

Development of Object Sorting Robotic Arm using Arduino

Submitted in fulfilment of the requirements for the award of

Bachelor of Engineering degree in Mechatronics

by

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**DEPARTMENT OF MECHATRONICS
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Niranjan Prabakaran (39090033)**, **Krishna Subbhiah Charyulu V (39090021)** who carried out project work entitled "**Development of Object Sorting Robotic Arm using Arduino**" under our supervision from June 2022 to May 2023.

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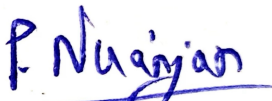
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DECLARATION

We, **Niranjana Prabakaran (39090033)** and **Krishna Subbhiah Charyulu V (39090021)** hereby declare that the Project Report entitled “**Development of Object Sorting Robotic Arm using Arduino**” done by us under the guidance of **Dr.R.B.Durairaj, M.Tech., Ph.D.**, is submitted in fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechatronics.

1. 

2. 

DATE: ____ May 2023

PLACE: Chennai, Tamil Nadu

SIGNATURE OF THE CANDIDATE

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ABSTRACT

The well-known idea of a robot is of a machine that looks and works like a person. The business is moving from present status of computerization to Robotization, to increment efficiency and to convey uniform quality. To recognize an item founded on variety which will be exceptionally valuable in a modern climate where the item area is fixed, and a fast method for Orchestrating is a cycle wherein no less than two objects of practically identical, yet different characteristics are coordinated in a proficient solicitation. Here, a profoundly robotized framework is proposed which involves Arduino UNO for distinguishing the presence of items and their variety and permits just those metal articles which are of wanted Variety (RGB) to go through transport line and deselect those hues objects and a direct actuator is initiated and pushes the article from the transport line.

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LIST OF ABBREVIATIONS

AC	Alternating Current
ALU	Arithmetic Logic Unit
AREF	Analog Reference
ASRS	Automated Storage and Retrieval System
CISC	Complex Instruction Set Computer
CNC	Computer Numerical Control
CPU	Central Processing Unit
DC	Direct Current
DoF	Degree of Freedom
IC	Integrated Circuit
IFR	International Federation of Robotics
LED	Light Emitting Diode
PIV	Peak Inverse Voltage
PMDC	Permanent Magnet DC
PWM	Pulse width Modulation
RCC	Remote-Centered Compliance
RGB	Red Green Blue
RIA	Robotic Industries Association
RTC	Real Time Counter
USB	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Mechanical arms resemble the human arm, and they are made of steel, cast iron, and aluminium. A mechanical arm is connected by individual joints and are controlled by either humans or computer. These are programmed in a way which has capacities like a human arm. Arranging of items is completed in numerous enterprises like food handling businesses, toy ventures, etc. This process is worked on utilizing mechanization.

Computerization is the use of discretionary structures like computers and robots to take over manual labour and provide mechanical aid in the management of various cycles and equipment. This method will not only cut down on human labor, but it will also speed up the process and improve its accuracy.

A robot is a machine that does jobs normally done by humans, but with greater efficiency, speed, and accuracy, and without the need for human interaction.

As much as the development of mechanical technology proceeds, the meaning of the robot will change occasionally, contingent upon the mechanical advances in its tangible ability and level of knowledge. However, the Robotic Industries Association (RIA) in 1979 awarded the robot with the most encompassing recognition of its significance to date. In assembling ventures, there will be a need to sort objects considering their properties viz., sizes, colors and so on. In this cycle, the items are grouped by their tones.

The term "mechanical arm" refers to a certain kind of programmable mechanical arm with capabilities similar to those of a human arm; the arm itself may be the whole of the component or a vital part of a more mind-boggling robot. The parts of such a regulator are connected together at strategic points called joints, which permit either rotational growth (as in a sensibly constructed robot) or translational (linear) movement of the various parts. The regulator's connections may be thought

of as the links in a kinematic chain. The regulator's end effector is the "hand" at the end of the regulator's kinematic chain. Regardless, the maxim "mechanical hand" as a likeness the mechanical arm is oftentimes denied. Mechanical arms can be used to robotize the most well-known approach to putting product or things onto beds. By means of automating the association, palletizing ends up being more definite, monetarily adroit, and obvious. The usage of mechanical arms similarly frees human workers from performing endeavours that present a bet of genuine injury.

Together, robots and humans are getting the job done in today's environment. An autonomous robot that can carry out duties without human supervision is called an assisting robot. Industries, military undertakings, medical sector are some of the fields where these robots are now being used. Working in assignments involving high temperatures or tasks like defusing bombs, handling molten metal might be fatal for people. Hence, Robots can replace humans to perform these kinds of dangerous tasks.

1.2 CLASSIFICATIONS OF ROBOTS

Despite the fact that robots may be broken down into a great number of categories, the following are particularly pertinent to our investigation:

- Classification based on coordinate frame.
- Classification based on locomotion method.
- Classification based on applications.

1.2.1 Classification based on coordinate frame

Cartesian robots, spherical robots, and cylindrical robots are the three main categories based on this criteria.

Cartesian robots perform tasks such as arc welding, machine tool manipulation, and sealant application. It's a robot with three linear control axes that are perpendicular to one another. The three movable joints allow the wrist to bend in, out, and back and forth. Some of applications of Cartesian robots are:

1.2.1.1. Application of Adhesive

This robot is being put to use adhering glass together, and it has no trouble working with materials as huge as glass.

1.2.1.2. Pallet transfer

This Cartesian robot setup moves Integrated Circuits (ICs) from a pallet to a designated location.

1.2.1.3. Product inspection

Companies need to monitor their products to ensure high quality. The cartesian robot is the most used in industrial robot, typically for CNC machines or 3D printing.

1.2.1.4. Transfer and stacking

Cartesian robots are great for moving and stacking flat materials like metal or wood sheets because of their linear motion. It may either take completed sheets from the processing equipment or feed them in.

Cylinder robots have a rotational and linear moving portion, making them somewhat more space efficient. Their portable nature makes them ideal for usage in confined places, where they may be utilised for light assembly and equipment maintenance. A Cylindrical robot may assume a cylinder shape by rotating around its central axis.

DNA screening, forensic science, medication research, and toxicology are just a few of the many medical applications that put medical robots to work. A robotic device that can autonomously take blood and promptly analyse samples is well-suited for use in the medical industry, since it has the potential to enhance hospital efficiency and provide medical staff more time to spend with patients. Because the robot is not subject to human mistake, it increases yields and consistency.

Robots that are spherical or polar in shape are able to rotate their arms in addition to moving them in a single linear direction. When in a horizontal posture, it extends your reach. It has a high capacity for lifting weights. Polar configuration fields have uses in machine tool loading, material movement, component stacking, heat

treatment, forging, and so on. Aside from welding applications, spherical robot also features in car assembling.

1.2.2 Classification based on locomotion method

Another mode of classifying robots is classification based on locomotion or kinematics method. The featured robots may be classified into two broad categories: stationary and mobile. Wheeled robots, tracked robots, legged robots, swimming robots, and flying robots are all distinct subsets of mobile robots.

1.2.3 Classification based on applications

Uses or applications are another possible way to categorise robots. According to this system, robots might be categorised as:

1.2.3.1. Cartesian robot

A cartesian robot consists of three prismatic joints, each of which axes coincides with a cartesian coordinate. A few examples of its usefulness include arc welding, working with precise equipment, and pick-and-place operations.

1.2.3.2. Cylindrical robot

Cylindrical robots have axes that make up a spherical coordinate system. It's used for a wide variety of tasks, including assembly, machine tool handling, spot welding, and diecasting machine manipulation.

1.2.3.3. Spherical robot

A spherical robot is one whose axis creates a polar coordinate system. Machine tool management, spot welding, die casting, fettling equipment, gas, and arc welding, etc. are just some of the many uses for this versatile instrument.

1.2.3.4. Scara Robo

The scara robot is defined by its two parallel rotary joints that allow for planar compliance. The scara robot is capable of four-way movement and manipulation. A workpiece may be attached to a Scara robot in any position. The parts feeder can run continuously for extended periods of time if a hopper is attached to it.

1.2.3.5. Articulated robot

Articulated robots have arms with at least three movable joints. It finds use in processes as varied as diecasting and assembly to fettling machines, gas welding, arc welding, and spray painting.

1.2.3.6. Parallel Robo

A parallel robot has arms that move in unison using prismatic or rotational joints. A portable platform that can manage a flight simulator cockpit is one application.

1.2.3.7. Anthropomorphic robot

An anthropomorphic robot has a mechanical arm that resembles a human hand and has individual fingers and thumbs.

1.2.3.8. Medical robots

One of the most well-known applications of medical robots is in surgery, where they assist surgeons by precisely manipulating surgical tools via a single or several tiny incisions.

1.2.3.9. Service robots

The best outcomes are supposedly achieved when these robots are used in tandem with humans. Cleaning, sanitizing, inventory management, patrolling for security, and automated valet are just a few of the many applications for service robots.

1.2.3.10. Military robots

The vast majority of robots in the military are remote-controlled and unarmed; they serve in roles such as reconnaissance, surveillance, sniper identification, neutralizing explosive devices, etc.

1.2.3.11. Entertainment robots

Entertainment robots are employed for entertainment. Movement simulators may be anything from miniature robots like Robosapiens or the running picture frames to fully functional, articulated robotic arms.

1.2.3.12. Space robots

Space robots are used for space missions and other space-related tasks. The Mars Exploration Rover is a Typical Illustration. IFR (International Federation of Robotics, 2003). Simply said, a manipulator is any mechanical system designed to manipulate things. The Latin word "manus," meaning "hand," is whence we get the English term "manipulate," which means "to move something with one's hands." The essential premise behind the above notion is that the human brain is capable of mechanically controlling the hands with the utmost precision, as can be seen in the work of a skilled guitarist or surgeon. (Angelo, 2007).

1.3 ROBOTIC ARM DEFINITION

A robotic arm is a mechanism that functions similarly to a human hand; it is made up of a series or parallel arrangement of linkages. It may be directed to carry out an operation according to predetermined instructions.

Joints of the manipulator connect the links that lead to the displacement which is either translational or rotational. A kinematic chain is formed by the links of the arm. End Effector is the terminating part of this kinematic chain, and it can be considered as the hand of a human.

The following components make up a typical object sorting robotic arm:

- Links and joints
- Actuators
- Controller
- End-effector
- Sensor (not present in some robots)

1.3.1 Links and joints

Robot Links refer to the connections between individual manipulator joints, while Robot Joints refer to the integration of two or more links. A robot's connection will be physically present as a piece of material, and there are two main kinds: input and output. The output link may move in a number of ways depending on the motion of the input link. A closer input connection is on the way. The essential component of every robot is the robot joint. The aids in movement of connections in various directions. The five most common kinds of joints are:

- Rotational joint
- Linear joint
- Twisting joint
- Orthogonal joint
- Revolving joint

1.3.2 Actuators

An actuator is a physical component that converts other forms of energy into mechanical motion. (Gruppen, 2015). Like the muscles in your arm, actuators store energy in order to produce motion. The joints of a robotic manipulator are manipulated by actuators. Pneumatic, hydraulic, and electrical actuators are the three most common kinds utilised in modern robotics. (Angelo, 2007). A motor provides the motive force for an electric actuator by transforming electrical energy into mechanical torque. Several distinct motors exist now:

- Direct Current (DC) motors
- Alternating Current (AC) motors
- Inductive motors

Stepper motors are controlled by varying the voltage, while feedback loops may be used to either slow or speed up the motor. (Servo motors). One of the least polluting and most accessible actuators is the electric actuator. In Pneumatic actuators, manipulator's joint moves using pressurised gas. Though pneumatic actuators are economical, they are rarely used because movement precision is low. As opposed to pneumatic actuators, which use compressed air, hydraulic actuators use pressurised liquid (usually oil) to actuate the manipulator joint. They are widespread, have strong power-to-weight ratios, and may produce substantial force.

1.3.3 Controller

The controller is the heart of a robot, processing data and carrying out commands. It's the "brain" of the robot and it directs its actions. A computer of some kind is often used to keep track of data pertaining to the robot and the workplace, as well

as to keep and run the programmes that control the robot. The robot can carry out its intended role thanks to the inclusion of programs, data algorithms, logic analysis, and other processing operations.

Controllers for modern robots are often computer or microprocessor based. These controllers are responsible for computational tasks as well as interfacing with and controlling sensors, grippers, tools, and other auxiliary devices. (Angelo, 2007).

Dedicated controller modules from the same manufacturer are the centre of attention in the design and production of most contemporary servomotor actuators. Common examples of such controllers are the Pololu Mini Maestro 12-channel USB Servo Controller and the Lynxmotion SSC-32 servo controller, both of which are built on microcontrollers.

1.3.4 End-effector

An end-effector is the part of a robotic arm that makes contact with its surroundings. The function of the robot determines the precise nature of this equipment. The end effector is the terminal component of a serial robotic manipulator, according to the precise definition. The equipment is connected at this terminal. As a more general concept, an end effector is any component of a robot that is designed to engage with the world of work. Neither the robot's wheels nor its feet are considered end-effectors since they are integral to the robot's mobility rather than its ability to perform a specific task. Major robot end-effector categories include:

1.3.4.1. Grippers

The majority of end-effectors are grippers. They may use various grabbing techniques. (Such as vacuum or use of fingers).

1.3.4.2. Material removal tools

Robotic tools for cutting, drilling, and deburring are available.

1.3.4.3. Welding torches

Welding is one of the most common uses for robots currently. Thus, modern welding torches are very effective end-effectors that can be precisely regulated for

optimised welding.

1.3.4.4. Tool changers

To allow a single robot to switch between a wide variety of end effectors, tool changers are used. To provide uniformity between the robot flange and the tool base, they are used. Either humans or machines can operate them.

1.3.4.5 Sensor

The ability of a robot to detect its physical environment and gather data about itself and its surroundings is made possible by physical equipment known as sensors. They provide information about the surrounding area to the robotic arm. They can make the robot partially perceptual. Data is gathered by the sensor and sent (electronically) to the robot's brain.

Color sensor is used in this project. The colour sensor reads the RGB value in a serial output after determining the colour. It has a colour detection range of 16.7 million and can report the corresponding RGB value. Each of the three fundamental colours red, green, and blue—have 8 bits of precision, and the detected colour is expressed as the sum of those three values. The RGB values allow for the easy separation and mixing of any colour into its component hues of red, green, and blue. (Dhananjay et al., 2015).

1.4 ARTIFICIAL INTELLIGENCE

Today, robots have become smarter, intelligent, and more efficient with the assistance of the computer science field. Thus, AI plays a crucial role not only in improving people's quality of life, but also in enhancing the efficiency and output of businesses, which includes lowering costs in both qualitative and quantitative ways. The word "artificial intelligence" refers to nothing more than a computer programme that is based on the creation and study of algorithms, which are, in turn, nothing more than another name for a computer programme that may produce a machine with its own behavior and intellect.

1.5 OBJECT RECOGNITION

Recognition of things in digital photos is only one part of object recognition, a larger category of related computer vision tasks. Predicting the category of individual items in a picture is what image classification is all about. Object localization is a subset of object recognition that involves pinpointing the precise position of an item or objects inside an image and then outlining their boundaries using a bounding box. Therefore, an Object detection system combines these two processes, since it too identifies and locates objects inside a given image.

1.6 CONTROLLER

A device which takes multiple inputs to adjust its output so that the connected gadget operates in a controlled way is called a controller. A microcontroller can be operated with more than one control outputs and conduct closed loop control. Since various actuators need various strategies for control to obtain stable output, the decision of which controller to utilise is crucial to the project's ultimate functioning. Arduino and Raspberry Pi are the most widely used controllers now a days.

1.7 CONVEYOR BELT

In the 1920s, conveyors began to be used in coal mines, and the technology behind them underwent significant development. Cotton and rubber were chosen as the primary materials for the construction of conveyor belts. Due to the wartime industrial boom, synthetic materials were developed for use in belting production due to a shortage of natural components. Conveyor belting nowadays may be fabricated from an almost infinite variety of synthetic polymers and textiles and adapted to meet a wide variety of needs. Conveyors are now employed in almost every industry that requires the handling, storage, or distribution of commodities, expanding their original scope of use. Currently in service, the world's longest conveyor belt stretches over 60 miles in length and is put to work in the Western Sahara's phosphate mines. The following criteria allow for the categorization of conveyors:

- Load: The type of product being handled (unit load or bulk load)
- Location: Location of the conveyor (overhead, on-floor, or in-floor)
- Accumulation: Whether or not loads can accumulate on the conveyor

1.7.1 Benefits of Conveyors

The numerous advantages of using conveyors are not hard to see. Workers at a warehouse or factory would have to physically carry an item from one location to another before the development of conveyors. The process was not only time-consuming for the worker, but also counterproductive for the business. Of the worker needing to physically go to a project, the conveyor system delivers the projects to them. Parts may be moved via a conveyor to various employees or storage areas inside a facility, and then to the loading dock for shipment.

Conveyors may improve quality control in a production or storage facility in addition to the obvious advantages of enhanced efficiency. The use of automated production lines enables the transportation of individual components to and from automated equipment, freeing up employees to focus on quality control and supervision/management procedures that are more difficult to automate. Conveyors may also improve the security of a building. Conveyors with specialised designs are used to move bulky or dangerous items while keeping workers secure.

The development of synthetic conveyor belts marked a major turning point in the industry. During World War II, when supplies of things like cotton, rubber, and canvas were low, it was put into widespread usage. Synthetic conveyor belts have now found widespread use in many different industries. As the need for conveyor belts grew, more and more synthetic polymers and textiles were used in their construction. Conveyor belts are made from a wide variety of materials nowadays, including cotton, canvas, EPDM, leather, neoprene, nylon, polyester, polyurethane, urethane, PVC, rubber, silicone, and steel. These days, a conveyor belt's function dictates the kind of material utilised in its construction.

CHAPTER 2

LITERATURE SURVEY

(Anughna et al). The author offers data gathered from accelerometers in this study. The Arduino Atmega328 serves as the controller. In order to mimic human arm motion, servo motors must be controlled by an Arduino ATmega328 that receives inputs from flex and gyro sensors indicating where the fingers should be moved. Arduino was programmed using the embedded C programming language. Fingers were positioned near where the Flex and Gyro Sensors were attached. When a change is observed, the controller takes into account data from both sensors. Potential Futures The use of five Flex Sensors close to the fingers and an additional Gyro for convenience is within the purview of this study. Using a Flex and Gyro Sensor for Wireless Robotic Arm Model Design and Implementation, 2020.

(Areepen et al). This investigation aims to build a colour-sorting manipulator utilising an Arduino Mega series microcontroller, some specialised motors, and photodiode sensors. The photodiode light sensor is capable of reading RGB colour space. In this setup, the observed colour is shown on an LCD screen in accordance with the output of an Arduino Mega 2560. The process of moving an item begins with identifying its RGB colour components. When a light photodiode sensor detects a certain hue, the robotic arm's gripper will move to collect things of that colour. A robotic arm equipped with the ATmega2560-based microprocessor Arduino Mega 2560 has 54 digital I/O ports of various kinds. A Color-Based Method for Robot Arm Movement: Widodo, 2019.

(Banga V K et al). The authors of this study report that they used soft computing to create a robotic arm with 4 degrees of freedom. They've used tools like GAs and fuzzy logic to figure out how to direct the robotic arm's motion and map out its intended path. (FL). Since effective locomotion is fundamental to the success of autonomous robots. This design is used to mitigate robotic arm concerns including motion, friction, and settling time. The optimal joint angles for these four degrees of freedom robotic system are determined through genetic optimisation. Inverse kinematics for robotic arm movement is supported by this sort of optimization,

which eliminates the time-consuming process of trial and error in pursuit of a better combination of joint angles. The joint movement, friction, and least settling time properties were used in the development of these logic models (Fuzzy logic). "Soft Computing Modeling and Simulation of Robot Arm Motion" (2011)

(Bindu A Thomas et al). This paper includes the design of an automatic robotic arm which is based according to the industrial applications. A functional prototype was constructed. This framework would make it simpler for man to maintain a strategic distance from the danger of dealing with objects which could be unsafe at the working environment. Businesses are encouraged to implement robot use policies for safety and financial gains. They included a 5-degrees-of-freedom (DoF) manipulator in their design. Channels in the connection wait for instructions from the microcontroller. The electric motor operates as per the given command and the speed of the motor as well as the direction and motion are controlled by the microcontroller. Meanwhile, in the mode of operation of robot, an obstacle sensor was programmed by the microcontroller such that it detects the presence of the obstacle in 10cm of radius. If an obstacle is sensed for the first time it pauses the work. Again, if the problem is not cleared, a feedback system such as buzzer gets turned on to bring this problem on notice of a personnel to clear the object. "Industry Based Automatic Robotic Arm" (2013)

(Dishant Khosla et al). It is a study research based on a smart robotic arm which provides technical information and basics about it. The robotic arm is an issue which is being researched due to problems being faced in day-to-day life and due to this there are varieties of robotic arms present in the market. This study includes the work of robotic arms and in which field they can be used.

As we know robotic arm can be operated through various methods like app, remote control, voice command. In their project they have used GUI which comforts the user to use this app efficiently and conveniently. It gives the user whether he/she must cut fruits or vegetables; if fruits, then which type of fruits; if vegetable, then which type of vegetable and how it should be cut.

Artificial intelligence and machine learning can also be used in robotic arms to

provide extra smartness to the arm that will make it think by its own and complete the task without human intervention.

Elements used in robotic arm are:

- Arduino
- Servo motor
- Gear box
- Side shaft geared motor
- L298n motor

"Smart Robotic Arm", 2019.

(Gurudu Rishank Reddy et al). The authors of this work have successfully constructed a robotic arm with four degrees of freedom to move metal sheets down a conveyor. Reducing manual handling of sheets from stack to shearing machine is the main reason of designing this pick and place robotic arm. Two pneumatic cylinders for the feeding mechanism, and a robotic arm for the workers' safety were designed. Integration of the manipulator position sensor in the robot's control unit is done by RCC which is installed in the robotic arm. Robot's ability to interact with the surrounding is possible with the help of RCC control.

A self-optimization system is provided by the manipulator depending upon the given conditions. Self-awareness system of the robot will ensure safety on site. Suction effect is produced by the vacuum cup (which is at the end effector) on the surface of the object. Continuous path, acceptable degree of freedom, speed control, repeatability and high resolution were the major factors which were processed by the manipulator. "Design and Structural Analysis of a Robotic Arm" (2016)

(Hui Wei A et al). By proposing an approach that can detect contour information from an image in real time and then determine the precise position of an object to be grasped by matching its contour with a given template, the authors of this paper developed an effective grasp synthesis method that can be used for closed-loop robotic grasping with the help of only a single monocular camera.

This strategy was far less resource-intensive than the status quo, particularly when compared to vision-based deep-learning algorithms that need no training at all.

Edge detection, super pixel segmentation, and form matching, all state-of-the-art methods, have been used. Authors of this system devised visual serving techniques that were robust in the face of environmental change and did not need precise camera calibration or position control. It was found experimentally that this method achieved very high levels of conformity, performance, and resilience over a wide range of experimental situations and environments. "Robotic object recognition and grasping with a natural background" (2020)

(Kemal Oltun Evliyaoğlu¹ et al). This paper discusses the author's efforts to develop a self-adaptive, reconfigurable, and low-cost robotic arm, highlighting how such an arm can be made to perform a wide range of tasks simply by modifying its design—for example, by altering the number of its links. The work presented in this article is a simplified robotic approach to solving a variety of problems. Two separate panels, each with its own wiring, make up the Design; they are organised and linked to servo motors in accordance with the needs of the application at hand. "Self-Adaptive, Reconfigurable, and Low- Cost Robotic Arm Design and Development."

(Kurt E. Clothier et al). In this paper, the author has taken a geometric approach to position the robotic arm in an autonomous manner. iRobot command model is the main controller for the robot. For additional hardware, there are four e-ports, and it is built around Atmega 168 microcontroller. The number of sensors used externally to iRobot Create are three. Two Sharp GP2D12 Range Finder sensors and one GP2D120 Range Finder sensor are used. An infrared beam is emitted from these sensors and the reflection angles are used to find the distance of the objects. Objects in the range of 10-80 cm are detected by GP2D12, whereas objects as close as 4-30 cm are detected by GP2D120. Element Direct, Inc is the screen used in this project, it came with four-character Display which was designed for the use with command module.

For scanning purposes, in the front of the robot, there are two infrared range finders. A distance in millimeters is received with the help of these sensors when anything blocks their line of sight, and hence we get the position of an object with the help of these distances. "A Geometric Approach for Robotic Arm Kinematics

with Hardware Design, Electrical Design, and Implementation" (2010)

(Nasr M. Ghaleb et al). This study presents the modeling, simulation, and control of a two-link, two-degree-of-freedom (DOF) robotic arm. Robotic arm forward kinematics were calculated using Denavit-Hartenberg parameters. Cartesian coordinates of the end effector were determined by performing inverse kinematics on the robotic arm. The arm was powered by a Permanent Magnet DC (PMDC) motor. For the simulation, MATLAB was employed. "Modeling and Control of 2-DOF Robot Arm" (2018)

(Pawan Shivaji Shinde et al). After analysing numerous prominent studies on manipulators, this review article focuses on the many facets of a robotic arm. Manipulators are readily updated and adjusted due to their classification as Flexible Automation. To better understand the various controllers and methodologies used by different authors when determining the degrees of freedom of a manipulator used for picking an object and placing it at a specified position, we have referred to a number of experimentally verified research papers. So, the Design of the Robotic Arm will benefit from the information gained from reading these publications. A Review Paper on the Development of an Industrial Pick and Place Robotic Arm (2018).

(Prasad Ban et al). Spotting of specific material or any element in physical world by any machine by inherited man-made intelligence is still a tedious task. These smart machines have the ability to complete a task as instructed by their operator. Objects may be identified in real time with the use of Computer Vision and artificial intelligence, a process that also makes use of Machine Learning principles. Smart robots are utilised to facilitate human life by reducing labour and improving accuracy. These advancements can make a robotic arm capable of picking and placing objects which will be recognized by the system.

This entire process of recognition depends on the data stored in the processing system. Physical world data is acquired, and the recognition system is complied with this acquired data through intelligent technology. The more the amount of acquired

data will be, more will be the accuracy of the detection system incorporated in robotic arm. In this research paper an uncomplicated machined arm has a dof of six.

The robotic arm has three basic components.

- Actuators (motor): Responsible for movements in different axis.
- End Effector: For performing various tasks like picking, placing, drilling, cutting etc.
- Controller (Arduino): Brain of whole system, this part controls every motion occurring.

"INTELLIGENT ROBOTIC ARM" (2020)

(Priyambada Mishra et al). In this study, four servo motors are employed to create the robotic arm's joints, and a potentiometer is used to regulate its motion. The Arduino UNO is the controller of choice. The Potentiometer receives the analogue input signals from the Arduino. Cardboard was used to construct the arm, and its various components are now coupled to their respective servo motors. The arm is designed to pick up and position lightweight items. Consequently, low-torque servos have been employed, with a range of 0 degrees to 180 degrees of rotation. Arduino 1.6.10 is used for the programming. So, the paper is mostly about making a robotic arm out of things that aren't very useful and using it for minor duties. "Arduino UNO Robotic Arm: A Review of Its Development" (2017)

(Puran Singh et al). They have finished the design of a robotic arm that can do spot welding by using its gripper and end effector. In order to do spot welding, the study proposes developing a robotic arm with just 2 DOF and fitting it with a gripper. An AC motor and a set of spur gears on threaded shafts make up the end effector. When designing the robotic arm, we kept in mind the following goals:

- Maintain a firm structure or form.
- Adjusting angles by moving components.
- To minimise energy use and maximise efficiency.
- Making use of the end effectors, the operation of spot welding may be carried out.

The plywood used in the construction of the robotic arm's base has the following

dimensions:

Length-48 cm, Breadth-28 cm, Thickness-2 cm.

Arm manipulator will be made up of plastic and has the following description-

Weight= $(30)^2=60$ g for big arm and $(10)^2=20$ g for small arm.

Length=25 cm for big arm and 5cm for small arm.

"Design of Robotic Arm with Gripper and End effector for spot welding" (2013)

(Sanzhar Rakhimkul et al). This study describes how a robotic arm that is operated by a joystick may have a more intuitive human machine interface. Automatic object recognition and location estimates were achieved via the use of an RGB-D sensor and a set of algorithms based on machine learning. A mechanical gripper with three fingers was employed to secure the item of interest. Robotic movement towards the item was initiated by clicking on a UI component.

The primary obstacle encountered throughout the implementation phase was the robotic arm occluding a target item. An object recognition model loses its ability to consistently perform when the robot moves to within a short distance of a target object and then seals off a portion of that item with its manipulator. An Intelligent Assistive Robot Manipulation System Using Deep Learning for Object Detection and Grasping, 2019.

(Shamsheer Verma et al). This article describes the development and implementation of a 3-degrees-of-freedom (d.o.f.) manipulator that responds to gestures. The robotic arm is the receiver, and it responds to signals sent by the glove, which acts as the transmitter. An Arduino Mega 2560 serves as the brains of the glove's electronics, and it's been configured to send and receive data from the robotic arm through an APC- 220 Module.

The gyroscope and accelerometer measure rotational and linear acceleration and communicate that data through wires to an Arduino Mega, which calculates the three angles associated with the user's hand (alpha, beta, and gamma). Additionally, finger movement data were sent to the controller through a flex sensor. Acrylic was used for the robotic arm's chassis. "Hand Gestures Remote Controlled Robotic Arm" (2013)

(T. Sunil kumar et al). Using servos to power the robotic arm's joints, they've created a more precise manipulator for this project. CATIA software was used to create the blueprints for the robot arm. The goal of this project is to build a robotic arm capable of ASRS. The project describes in depth the steps used to decide which servos will be utilised to provide power to the various joints of the arm. Aluminum will be used in our production. In this project, we will determine the amount of torque being applied at each joint and then choose a servo that can provide that amount of torque. Microsoft's programming language is used to choose a suitable servo controller and construct control software for the Robotic arm.

Kinematic Analysis

The branch of mechanics which deals with the study of the system of bodies without giving any importance to any other factor like force, mass is called Kinematics. There are two categories of kinematics for robotic arm:

- Forward kinematics
- Inverse kinematics

"Design and fabrication of pick and place robotic arm" (2020)

(Timothy Karl Findling et al). This paper was a thesis on solving the problem of soldering a line on a remote surface using a laser beam with the help of a robotic arm consisting of six servo motors controlled by Arduino micro-controller. With the help of various algorithms, this robotic arm was used to solder the cracks on a surface. A camera was used as the feedback device to give the position feedback to the controlling software by giving the current position of the laser dot. In this study, we use an embedded programme for the Arduino microcontroller, an image processing software, and a control software. The robotic laser arm was kept 81.28 cm away from a whiteboard. Joysticks can also be used to position the robotic arm, in that the Arduino controller was disconnected from the PC. "Robotic Arm Tracing Curve Recognized by camera" (2016)

(Yagna Jadeja et al). The authors of this research have constructed a robotic arm with five degrees of freedom. They have implemented the usage of a single M3 LPC1768 cortex microcontroller (Mbed). A maximum of 100g may be lifted using it. In this setup, ultrasonic sensors were utilised to gauge how far away an item was from the robotic arm. The item may be located using the transmitter, which

broadcasts a signal at a higher frequency than the sound. The receivers pick up the sent signals after they have been reflected off the intended target. Their robotic arm manipulator technology is therefore capable of object detection. The robotic arm's servo motors are activated by signals from the microcontroller after the item has been located. "Design and Development Of 5-DOF Robotic Arm Manipulators" (2019)

CHAPTER 3

AIM AND SCOPE OF THE EXPERIMENT

3.1 AIM AND SCOPE

In some industries, manpower is used to transfer the material from one place to another place which is time consuming and possibilities of risks factors like damaging of materials might happen.

The purpose of this project is to develop a pick-and-place robot equipped with an RGB colour sensor to facilitate the sorting process. The overarching goal of this project is to demonstrate how pick and place units may be used to sort coloured items down a conveyer belt, therefore enhancing production quality and decreasing error-related downtime.

The performance of the proposed intelligent device has been tested through the detection of random coloured objects. But it will only detect and pick RGB colors and place them to the desired location. The high-color sensor has great potential, however, and its efficiency can be improved in the future.

3.2 PROBLEM STATEMENT

The problem in the manual sorting process is that it takes a lot of time and humans cannot lift heavy objects whereas robotic arm can lift heavy objects and complete the work in no time. Robots can work 24/7 where in case of humans they cannot work continuously.

3.3 EXISTING SYSTEM

In the current framework, the articles are arranged physically. This creates a tendency for human errors and thus results in the incomplete or incorrect work and defective product.

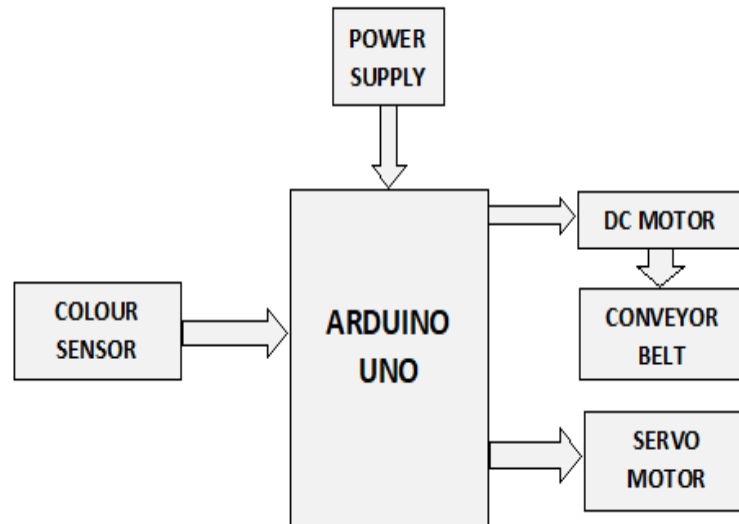


Fig: 3.1: Block diagram of the existing system

3.4 EXPERIMENTAL SYSTEM

Machines that categorise colours often work using the RGB colour model. In order to organise items by color, this machine uses a system of optical sensors. Arduino UNO was used to completely automate the colour sorting process. An Arduino UNO serves as the brains of the operation, with other components including servo motors, an RGB colour sensor, a DC gear motor, a conveyor belt, and a gripper.

The servo motor is used, making the servo library a crucial component of the code. Two servo motors are employed in the experimental system. If a coloured item is recognised as non-metal by the metal sensor, it will be moved by the first servo to the TCS230 detector, and then to the sorting position, where it will be picked up. Once in the sorting position, the second servo will choose one item and deposit it in the appropriate container.

In the proposed / experimental system, in order to sort the metal objects, a mechanical system is required that uses a servo motor, metal sensor, conveyor belt and a robotic arm. This system can sense more quantity of objects to sort in faster and efficient way and could also reject metal objects.

The system will eliminate manual error, quick object sorting time based on colour, which is done by RGB color sensor, high accuracy and most importantly results in cost reduction.

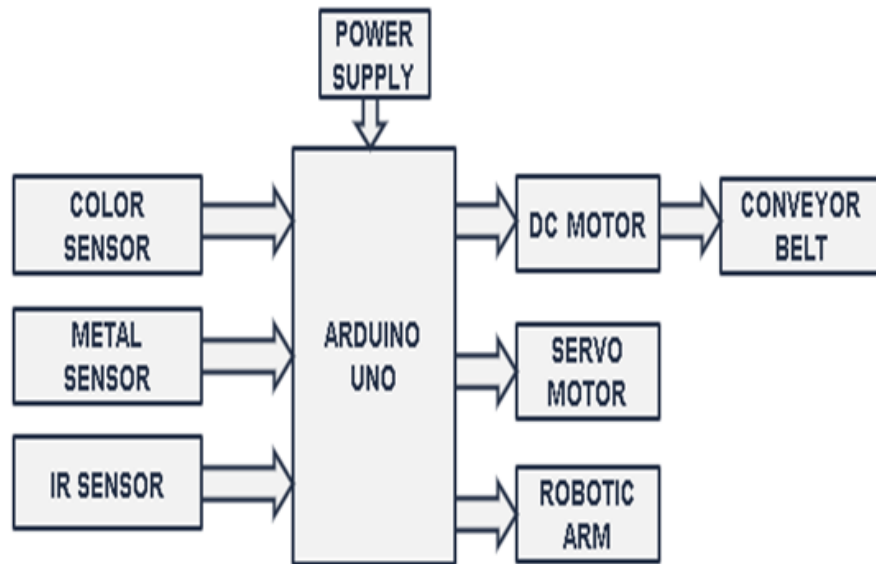


Fig: 3.2: Block diagram of the experimental system

In the experimental system, to sort the metal objects, a metal sensor is used which, when an object is passed through conveyor belt, detects non-desired objects, and pushes it from conveyor belt. When desired objects are passed through metal sensor, it is again sensed by a TCS230/TCS3200 Colour Sensor which will identify the colour of the object and places it in the respective box.

The robotic arm is typically comprised of several joints that are controlled by motors and can be programmed to move in various ways. The object's colour is read from the RGB colour sensor's three main colour channels (red, green, and blue) and then processed by the Arduino microcontroller to provide an accurate colour measurement.

Arduino then sends a signal to the robot arm to pick up the sample after the colour has been determined. The ability of a robotic system to pick up and handle things is made possible by its use of end-effectors, one kind of which is the mechanical robotic gripper. It works by using a combination of mechanical components and actuators to apply a gripping force to an object, which allows it to be lifted and moved to a different location.

The exact working of a mechanical robotic gripper for pick and place function may vary depending on the specific design of the gripper, but in general, it involves the following steps:

In the opening the gripper step, the gripper starts in a closed position, with its jaws or fingers tightly together. To open the gripper, an actuator such as a pneumatic cylinder or motor is used to move the jaws or fingers apart, creating a space for the object to be picked up.

In the approaching the object step, the robotic arm equipped with a gripper is then positioned over the target for recovery. The gripper is brought down until its jaws or fingers make contact with the item.

In the closing the gripper step, the actuator is then utilised to shut the jaws or fingers of the gripper, therefore delivering a gripping force to the item. The amount of pressure used will change based on the gripper type, the object's weight, and form.

In lifting the object step, once the gripper has a secure grip on the object, the robotic arm is activated to lift it off the ground or surface it is resting on.

In moving the object step, the robotic arm then transports the item and the gripper to the next step in the process, which might be anywhere from a different station on the assembly line to a storage facility.

In releasing the object step, once the intended place has been reached, the gripper will open its jaws or fingers to release the item.

The mechanical robotic gripper is able to execute the pick and place function because to the combination of mechanical components and actuators that allow it to grasp an item, raise it, move it, and then release it at a predetermined area. the mechanical robotic gripper works by using a combination of mechanical components and actuators to grip an object, lift it, move it, and release it at a desired location, thereby performing the pick and place function.

CHAPTER 4

METHODS, COMPONENTS AND ALGORITHMS USED

4.1 METHODOLOGY

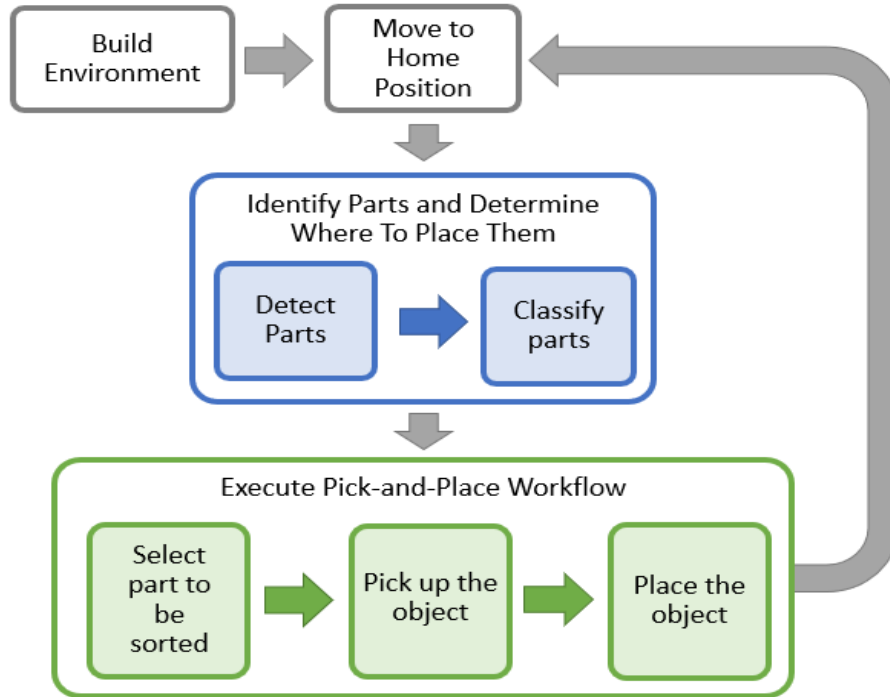


Fig: 4.1: Methodology of the experimental system

The workflow of the object sorting system using RGB color sensor is described as in the above fig: 4.1

4.1.1. Sensing Circuit

The object's metal content may be determined by the sensor circuit as it travels down the conveyor belt. If it is a metal, will be pushed from the conveyor belt as the scope of the system is to identify and sort RGB color objects and places in the respective boxes.

4.2 DESIGNING A PICK AND PLACE ROBOTIC ARM

The mechanical design of the arm, the programming of the Arduino, and the integration of the RGB colour sensor to identify the colour of the item to be selected and put are just some of the phases involved in designing a pick and place robotic

arm utilising an RGB colour sensor and Arduino. Here is a general overview of the process:

The robotic arm's mechanical construction. The first step is to create a plan for the robotic arm's internal workings, which may require 3D modelling and printing. The arm should have flexible joints that allow for rotation and movement in various planes. How many joints an arm has is determined by how much range of motion it needs.

Choose an RGB colour sensor The next step is to choose an RGB colour sensor capable of identifying the target object's colour. There are different types of RGB color sensors available in the market, such as the TCS230/TCS3200 sensor, which can detect different colors and output the RGB values of the detected color.

Program the Arduino the Arduino board will act as the controller for the robotic arm and RGB color sensor. You need to program the Arduino board to read the output values from the RGB color sensor and use these values to determine the color of the object to be picked and placed. In addition, the robotic arm's motion must be coded into the Arduino.

Integrate the RGB color sensor to the robotic arm The RGB color sensor needs to be integrated into the robotic arm such that it can detect the color of the object in the workspace. The sensor should be placed in a position that can easily detect the object's color and communicate with the Arduino board.

Test the system Once the robotic arm and RGB color sensor are integrated and programmed, you need to test the system. Test the robotic arm by programming it to move to different positions, pick up objects of different colors, and place them at different locations.

Designing a pick and place robotic arm using an RGB color sensor and Arduino involves designing the mechanical structure of the arm, choosing a suitable RGB color sensor, programming the Arduino board, integrating the sensor into the arm, and testing the system. The exact calculation involved will depend on the specific design of the arm and the type of RGB color sensor used.

4.3 COMPONENTS USED IN THIS EXPERIMENT

Table 4.1: Components used in this experiment.

Sno	Name of the Components	Count
1	Arduino uno	1
2	TCS230/TCS3200 Colour Sensor	1
3	Metal Sensor	1
4	IR Sensor	4
5	DC Motor	2
6	Servo Motor	3
7	Robotic Arm	1
8	Conveyor Belt,	1
9	Power Supply	1

4.4 COMPONENTS DESCRIPTION

This section describes about the hardware components listed in the above table 4.1 which are used in the robot.

4.4.1. Arduino Uno

Fig: 4.2 depicts this a portable computer serving as the robot's central processing unit (CPU). It may be set up to regulate the interactions of various electrical components, such as buttons, motors, switches, and lights. Arduino is a freely available hardware and software electronics platform. Arduino boards may convert inputs, such as light on a sensor, a finger on a button, or a tweet, into outputs, such as powering on a motor, lighting up an LED, or posting the results online.



Fig: 4.2: Arduino Uno

Power (USB / Barrel Jack)

A way of connecting an Arduino board to a power supply is essential. The Arduino UNO accepts power from a computer's USB port or from a barrel-jacketed wall adapter like this one. The photo up above shows a USB port dubbed (1) and a barrel jack labelled (2).

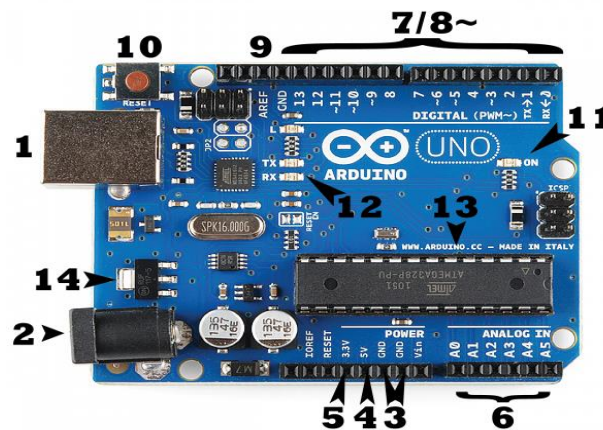


Fig: 4.3: Arduino Pinout

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are where you'll attach wires when building a circuit (often using a breadboard and some wire). Standard features include black plastic "headers" for direct wire connection. The Arduino's board has a variety of pins with distinct purposes, all of which are clearly identified.

GND (3) Short for 'Ground'. The Arduino has many GND pins that may be utilised to ground your circuit.

5V (4) & 3.3V (5) The 5V pin provides 5 volts of power, while the 3.3V pin provides 3.3 volts of power, as one would expect. Most Arduino-compatible basic components can be powered by either 5 or 3.3 volts with no issue.

Analog (6) Analog In pins are labelled as such on the UNO, and they may be found in the region from A0 to A5. The signal from an analogue sensor (such a temperature sensor) may be read by these pins and converted to a digital value.

Digital (7) The digital pins are directly opposite the analogue one. (0 through 13 on the UNO). The information received from these pins may be converted into a digital signal and sent to another device. (like powering an LED).

PWM (8) Some of the digital pins may have a tilde (~) next to it. (3, 5, 6, 9, 10, and 11 on the UNO). These pins can be used for PWM in addition to their typical digital duties. (PWM). PWM is covered in detail in a separate course, but for now, consider of these pins as analogue output simulators. (like fading an LED in and out).

AREF (9) Stands for Analog Reference. This pin may be ignored for the most part. The analogue input pins can have their maximum value limited to an external reference voltage (often between 0 and 5 Volts).

Reset Button

The Arduino features a reset button, much like the original Nintendo. (10). When pressed, it will momentarily short the reset pin to ground, which will cause the Arduino to restart whatever code is currently running on it. If your code never repeats but you still want to run the tests several times, this is a great option. However, unlike the original Nintendo, issues with an Arduino cannot generally be resolved by just blowing on it.

Power LED Indicator

On your circuit board, you'll see a little LED to the right of the word "ON," directly under the word "UNO." (11). When you connect your Arduino to a power source, this LED should light up. There's probably something wrong if this light doesn't come on. It's time for a circuit check!

TX RX LEDs

Transmit, or TX for short. Receive is abbreviated as RX. In electronics, these symbols are often used to identify the serial communication pins. TX and RX show twice on the Arduino UNO; first by digital pins 0 and 1, and again next to the TX and RX indication.

LEDs (12).

Whenever our Arduino is sending or receiving data (such as when we're putting a new programme onto the board), these LEDs will offer us some lovely indications in color.

Main IC

An Integrated Circuit (IC, the black object with the metal legs) (13). Consider it our Arduino's central processing unit. The Arduino's central integrated circuit (IC) varies significantly depending on the kind of board it is built on, although it is often part of the AT mega range of ICs manufactured by the ATMEL company. This may be significant since the IC type (together with the board type) may be required when uploading a new programme via the Arduino IDE. Typically, this data is printed on the top of the IC. Reading the datasheets is an excellent idea if you want to learn more about the differences between different ICs.

Voltage Regulator

Unfortunately, the Arduino's voltage regulator (14) is not something you can (or should) tamper with. But knowing it exists and its purpose might be helpful. The voltage regulator's stated purpose is to regulate the input voltage to the Arduino board. Like a gatekeeper, it prevents any harmful voltage from entering the circuit. Don't try to power an Arduino with more than 20 volts, since it will damage the board.

4.4.2. ATMEGA328 Microcontroller

The Atmel AVR® core has a large number of instructions and 32 general-use data registers. All 32 registers are directly coupled to the ALU, allowing for simultaneous access to both registers in a single instruction that takes just one clock cycle to complete.

The resultant design is up to 10 times quicker than regular CISC microcontrollers and is more code-efficient. Features offered by the ATmega328/P may be seen in Fig: 4.4.

There are 32Kbytes of rewritable programmable flash memory, 1Kbytes of erasable PROM memory, 2Kbytes of static RAM, 23 general-purpose I/O lines, 32 general-

purpose working registers, a Real Time Counter (RTC), three programmable Timer/Counters with compare modes and PWM, one serially programmable USART, one byte-oriented 2-wire Serial Interface (I2C), six channels of 10-bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes.

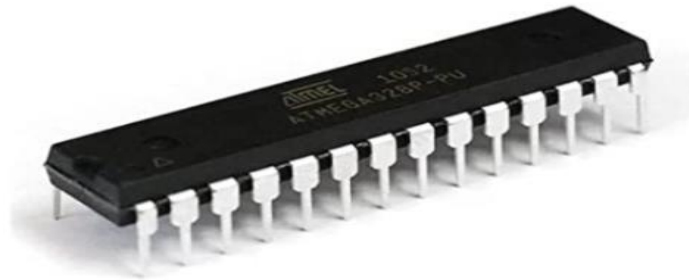


Fig: 4.4: ATMEGA328 Microcontroller

The Application Flash memory application may be downloaded by the Boot programme through any available interface. True Read-While-Write functionality is provided by keeping Boot Flash software running while updating the Application Flash software. The Atmel ATmega328/P is a powerful microcontroller that offers a highly versatile and cost-effective solution to many embedded control applications by combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a single chip.

4.4.3. Robotic Gripper

Fig: 4.5 depicts a gripper, a device that allows a robot to take up and grasp an item. The mechanical robotic gripper works by using a combination of mechanical components and actuators to grip an object, lift it, move it, and release it at a desired location, thereby performing the pick and place function.

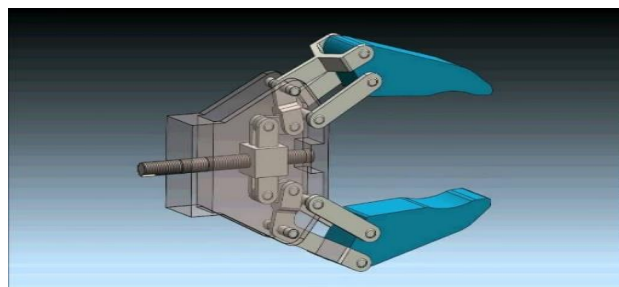


Fig: 4.5: Robotic Gripper

The gripper picks up the object using a gripper or other type of grasping mechanism. The arm then moves the object to a designated location, which can be determined by a pre-programmed set of coordinates or through real-time input from the operator.

4.4.4. Motor Driver

MG995 Servo motor as in Fig: 4.6 is used to actuate the joints in the robotic arm to accurately place an object from position A to position B.



Fig: 4.6: MG995 Servo Motor

4.4.5. DC gear motor

DC motors have a voltage sweet spot, and the greater the input voltage, the faster the motor will spin. Electric motors that use direct current power are referred to as DC motors and are shown in Fig: 4.7. The workings of an electric motor are based on elementary electromagnetism. When a conductor carrying an electric current is put in an external magnetic field, the resultant magnetic field exerts a force on the conductor that is directly proportional to the magnitude of the electric current. A device that does this is called a "mechanical energy converter." The device operates on the principle that a conductor carrying an electric current put in a magnetic field will undergo a rotational force. A field winding supplies the magnetic flux for a DC motor, while the armature performs the function of a conductor.

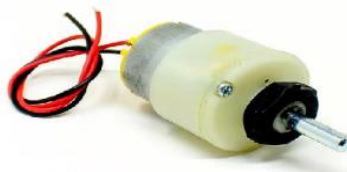


Fig: 4.7: DC motor

Torque is the output of a brushless DC motor, which receives current or voltage as input. The DC motor's functioning may be grasped easily from the simplified figure shown below. A DC motor has two primary components. The section that spins is called the rotor, while the part that doesn't move is called the stator. The rotor spins around the stator. The windings on the rotor are connected to the commutator electrically. Because of the way the brushes, commutator contacts, and rotor windings are arranged, the polarities of the energised winding and the stator magnets are initially reversed when power is given, but the rotor will continue to rotate until it is approximately aligned with the stator's field magnets. The brushes will shift to the next set of commutator contacts and energise the next set of windings when the rotor comes into proper alignment. As the rotor continues to spin, the current flowing through its windings will also reverse, causing a corresponding change in the rotor's magnetic field.

Construction of DC Motor, Fig: 4.8. The DC motor's build-up is shown in the diagrams below. Understanding its design is crucial to comprehending how it functions. Both the armature and the stator are crucial to the operation of this motor.

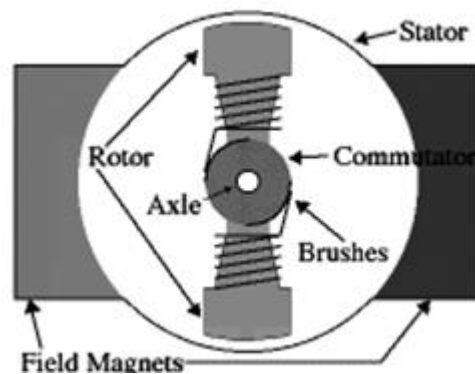


Fig: 4.8: Construction of a DC motor

The stator is the non-moving component while the armature coil is the moving element. The DC supply is linked to the armature coil through brushes and commutators in this configuration. The commutator's primary role is to transform the alternating current (AC) generated in the armature into direct current (DC). The rotating section of the motor may be used as a brush to provide current to the inactive external load. The armature's placement might be either temporary (between the electromagnet's poles) or permanent.

4.4.6. TCS230 Color Sensor

TCS230 color sensor as in Fig:4.9 works by detecting the color of an object and providing information about its hue, saturation, and brightness. It typically consists of an RGB (red, green, blue) sensor that measures the intensity of light reflected off an object in each color channel. A computer method is then used to infer the object's colour from this data.

The object's colour is determined by the colour sensor's emission of a certain wavelength of light and the intensity of the reflected light. It then converts this information into digital signals, which can be processed by a microcontroller or computer to perform further actions such as sorting, counting, or quality control. Color sensors can be used in various applications, including automotive, textiles, printing, and packaging industries, for color matching, color sorting, test strip reading and much more.



Fig: 4.9: TCS230 color sensor

The colour sensor is included into the system's colour-classification machinery. The RGB colours are processed by the colour sensor and the resulting output values are sent to the Arduino UNO. The PCB module of the TCS230 colour sensor consists of an RGB chip, four white LEDs, and an LED control circuit.

4.4.7. IR Sensor

As can be seen in Fig: 4.10, an infrared sensor is a kind of electrical equipment that uses emitted infrared light to gather information about its immediate environment. An IR sensor can detect motion and measure an object's temperature simultaneously.

An infrared (IR) sensor is a sensor capable of picking up the heat signature left behind by any object. An infrared (IR) sensor may be used to detect obstacles in the path of a pick-and-place robot.

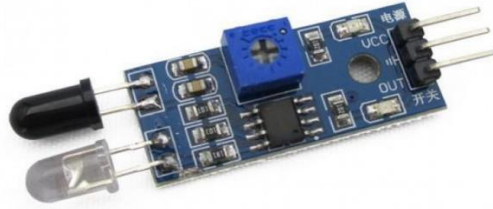


Fig: 4.10: IR sensor

This sensor is an electrical tool for detecting infrared radiation emitted by certain objects in the environment. In this case, we used two infrared (IR) sensors mounted in a reflecting arrangement; if either sensor is in range of a reflective surface, the IR LED's light will be picked up by the corresponding photo diode, and the Arduino will keep track of the resulting data.

4.4.8. Metal sensor / detector

A metal detector works by detecting the presence of metal objects in its vicinity, Fig: 4.11. It typically consists of a coil of wire that generates a magnetic field and a metal detector circuit that detects changes in the magnetic field caused by the presence of a metal object. The metal detector works by inducing an eddy current in the item being scanned, which generates a secondary magnetic field. The metal detector circuit picks up on the change in magnetic field strength caused by the interaction of this secondary magnetic field with the main magnetic field created by the metal detector.



Fig: 4.11: Metal sensor

The metal detector can be used in various applications, including security, archaeology, construction, and mining industries. It can be designed to detect several types of metals such as ferrous (iron-containing) and non-ferrous (non-iron-containing) metals. Metal detectors can also be used in combination with other sensors, such as color sensors, to enhance their functionality and accuracy.

4.4.9. Conveyor Belt

As may be seen in Fig: 4.12, conveyor belts consist of two pulleys that form a continuous loop around the material that spins over them. This is accomplished using a seemingly endless supply of hooks, gears, and a substantial rubber belt. The belt may be carried along the route by the rollers. The objects are moved from one end of the sorting machine to the other using a conveyer belt in this project. For sorting effectively.

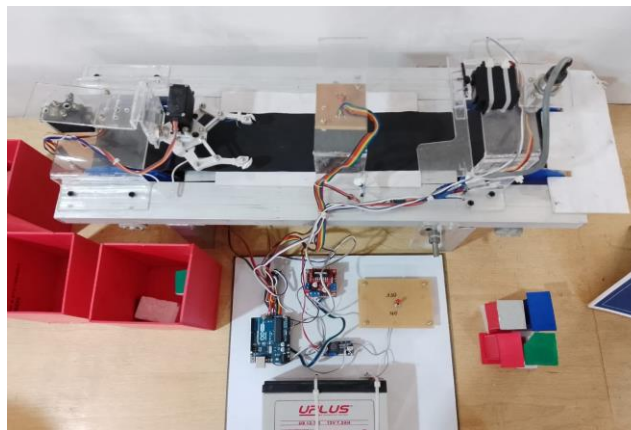


Fig: 4.12: Conveyor belt

In a belt conveyor system, the belt does the carrying. (Often shortened to belt conveyor). There are various varieties of conveyor systems, and belt conveyors are only one of them. A belt conveyor system consists of a closed loop of carrying medium, the conveyor belt that revolves around a set of pulleys (sometimes called drums). By applying energy to any or both pulleys, the belt and its load are propelled in one or both directions. The driven pulley is known as the drive pulley, while the undriven one is known as the idler pulley. General material handling belt conveyors, like those used to move boxes around an assembly line, and bulk material handling belt conveyors, like those used to transport large quantities of resources and agricultural materials like grain, salt, coal, ore, sand, overburden, and so on, make up the two main industrial classes of belt conveyors.

4.4.10. Voltage Regulator

The term voltage regulator, as seen in Fig: 4.13, explains it all of it. The alternator in your automobile charges the battery, the electrical outlet in your house gives as much power as you need, and the cell phone you carry with you at all times, all of these depend on a constant voltage. Outputs that spike over 2V might be dangerous for your charging devices and lead to inefficient operation. There are several potential causes of voltage fluctuations, such as the age of the electrical grid, the use of other appliances, the time of day, weather, etc. The voltage regulator was developed in response to the need for a constant, constant voltage.

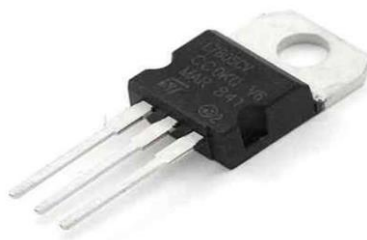


Fig: 4.13: Voltage Regulator

A voltage regulator is an IC that maintains a predetermined output voltage in spite of fluctuations in either the input voltage or the load. This may be accomplished in a variety of ways depending on the internal circuit architecture, but for the sake of simplicity, we'll be concentrating on the linear regulator. To maintain a constant output voltage regardless of changes in load or input, a linear voltage regulator uses a feedback loop to automatically adjust the resistance.

To ensure that the DC voltage provided to the load remains relatively constant after rectification, capacitors are often employed in power supplies to smooth (filter) the pulsing DC output. The rectifiers' alternating current (AC) output consists of a steady state DC value and a fluctuating AC component known as ripple voltage. The ripple voltage is lowered to a safe level by the filter capacitors. In addition to capacitors, resistors and inductors may be used to build filter networks. Only capacitive filters will be discussed here. During the positive half of the input voltage, the capacitor in a filter circuit is charged to the peak of the rectified voltage. The capacitor starts discharging into the load as soon as the input gets negative. The RC time constant created by the capacitor and the resistance of the load establishes the discharge

rate. Filters may be used to get rid of unwanted noise and ripples.

4.5 EXPERIMENTAL SETUP AND POWER CIRCUIT

This experimental setup demonstrates the functionality of an Arduino-based pick-and-place robot and provides an explanation of how colour sorting is achieved. This trial arrangement has an Arduino UNO as the primary regulator for the program for pick and spot capability is given as codes. Then it has IR sensors for any motion detection in the conveyor belt so that when an object passes through it, the sensor recognizes the item and convey message to the regulator and that will convey message to the gripper to get the article.

Servo engines are utilized to run the transport line in a rotational development and furthermore the gripper for pick and spot capability. When the article is set in the transport line, it will first cross the metal detector for any metal objects and then moves on to the color sensor for color detection and then moves to the gripper for pick and place operation.

The power for this setup is given from the 12V battery but not connected directly, the supply is given to a DC-DC buck convertor and then the power is circulated to all the required components. The engine utilized in this arrangement is constrained by an engine driver which controls all the activity of engines. Everything the electrical circuit is fixed in one board independently and the transport line, gripper, variety sensor and the metal sensor are associated as a solitary piece. The inductor in the data impediment has a frightening assortment in the data current. If the switch is kept as high (on), the inductor deals with the energy from the data and stores the energy as appealing energy. Two pulleys continuously rotate over the material moving down the transport line. A broad elastic belt and an endless procession of gears serve as the final touch. The rollers will support the belt as it travels. The objects are moved from one end of the sorting machine to the other using a conveyer belt in this project.

A metal detector is an instrument used to identify the presence of metal. A metal detector may be included into the gripper of a pick-and-place robot to help the robot identify the presence of metal items. The metal detector works by emitting an

electromagnetic field and then detecting any changes in the field caused by the presence of metal. When the metal detector detects a metal object, it sends a signal to the robot controller to stop the robot's movement or take some other action, such as alerting the operator or diverting the robot's path. Integrating a metal detector into a pick and place robot can help ensure the safety and accuracy of the robot's operation, as it can prevent the robot from accidentally picking up or dropping metal objects that could cause damage or injury. It can also be useful in industrial settings where metal debris or foreign objects may be present, helping to prevent damage to the robot or the products being handled.

The IR sensor works by emitting an infrared beam and then detecting any reflections or changes in the beam caused by the presence of an object. The robot's controller receives a signal from the sensor whenever an item is detected and uses this data to direct the robot's movement or initiate some other action, such as picking up the object or avoiding a collision.

Integrating an IR sensor into a pick and place robot can help improve the robot's accuracy and efficiency. It can help the robot identify where and how things are placed in its workplace, which facilitates picking them up and relocating them. IR sensors can also be used to detect the presence of obstacles or other objects that the robot needs to avoid. Overall, an IR sensor can help make a pick and place robot more versatile and adaptable to a range of different tasks and environments.

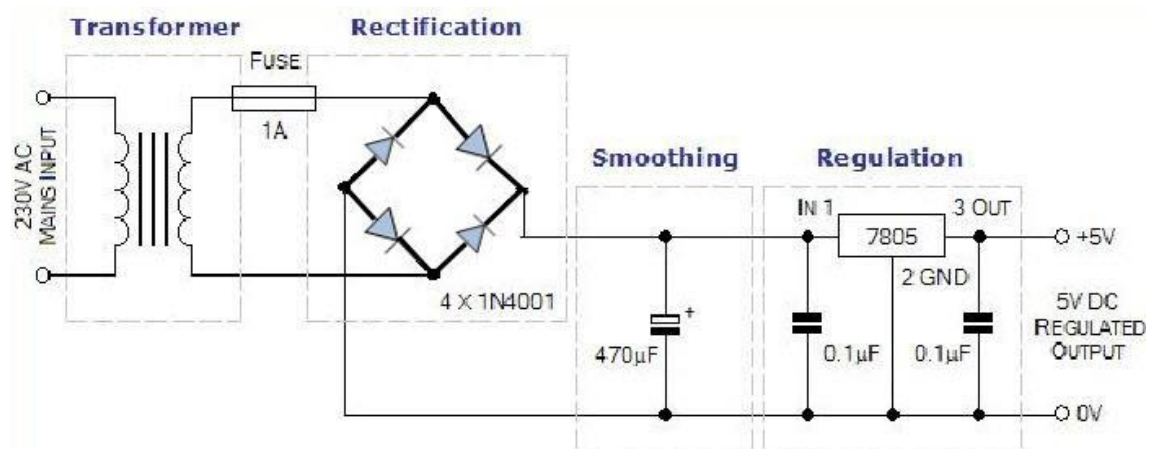


Fig: 4.14: Power Supply Circuit

Electronic power supply often includes a bridge rectifier circuit. Rectified DC power supplies convert the available AC mains supply into a voltage that can power the many electronic circuits' essential components. This rectifier is used in many common household appliances, motor controllers, modulation processes, welding applications, etc. that run on alternating current (AC).

To convert the alternating current (AC) from the mains to direct current (DC), a device called a bridge rectifier is used. Power supplies that provide the required direct current (DC) voltage to electronic components or devices often use bridge rectifiers. They may be built from any combination of four or more diodes or other types of controlled solid-state switches.

The kind of bridge rectifier used is determined by the required load current. When choosing a rectifier power supply for an electronic circuit, it is important to take into account a number of factors, including the ratings and specifications of the components, the operating temperature range, the transient current rating, the forward current rating, and the mounting requirements.

Bridge rectifiers have a significant advantage over full wave rectifiers with a centre-tapped transformer because they provide an output voltage that is almost twice as high. However, unlike a conventional rectifier, this circuit does not call for a centrally located transformer. The transformer, Diode Bridge, filtering, and regulator stages are only some of the components in the bridge rectifier circuit schematic. The combination of these blocks is known as a regulated DC power supply, and it is used to power a wide range of electronic devices.

The circuit begins with a step-down transformer, which reduces the input voltage's amplitude. A 230/12V transformer is used to convert the 230V AC mains voltage to a more workable 12V AC voltage for most electrical tasks. The next component is a diode-bridge rectifier, which may have anywhere from four to twelve diodes. The device's Peak Inverse Voltage (PIV), forward current I_f , voltage ratings, etc., must be taken with account when selecting a diode or other switching device for a similar rectifier. By switching on and off a pair of diodes at the frequency of the input signal, it generates a DC current in the load. The output of diode bridge rectifiers is pulsing,

hence filtering is required to convert it to pure DC. To smooth out waves, filtering is often done by connecting one or more capacitors across the load, as shown in the diagram below. The output voltage is also a factor in determining this capacitor's rating. A voltage regulator is used as the last component of this controlled DC supply to keep the output voltage stable. Assuming the microcontroller requires 5V DC, but the output from the bridge rectifier is roughly 16V, a voltage regulator is required to bring the voltage down to 5V and keep it there regardless of changes to the input voltage.

A single-phase bridge rectifier, which consists of four diodes linked across the load, as described in the previous section. The following circuit is presented for illustrative purposes only and should not be used in practise. Diodes D1 and D2 are forward biased, while diodes D3 and D4 are reverse biased, during the Positive half cycle of the input AC waveform. The load current follows the red lines in the picture below when the applied voltage is greater than the threshold level of diodes D1 and D2.

Diodes D3 and D4 are forward biased while diodes D1 and D2 are reverse biased during the negative half cycle of the input AC waveform. When diodes D3 and D4 begin conducting, the load current begins to flow through them. In both circumstances, the load current flows in the same direction, from top to bottom as seen in the image. This suggests that the current is DC (direct current) and flows in just one way.

Therefore, a bridge rectifier is used to convert the incoming alternating current (AC) into a direct current (DC). This bridge wave rectifier has a pulsing output at the load, and a filter like a capacitor is needed to get pure DC out of it. Different bridge rectifiers all function in the same way, however controlled rectifiers need thyristor triggering to provide current to the load.

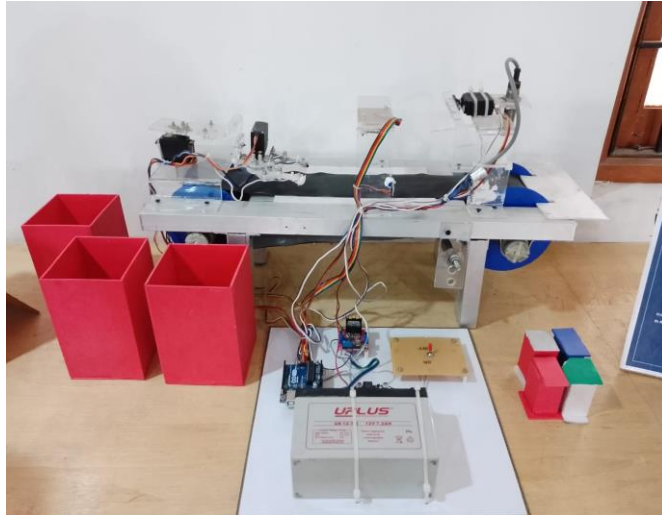


Fig. 4.15: Model of the experimental system (a)

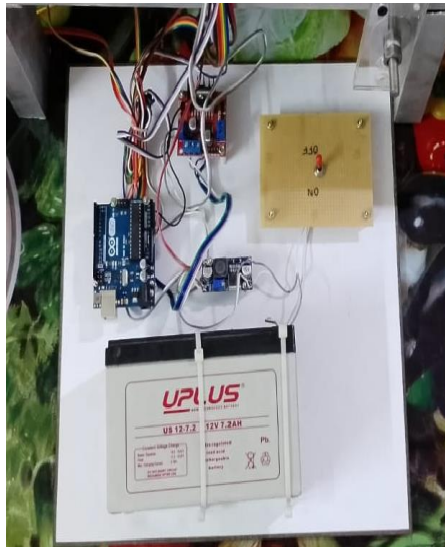


Fig. 4.16: Model of the experimental system (b)

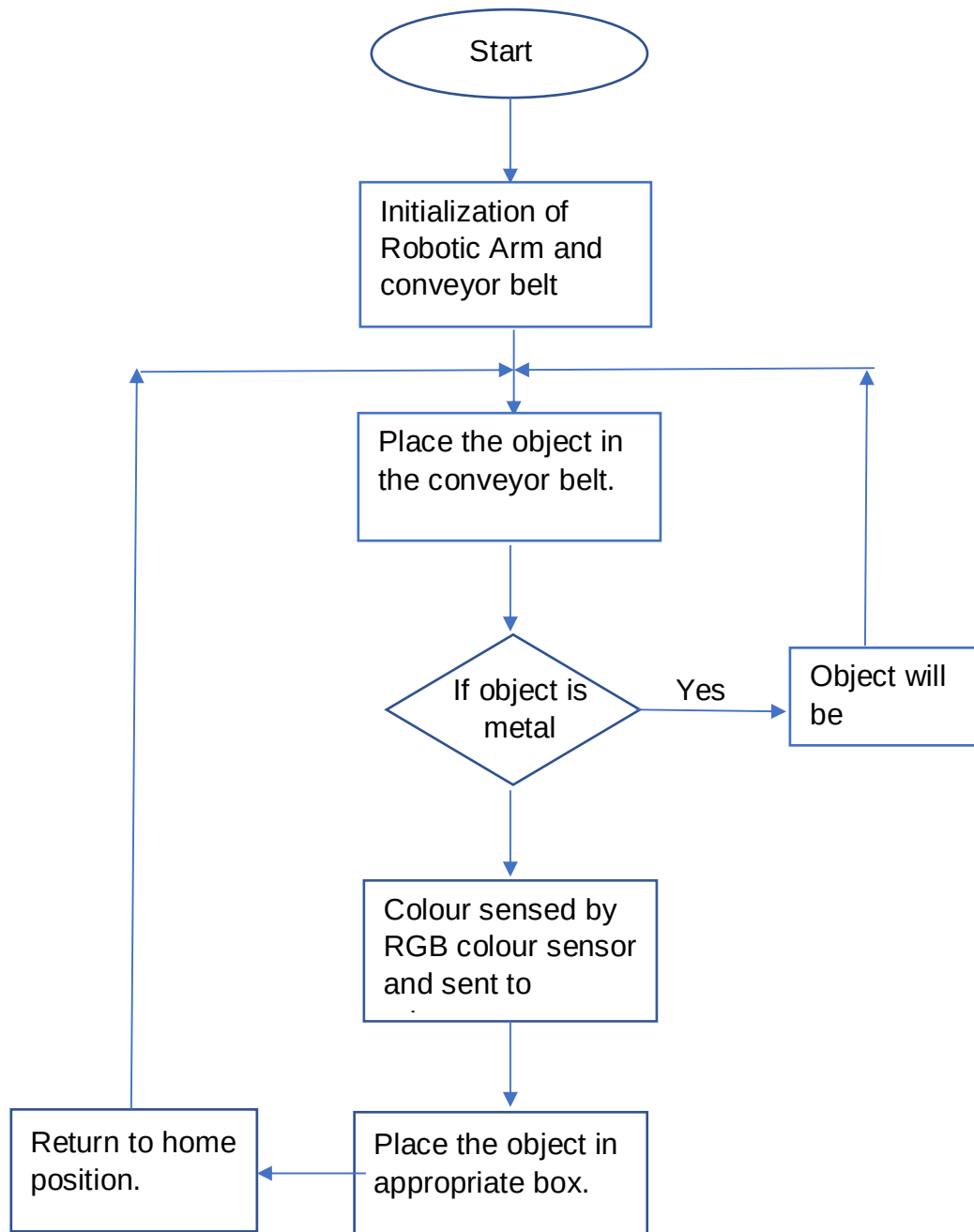


Fig. 4.17: Flow Diagram of the experimental system

4.6 ALGORITHM

Step 1: Start

Step 2: Initialization of Robotic arm and Conveyor belt

Step 3: Place the object in the conveyor belt

Step 4: If object is metal, the object will be rejected and go to step 3.

Step 5: If object is non-metal, it will be passed to RGB colour sensor.

Step 6: Colour is detected and sent to the gripper for pick up.

Step 7: Gripper places the object in the appropriate box.

Step 8: Return to home position and go to step 4.

4.7 ADVANTAGES OF EXPERIMENTAL WORK

- This experimental work performs defined task with accuracy and speed
- Increase in productivity and consistency
- It has simple design
- It's reliable
- It has organized control over its functions and objects

4.8 PICK AND PLACE ROBOTS' APPLICATIONS

- Pick and place robots can be used for sorting based on their colour, shapes, sizes, barcodes etc.
- It can be used to identify and select required parts which are mixed
- It can be used in assembly applications where parts can be identified to join, place or to insert parts
- Pick and place robots can be used in packing process including packing and placing or loading of materials
- It may be used to check and remove undesired or broken components.
- Coded markings are identified, and package information codes are scanned during colour-based product grading.
- Used for digital processing, image analysis, and object recognition
- Internal visual inspection instruments control in the textile, automotive, culinary, printing, pharmaceutical, and other sectors
- Quality control, production monitoring, and process regulation
- Colorimeters are that use spectral sensing
- Environment detection

CHAPTER 5

RESULTS, DISCUSSION AND ANALYSIS

The main difference between existing and proposed system is that the robotic arm is present in the proposed system which using servo motor picks the object that is passed through metal and colour sensor and places in the required and specified boxes.

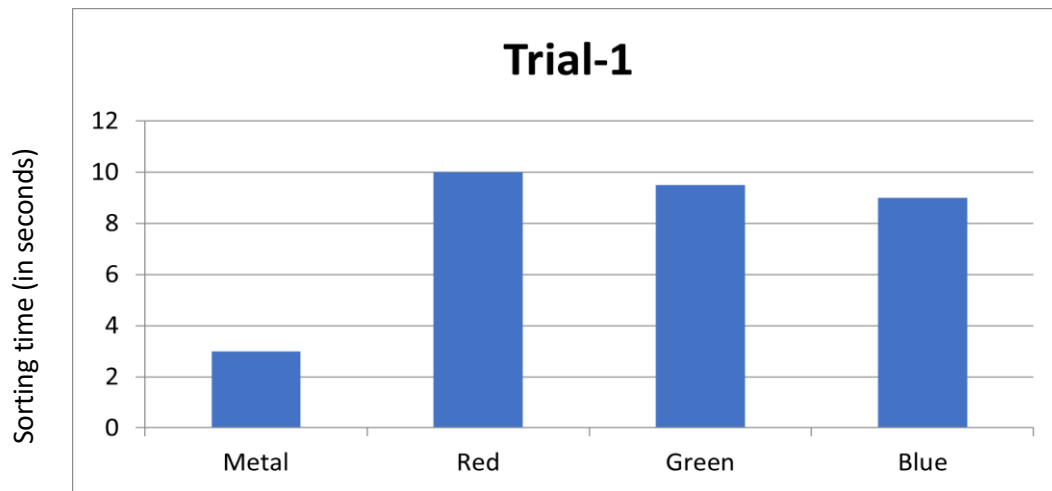
When metal objects are passed in the conveyor belt using servo motor, the metal sensor will sense the object and separate the non-desired item and pushes out from the conveyor belt. When the ideal variety object is gone through metal sensor, it is then detected by a TCS230/TCS3200 variety sensor, and the mechanical arm will place the article in the respective box.

This research focus only on sorting black coloured objects. This exploration involves Cabot framework for arranging by the utilization of an IR sensor to identify dark tone. Whereas this proposed system detects RGB coloured objects and detects for any metal objects so it can be used for various purpose. And this system is automated so once the objects are coming in the conveyor belt, it automatically starts detecting the coloured and metal objects and starts sorting.

Table 5.1: Time taken for sorting objects.

Colour Sorting	Time taken to sort colours (in seconds)			
Objects	Metal	Red	Green	Blue
Trial-1	3	10	9.5	9
Trial-2	2.7	9.5	9.2	8.7
Trial-3	2.9	9.7	9.4	9.2

In the above Table 5.1, there are four columns referring to the sorting time of the objects. The metal objects will be rejected at the starting itself and the coloured objects will be sorted according to the colour. This prototype can easily sort coloured and metal objects with the help of colour and metal sensor.



Sorting time for Trial-1

Fig. 5.1: Graph showing results of Trial-1

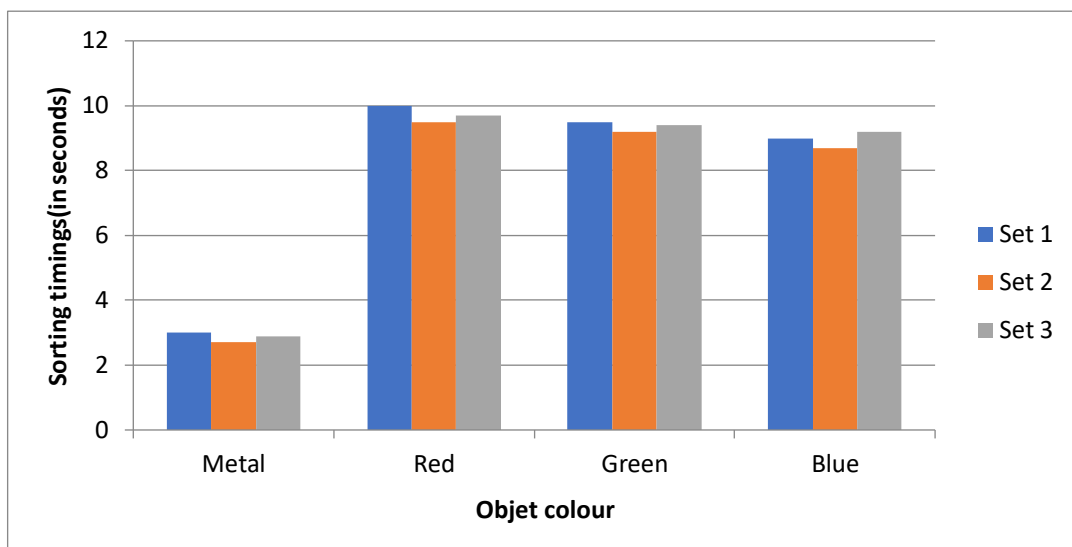


Fig. 5.2: Graph showing results of color sorting timings.

The above graph represents the time taken for each colour to be sorted and number of times the process has been repeated. The Red colour takes 10 seconds to pick up and place in its desired box while the green colour takes 9 seconds to get sorted and the blue colour takes 9 seconds to sort. Sometimes the object stops at the colour sensor and then goes to the gripper, that's because the colour sensor takes some time to sense the colour for sorting them.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

This paper addresses the plan and improvement of pick and spot mechanized framework for arranging RGB tones and metal articles, place the thing in a particular spot by utilizing an Arduino Nano and servo motors to control the robotized arm. The exhibition of the proposed clever gadget has been tried through the recognition of irregular hues of objects. The proposed framework is supposed to decrease work expenses and increment efficiency and productivity in businesses. This paper makes sense of the significance of computerized framework as it includes less work cost and further develops the creation rate and less human mistake and so on. This method is used for sorting the objects based on its colour in an effective manner. It explains the importance of robotic arm and its needs. The working is based on Arduino coding, and the power supply is given from the battery.

6.2 CONCLUSION

Chapter 6 of this report details the outcomes of the item sorting robotic arm, proving that the project's primary objective—the development of an Arduino-based robotic arm suitable for usage in multi-product packaging and other industries—was accomplished successfully. This method can be further expanded by adding multi colours for colour sorting and can be used in many industries for many purposes. And, if we attach a wheelbase for the gripper and made it like a robotic arm with wheels attached, it can be even helpful in sorting process. For e.g., the item after being arranged by its variety it very well may be taken to the specific box by the mechanical arm itself with the assistance of wheels. The work is diminished significantly, and labour necessity is less, and the robot can work constantly.

The pick and spot robot was programmed to retrieve the item and place it in its designated location based on the data collected by the sensors in the collection area. Objects identification and confirmation of the collection itself are the two cornerstones of the differentiating section of the sorting process. With the aid of an assortment sensor, the building was able to accomplish the objectives of the dealing station, to wit: picking and placing an instrument. As a consequence, a financially

savvy Mechatronics system was set up using the least difficult ideas, and the beneficial outcome was being noted. This layout is a paradigm for organisational orchestration systems.

The scope of potential applications for robotics technology has been greatly expanded thanks to this effort. The space sector, the medical field, the military, etc., may all benefit from robotics technology. In order to improve sorting accuracy, consumer safety, production efficiency, and costs, the agro-based multi-product packaging industry and others need to use object sorting robotic technologies.

The following features can be integrated to the object sorting robotic arm to improve it:

- The use of a high-quality microcontroller's CPU can further increase a system's speed and efficiency.
- In order to improve the system's colour identification abilities, the colour sensor TCS230 utilised for this purpose can be swapped out with a colour-based image processing camera.
- Large, heavy things can be picked up and sorted efficiently with the help of today's sophisticated robotic arms.
- The range of hues that may be detected can be expanded, enabling a more nuanced classification of a broader set of objects.
- Color detection, in addition to pattern recognition and speech recognition, can be incorporated to improve accuracy, as these capabilities will be crucial in many different sectors.
- The robotic arm may be made more flexible by increasing the amount of degrees of freedom that it possesses.

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ANNEXURE

- Design Patent has been applied for a Real-Time sorting modular Robot on 23rd March 2023.
- Review paper on the title “Pick and Place Robotic Arm using Arduino and RGB Colour Sensor”, a review by R.B.Durairaj, P.Niranjan, V.Krishna Subbaiah has been published in the “Industrial Engineering Journal”, Volume 15, Issue 10 of October 2022.
- Research on the title of “Development of Object Sorting Robotic Arm using Arduino”, a case study by R.B.Durairaj, P.Niranjan, V.Krishna Subbaiah has been presented in the 11th International Conference on Contemporary Engineering and Technology 2023 organized by Organization of Science & Innovative Engineering and Technology (OSIET), Chennai, India in Collaboration with Samarkand State University, Uzbekistan and in association with Prince Shri Venkateshwara Padmavathy Engineering College, Prince Dr.K.Vasudevan College of Engineering & Technology on 1st & 2nd May 2023.

C++ coding for Arduino UNO)

```
#include <Servo.h>

Servo servo1;
Servo servo2;
Servo servo3;
int ir1 = A0;
int ir1value=0;
int ir2 = A1;
int ir2value=0;
int ir3 = A2;
int ir3value=0;
int ir4 = A3;
int ir4value=0;
int in1=2;
int in2=12;
int speeds=3;
#define S0 4
#define S1 5
#define S2 6
#define S3 7
#define sensorOut 8
int frequency1 = 0,frequency2 = 0,frequency3 = 0;
void setup() {
  Serial.begin(9600);
  servo1.attach(9);
  servo2.attach(10);
  servo3.attach(11);
  pinMode(ir1,INPUT);
  pinMode(ir2,INPUT);
  pinMode(ir3,INPUT);
  pinMode(ir4,INPUT_PULLUP);
```

```

pinMode(S0, OUTPUT);
pinMode(S1, OUTPUT);
pinMode(S2, OUTPUT);
pinMode(S3, OUTPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(speeds, OUTPUT);
pinMode(sensorOut, INPUT);
digitalWrite(S0,HIGH);
digitalWrite(S1,LOW);
analogWrite(speeds,400);
servo1.write(140);
servo2.write(0);
servo3.write(168);
delay(1000);
}
void loop() {
ir1value=digitalRead(ir1);
ir2value=digitalRead(ir2);
ir3value=digitalRead(ir3);
ir4value=digitalRead(ir4);
digitalWrite(S2,LOW);
digitalWrite(S3,LOW);
frequency1 = pulseIn(sensorOut, LOW);
delay(100);
digitalWrite(S2,HIGH);
digitalWrite(S3,HIGH);
frequency2 = pulseIn(sensorOut, LOW);
delay(100);

```

```

digitalWrite(S2,LOW);
digitalWrite(S3,HIGH);
frequency3 = pulseIn(sensorOut, LOW);
delay(100);
if(ir1value==0)
{
delay(650);
digitalWrite(in1,LOW);
digitalWrite(in2,LOW);
servo1.write(20);
}
else if(ir1value==1)
{
delay(100);
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
servo1.write(130);
}
if(ir2value==0)
{
digitalWrite(in1,LOW);
digitalWrite(in2,LOW);
delay(1000);
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
if(frequency1<20)
{
Serial.println(" RED ");

```

```

digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
if(ir3value==1)
{
digitalWrite(in1,LOW);
digitalWrite(in2,LOW);
servo2.write(40);
delay(1000);
servo3.write(0);
delay(1000);
servo2.write(0);
delay(500);
servo3.write(165);
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
else
if((frequency1<75)&&(frequency2<40)&&(frequency3<65)&&(frequency1>35)&&(f
requency2>10)&&(frequency3>30))
{
Serial.println(" GREEN ");
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
if(ir3value==1)
{
digitalWrite(in1,LOW);
digitalWrite(in2,LOW);
servo2.write(40);

```

```

delay(1000);
servo3.write(50);
delay(1000);
servo2.write(0);
delay(500);
servo3.write(168);
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
else if((frequency1>35)&&(frequency2>30)&&(frequency3<30))
{
Serial.println(" BLUE ");
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}
if(ir3value==1)
{
digitalWrite(in1,LOW);
digitalWrite(in2,LOW);
servo2.write(40);
delay(1000);
servo3.write(100);
delay(1000);
servo2.write(0);
delay(500);
servo3.write(168);
digitalWrite(in1,LOW);
digitalWrite(in2,HIGH);
}

```