interrupt Controller	-
Development Tools	MPLAB IDE	Atmel Studio IDE	-

The PIC 18F4550 microcontroller was chosen over the ATMega 328p microcontroller because it has more general-purpose input/output (GPIO) pins. The project required 27 GPIO pins to interface all of the sensors and actuators, and the ATMega 328p only has 23 GPIO pins, while the PIC 18F4550 has 33. Additionally, the oscillator frequency of the PIC 18F4550 is higher than that of the ATMega 328p. The project required a higher clock speed to make quick decisions, such as starting and stopping the conveyor, sensing the color of the object, and adjusting the jaw that sorts heavy objects.

CHAPTER 3: System Design

3.1 Calculations

Designing a linear variable power supply using the LM317 IC requires several calculations and considerations. Here are the detailed calculations and formulas for each component of the design:

1. Input Voltage (Vin):
   -Vin = 15V.

2. Output Voltage (Vout):
   - Determine the desired output voltage range. Let's assume Vout can be adjusted from 1V to 12V.

3. Resistor R1 Calculation:
   - Use the formula: Vout = 1.25V × (1 + R2/R1) …..(Equation 3.1.1)
   - Choose R1 based on the desired Vout range and R2 value.
   - For example, if R2 is a 240-ohm potentiometer and you want Vout to range from 1V to 12V, you can select a fixed resistor R1 = 220 ohms.

4. Resistor R2 Calculation:
   - Use the formula: Vout = 1.25V × (1 + R2/R1)
   - Rearrange the formula to solve for R2: R2 = R1 × (Vout/1.25V) - R1 …..(Equation 3.1.2)
   - Calculate the value of R2 for different desired output voltages (Vout) using the chosen R1 value.
   - Note that R2 is typically a potentiometer to allow adjustable output voltage.

5. Current Limiting Resistor (R3) Calculation:
   - The LM317 has an internal reference voltage of 1.25V.
   - To limit the maximum current, use the formula:
     Iout(max) = 1.25V/R3 …..(Equation 3.1.3)
   - Determine the maximum desired output current(Iout(max)).
   - Calculate the value of R3 using the desired Iout(max). Keep in mind the power dissipation of R3 (P = I^2 * R) and select a suitable wattage resistor. ....(Equation 3.1.4)

6. Input Capacitor (C1) Calculation:

- Determine the desired input voltage ripple and the input current requirements.
- Calculate the minimum value of C1 using the formula:

$C1(min) = Iin(max)/(\Delta Vin \times f)$ …..(Equation 3.1.5)

- Iin(max) is the maximum input current, ΔVin is the acceptable input voltage ripple, and f is the mains frequency (typically 50Hz or 60Hz).

7. Output Capacitor (C2) Calculation:

- Determine the desired output voltage ripple and the load current requirements.
- Calculate the minimum value of C2 using the formula:

$C2(min) = Iout(max)/(\Delta Vout \times f)$ …..(Equation 3.1.6)

- Iout(max) is the maximum output current, ΔVout is the acceptable output voltage ripple, and f is the desired ripple frequency (typically 100Hz or higher).

Note: It's important to consult the LM317 datasheet for specific guidelines, recommended component values, and additional considerations. Additionally, ensure that you consider heat dissipation and thermal considerations when designing a linear power supply.

Please keep in mind that working with mains voltage and power supplies involves safety risks. It's crucial to follow appropriate safety measures and consider consulting with an experienced engineer or professional during the design process.

Power supply Calculations:

Vo=0-30 V

I0= 1.0A

Vo=1.25*(1+R2/R1)

Vo=12V

Here R1=220Ω

Hence,

R2= R2=R1*(Vout-1.25)/1.25

R2=1.8KΩ

3.2 List of Components

Finally list all the components selected, calculated in the table below

Table 3.2.1: List of components required in project.

Sr. No	Name and description of part	Value / model number
1	PIC Microcontroller	PIC 18F4550
2	Unipolar Stepper Motor – Permanent magnet	28BYJ-48
3	DC motor – 12 V	10 rpm, 7 kg-cm torque
4	Color Sensor	TCS-3200
5	IR sensor	Self-designed
6	Limit switch	-
7	Conveyor belt	200 cm x 8 cm
8	DC Motor Driver	L293D
9	Stepper Motor Driver	ULN2003

3.3 Mechanical Design

Design of the conveyor system – The dimension of the conveyor is 100 cm x 10 cm x 10cm. The diameter of the rollers is 7 cm. The base is 120 cm in length and 20 cm in width. The entire proposed model is shown below. Figure 3.3.1 shows the top view of the Conveyor system.

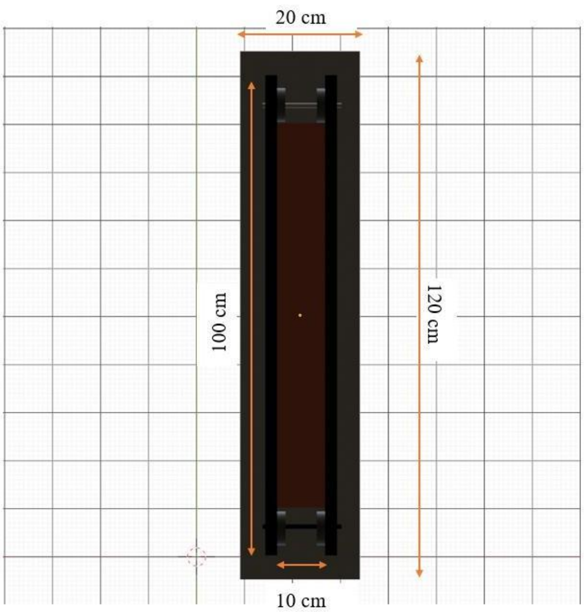

Figure 3.3.1 Top view of the conveyor system

Figure 3.3.2 shows the front view of the Conveyor system.

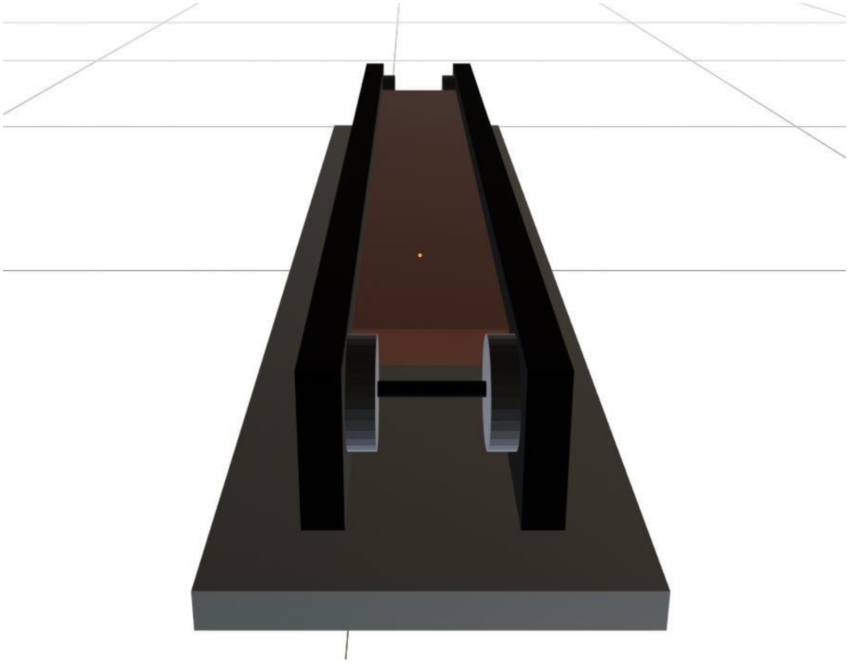

Figure 3.3.2 Front view of the conveyor system

CHAPTER 4: Implementation, testing and debugging

4.1 Implementation on bread board, observation table

Figure 4.1.1 shows breadboard implementation of variable power supply using regulator IC LM317 and rectifier and filter circuits and potentiometer for varying output voltage.

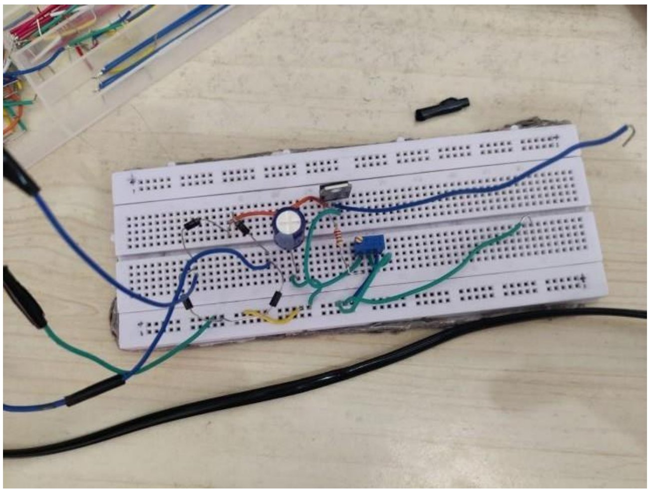

Figure 4.1.1. Power supply breadboard testing

Table 4.3.1.Variable Power Supply Observation Table

Sr No	Voltage (volts)	Rheostat (kΩ)
1.	5	0.644
2.	6	0.830
3.	7	1
4.	8	1.3
5.	9	1.38
6.	10	1.6
7.	11	1.83
8.	12	1.86

Figure 4.1.2 shows breadboard testing of IR sensor, the left image showing no object and the one on the right showing object detection.

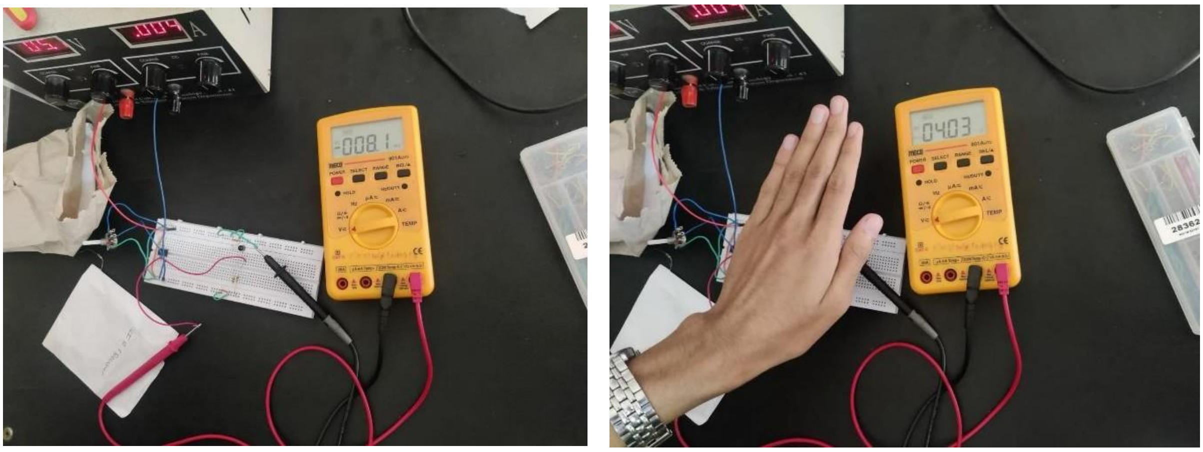

Figure 4.1.2. IR sensor breadboard testing

4.2 Testing, Debugging, Observation table

In figure 4.2.1, the pcb of variable power supply is tested of variable voltage levels

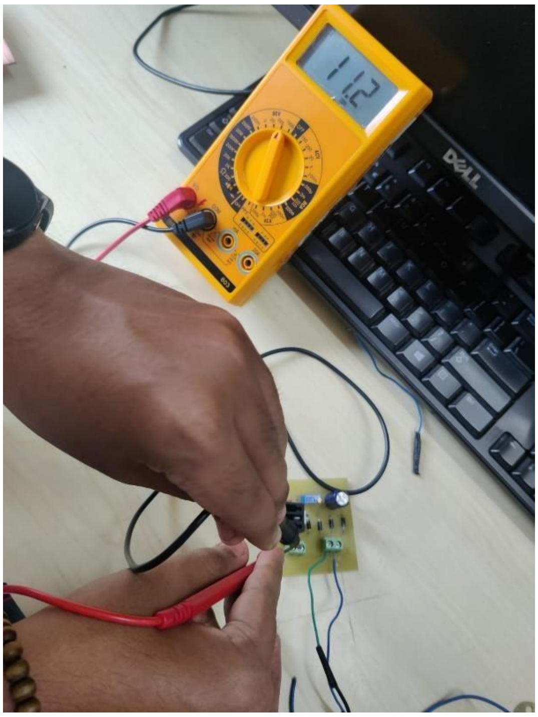

Figure 4.2.1 Power supply PCB testing

Figure 4.2.2. shows the IR sensor pcb testing. High output voltage is obtained when object is detected by IR sensor

Figure 4.2.2 IR sensor PCB testing

4.3 Simulation results, observation table

Figure 4.3.1 show simulation of variable power supply in proteus software. The simulation can provide insights into power distribution, regulation and performance of the circuit under different conditions. This allows assessment of power requirements, efficiency and potential issues before implementing actual physical implementation.

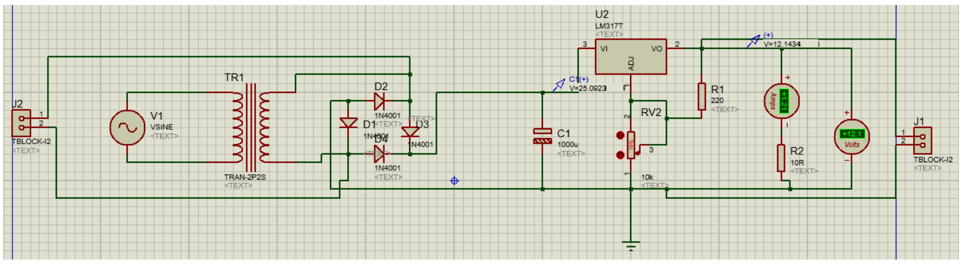

Figure 4.3.1 Power supply Simulation

Figure 4.3.2 shows schematic of IR sensor made using proteus software. The behavior of IR sensor can be tested before implementing on actual circuit through this simulation.

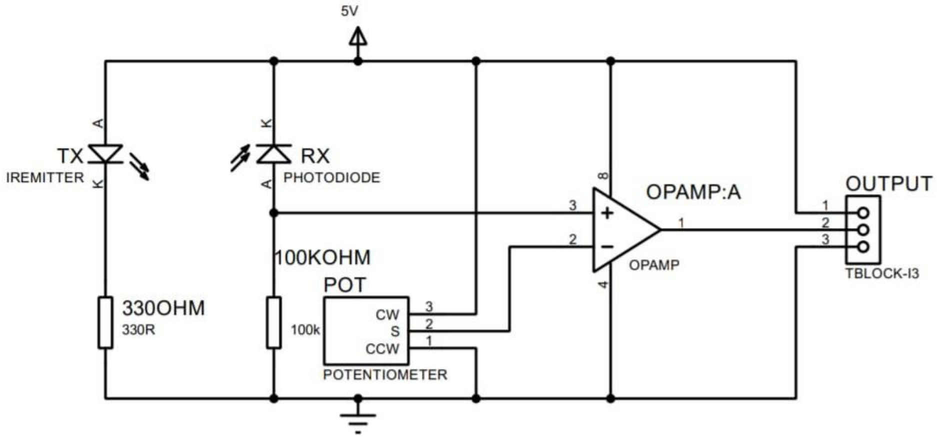

Figure 4.3.2 IR sensor schematic

Figure 4.3.3 shows schematic of the sorting mechanism consisting of 2 IR sensors, a color sensor, limit switch, motors and their drivers.

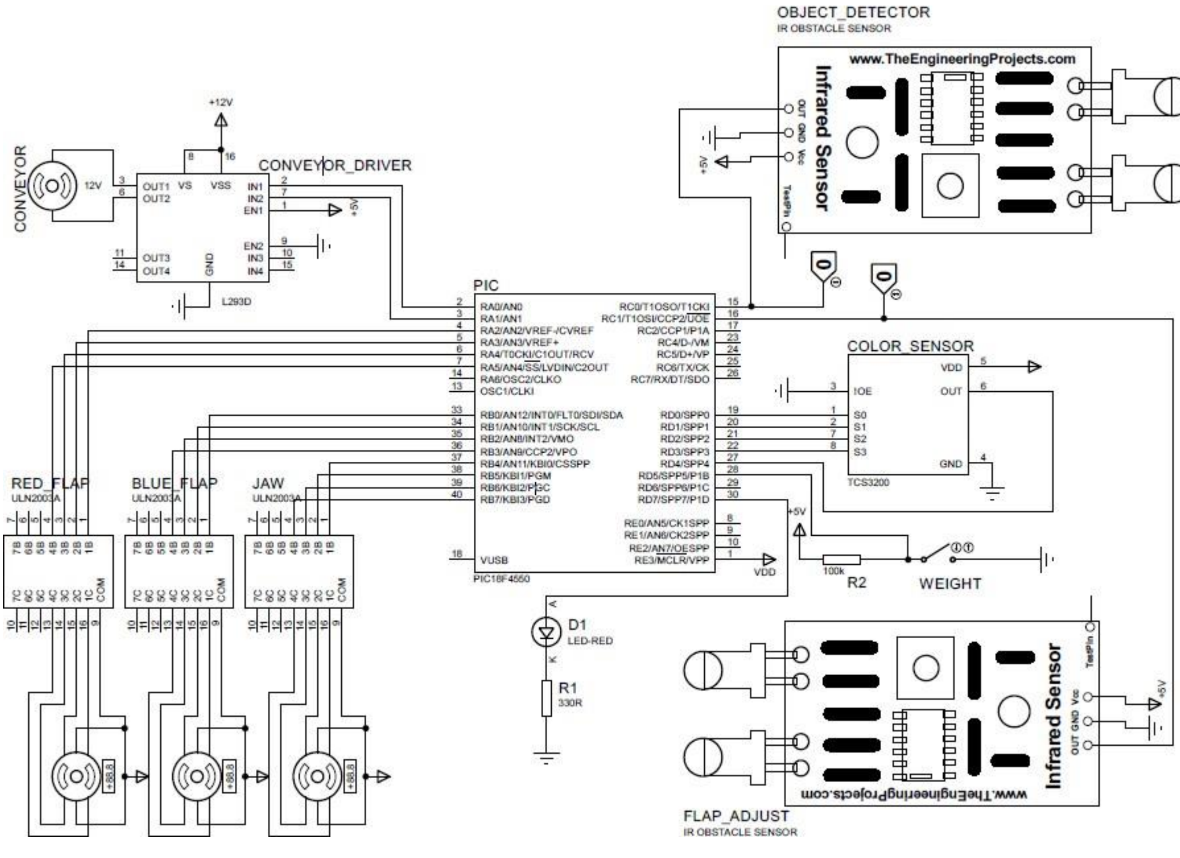

Figure 4.3.3 Sorting mechanism schematic

4.4 PCB design

Figure 4.4.1. shows PCB design of variable power supply.

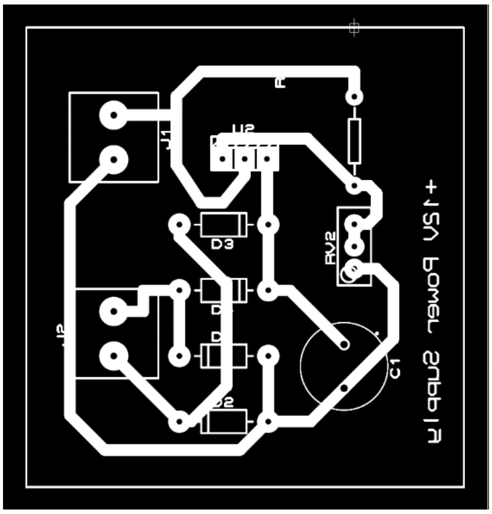

Figure 4.4.1 Power supply pcb design

Figure 4.4.2. shows PCB design of IR Sensor

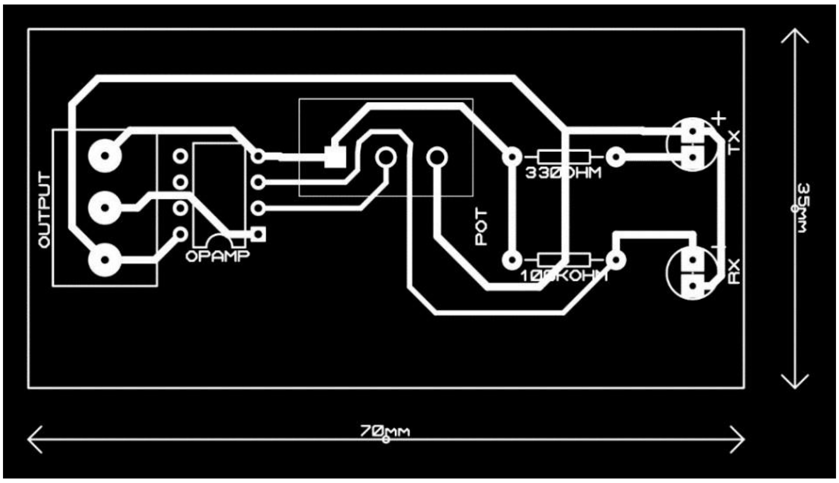

Figure 4.4.2. IR sensor pcb design

Figure 4.4.3. shows PCB design of PIC Board for Interfacing the I/O Devices

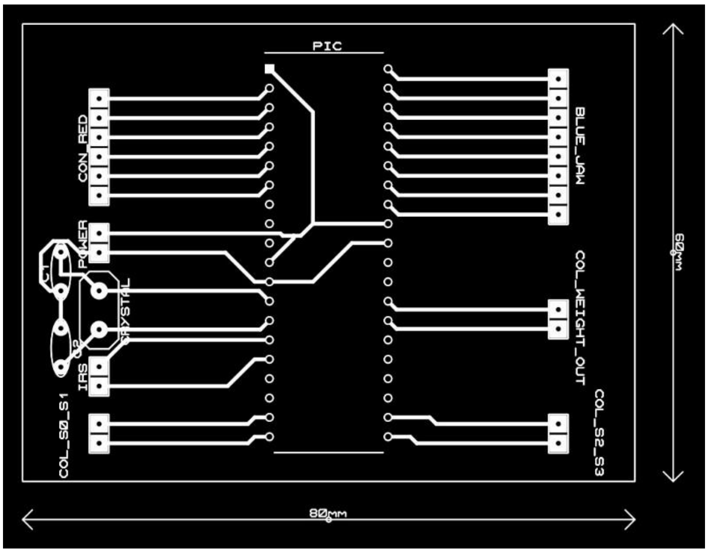

Figure 4.4.3. PIC board pcb design

4.5 Final project photograph and working

Figure 4.5.1 shows the complete conveyor assembly and the sorting mechanism. Blue color object is placed on the conveyor. A 12-volt power supply drives the dc motor for conveyor and the flap mechanism using stepper motors. Also, a 5-volt power supply drives the pic microcontroller and the IR sensor module. A detailed step by step working is as follows:

1. The blue object is placed on the conveyor belt.
2. The infrared sensor detects the object and sends a signal to the PIC microcontroller.
3. The PIC microcontroller reads the signal from the infrared sensor and determines the color of the object.
4. The PIC microcontroller reads the signal from the weight sensor and determines the weight of the object.
5. The PIC microcontroller sends signals to the stepper motors that control the flaps.
6. The stepper motors move the flaps to the appropriate position.
7. The conveyor belt moves the object to the flaps.
8. The object is sorted into the appropriate bin.

The TCS 3200 color sensor consists of 64 photodiodes distributed equally. 16 have red light filters, 16 have green light filters, 16 have blue light filters and the remaining 16 have no filters. Each type of diode can be selected using S2 and S3 select pins. Only red and blue filters are needed. The output of the color sensor can be seen at the ‘out’ pin of the sensor.

The out pin returns the pulse width of the selected color. If the red color pulse width is more than the blue color pulse width, the object is of blue color (as pulse width is inversely proportional to frequency).

Figure 4.5.1 shows the complete conveyor assembly and the sorting mechanism.

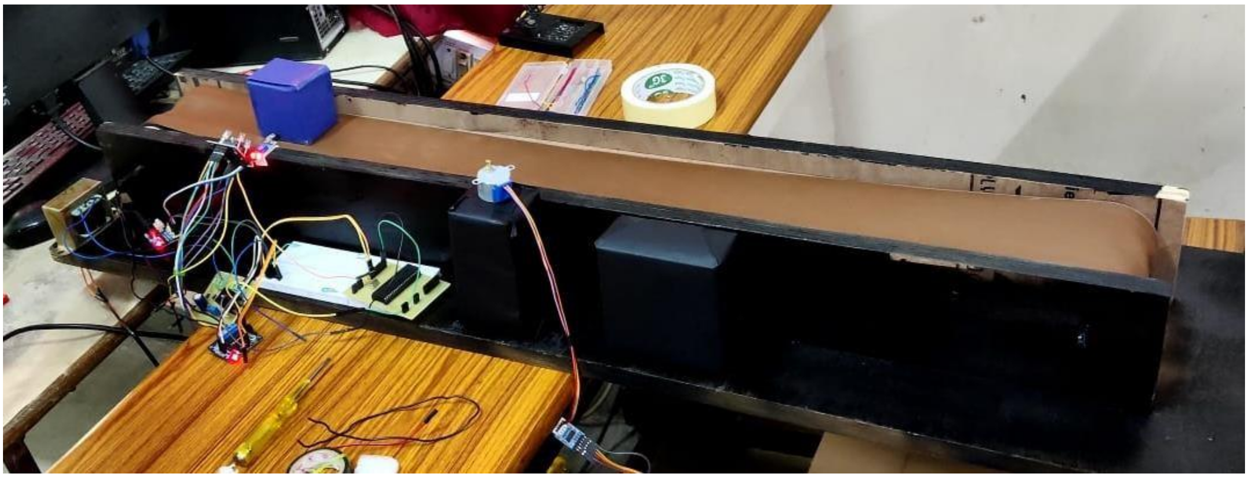

Figure 4.5.1. Final project photograph

CHAPTER 5: Results and Discussion

The IR sensor module, designed by us, was tested and gave the following results. Given below are the threshold voltage values for specific distances of the object from the sensor.

Table 5.1 Distance vs Threshold Voltage of IR Sensor

Threshold Voltage (V)	Object Distance (cm)
4.6	12
4.69	11.5
4.75	11
4.78	10.5
4.81	10
4.85	9.5

Figure 5.1 shows the plot for 'Threshold Voltage vs Distance' for IR sensor. In this graph, the threshold voltage is plotted on the horizontal axis, while the object distance is plotted on the vertical axis. Each data point is represented by an asterisk (*) to indicate the estimated relationship between threshold voltage and object distance.

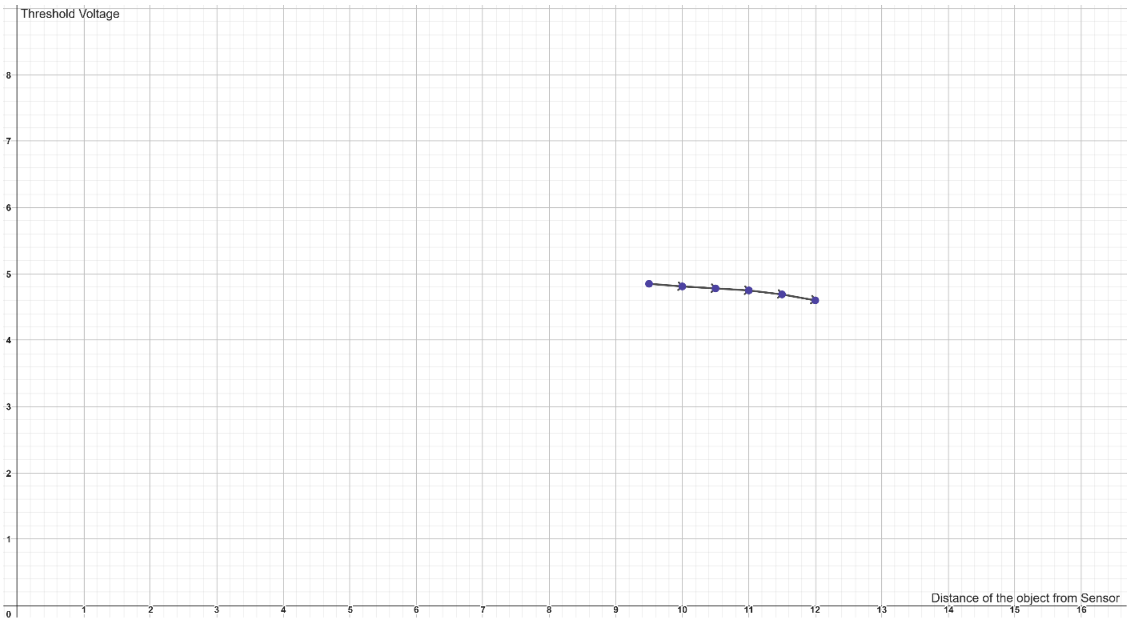

Figure 5.1 Threshold Voltage Vs Distance of Object for IR sensor

A robust and low-cost sorting mechanism was implemented that sorts objects based on their color and weight. The mechanism currently includes two colors and two weight categories light and heavy The prominent achievement of the system is that it achieves 4-way sorting using a single conveyor belt.

The weight categories for the model were decided by the placement of the limit switch. If the limit switch is placed higher, the threshold weight decreases and if it is placed lower, the threshold weight increases. Thus, the threshold voltage can be adjusted by the strategic placement of the limit switch.

The system was tested with a variety of objects and was able to sort them accurately. The system is still under development, but it has the potential to be a valuable tool for a variety of applications.

Conclusions

In conclusion, the project on color and weight-based sorting has demonstrated the feasibility of designing an efficient and cost-effective sorting system for small-scale operations. The system can sort objects based on their color and weight characteristics and has the potential to be extended to incorporate additional parameters for more precise sorting. The system comprises a microcontroller PIC, a color sensor, a limit switch, and motors for separating the sorted objects. The system can differentiate between distinct colors and weights of objects and make decisions based on pre-programmed rules. The use of a color sensor has enabled accurate color detection, while the limit switch sets a threshold for the weight parameter.

Overall, the project has provided valuable insights into the design and development of color and weight-based sorting systems using microcontrollers and sensors. The system's scalability and cost-effectiveness make it suitable for small-scale applications in industries such as food processing, recycling, or logistics. Future research can explore the integration of advanced sensor technologies and artificial intelligence techniques to further enhance the sorting process's accuracy and efficiency.

Future Scope

The project on color and weight-based sorting has several potential future scopes that can be explored. Here are some areas to consider for future development and research:

1. Integration of Advanced Sensor Technologies: Investigate the use of advanced sensor technologies such as hyperspectral imaging or 3D scanning to enhance the accuracy and reliability of color and weight-based sorting systems. These technologies can provide more detailed information about the objects being sorted, enabling better decision-making algorithms.
2. Machine Learning and Artificial Intelligence: Explore the application of machine learning and artificial intelligence techniques to improve the sorting process. Develop algorithms that can learn and adapt to different objects and sorting criteria, optimizing sorting efficiency and reducing errors.
3. Multi-Parameter Sorting: Extend the sorting system to incorporate additional parameters beyond color and weight. Consider integrating shape, texture, size, or other relevant features into the sorting process. This can enhance the system's capability to differentiate and classify objects accurately.
4. Real-Time Sorting Optimization [1]: Develop algorithms and strategies to optimize the sorting process in real-time. Consider factors such as throughput, energy efficiency, and sorting accuracy to dynamically adjust the sorting parameters and maximize overall system performance.

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