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Sonargaon University (SU)
সোনারগাঁও ইউনিভার্সিটি (এসইউ)

Metal and Nonmetal Product Sorting System with Conveyor Belt Using Pneumatic Technology

A Thesis
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In partial fulfillment of the requirement for award of the degree

Of

Bachelor of Science in Mechanical Engineering

January, 2025

LETTER OF TRANSMITTAL

January, 2025

To

Hasan Tareq Mahin

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Sonargaon University

Subject: Submission of Project Report**.**

Dear Sir,

We are pleased to submit the project report on **"Metal and Nonmetal Product Sorting System with Conveyor Belt and Pneumatic Technology"**. It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

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DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for award of any degree or certificate

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.

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Abstract

The developed automated sorting machine is able to incorporate flexibility and separate pieces of nonmetal object and at the same time move object automatically to the bucket as define buy the regulation of the microcontroller with a capacitive proximity sensor to detect a value rang of object .The result obtained shows that metal and nonmetal were sorted in to their respective and correct position with a good average time. The projected system involves sensing element, IR sensor, proximity sensor for sensing product exactly .

This project comes with an idea of the sorting of metals & non-metals. It will be a revolution for industries in which proper management of materials is required for delivering quality assured products at cheaper prices. Sorting is done to separate out metal and non-metal materials differently. The whole setup is fully automated which is useful as well as eco-friendly.

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List of Abbreviation

GP	Galvanized Plate
SMPS	Switch Mood Power Supply.
IR	Infrared
NO	Normally Open
NC	Normally Closed
LED	Light Emitting Diode
DC	Direct Current
AC	Alternating Current
SS	Stainless Steel
MS	Mild Steel
CI	Cast Iron

CHAPTER 1

INTRODUCTION

1.1 Introduction:

The sorting of materials in garbage industries square measure created manually at this time days. There could also be likelihood of errors in sorting. We've enforced an answer for substitution human by automatic management while not manual power. The project detects the objects completely different of various} materials and segregate in 3 different boxes. By usage of sensors decreases the errors in sorting and reduces the person power. The projected system involves detector, IR sensor, mini limit switch for sensing weight and for sorting purpose linear motion electrical actuators square measure used [1]. The motor shaft is connected to the roller and also the conveyor belt is placed on the roller these provides sensible tension over the belt. The conveyor motors input gets from electrical device.

The negative feedback circuit consists of ARDUINO board, relay interfacing board, transformer, input interfacing board, DC motors [2]. The logic used for sensors for characteristic materials is finished in program by weight and inductive means that it's sorted as metal. By weight and reflection it's sorted as glass and if solely reflection it's known as plastic. The material sorter has been designed in such the simplest way it will fulfill all the wants of the packaging industries wherever merchandise of various materials square measure factory-made. It has innumerous application like garbage industries, packaging fields. The project is intended in such the simplest way that may manufacture high productivity and may type materials while not smashup. By this packaging system becomes easier.

1.2 Literature Review:

The concept of automatic sorting arose due to the difficulties faced by the packaging industries. The idea of sorting has existed for quite a while after there have been advancements in the technology. Shen and Hassan [1] states that an approach for continuous recognition and the sorting of objects into their respective and desired location can be implemented as an image of colour processing that can attract an enormous

attention leading to a possible widening scope of application in a different field in a modern technology. A colour-sorting robot is designed and developed using an Arduino Uno micro-controller, SG90 Tower Pro Servo Motor, TCS3200D colour sensor and several other electronic components. The system has the potential to sort the objects according to their colours into their relevant colour station in a less time. A distinct code for this system is developed. According to Yunardi et al. [2],

A 3D volume of the packed box is well quantified from the 2D images using the techniques of image processing. The 2D image consists of two images captured on the camera with a horizontal view and a vertical view. With the parameters, that is, the length, width and the height, a multiplication program is used to obtain the result of the volume. Consequently, contour based object detection can be appertained to the automatic sorting system to measure the volume of an object in a computer-based vision. According to Babita [3], sensors are embedded at several places that detects and senses the materials of various sizes that gets sorted at different stations based on their sizes. For sensing, the material used is an infrared sensor that is so sensitive. All the process is controlled and handled by a PLC. Kulkarni et al. [4] has implemented the sorting of the boxes using a barcode, which is decoded by raspberry pi.

This raspberry pi sends a signal to the motor driver to start and stop the motor accordingly. Proximity switches are implanted on every cylinder to sense the box position, which again sends back the signal to raspberry pi. Relay is used as an interface for the motor driver and motor. The relay used is of solid relay type. Raspberry pi uses cameras of five megapixels to capture the image, which will then be decoded. The sorting process is controlled and handled by Arduino Microcontroller. Automating every sector of industry is an important step towards increasing efficiency and reducing human related errors, here we try to automate the sorting process by using Controller. The program fed in the Arduino controls the entire process. [5]

1.3 Objectives

- The objectives of this project are:
- To study about metal non-metal product sorting system.
- To separate metal and non metal with pneumatic technology.
- To test the performance of the Metal Non-metal sorting system with Conveyor belt & Pneumatic Technology for future modification.
- To Implement Our System Proximity Sensor, Collector Bucket , Mini Air Compressor Pressure and IR Sensor.

CHAPTER 2
THEORY & WORKING PRINCIPLE

2.1 History:

This metal non-metal sorting system is so effective and safe process. It is mainly used in factory and industrial area. After it used we reduce the manpower and time. That's way we get good efficiency. Where very difficult to move company product from here to another location perfectly that moment we can easily use this machine. This machine is very easy to use and it works very effectively. A relevant picture is added below –

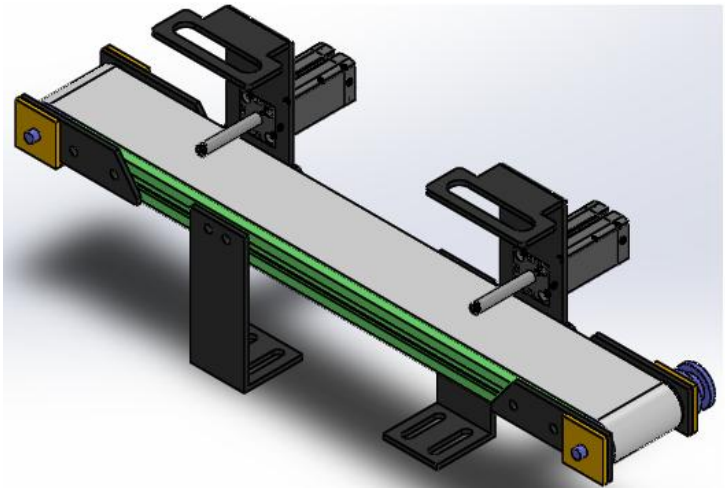


Fig 2.1 : Metal Non-metal sorting system with conveyor belt 3d image.
#Reference: Cad Cam Solution BD,

2.2 Methodology:

- Creating an idea for design and construction of a metal non-metal product sorting machine.
- Collecting the all components/materials for construct the system.
- Finally, we made this system & checked it finally that working very well.
- And drawing and listed of components/materials to know which components/materials need to construct it.

2.3 Block Diagram:

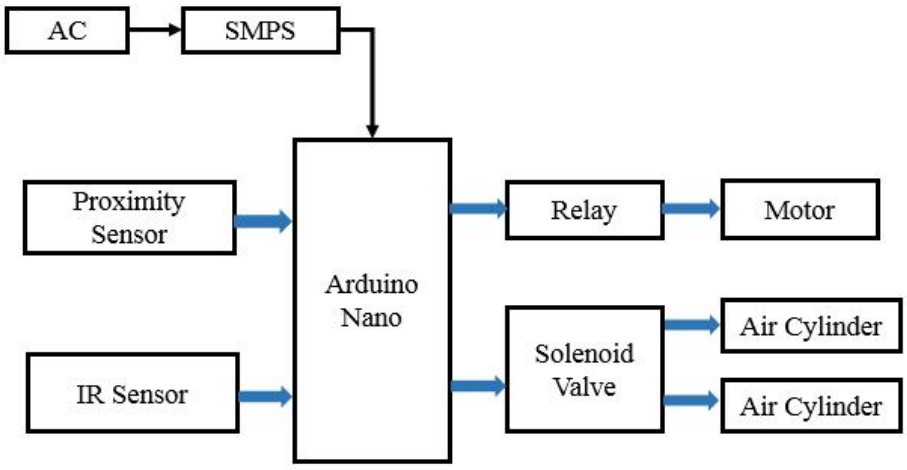


Figure 2.2: Block Diagram of metal non-metal product sorting system with conveyor belt & Pneumatic Technology.

2.4 Circuit Diagram

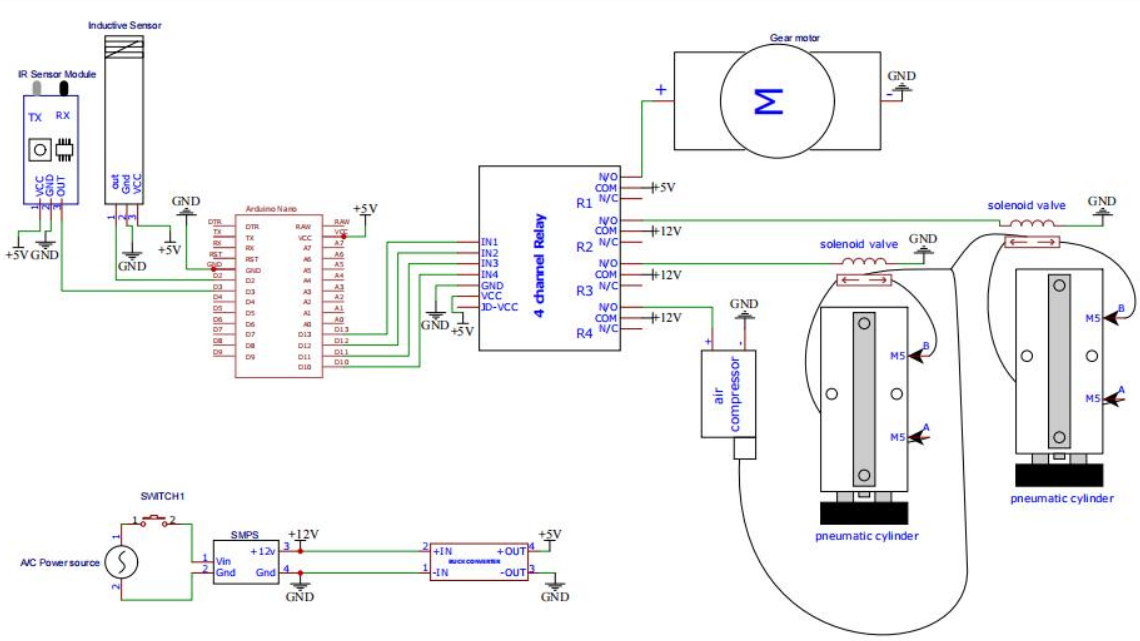


Figure 2.3: Circuit Diagram of metal non-metal product sorting system with conveyor belt & Pneumatic Technology.

2.5 Working Principle:

Our project is designed to separate metal non-metal objects. We are using Arduino Nano for controlling our project, which is acting as the main controller here. Also used here sensors, relays, valves, motors and air cylinders. Everything comes connected with Arduino.Here the current from AC is entering the circuit at 12 volts via SMPS. The Arduino Nano is equipped with two sensors. They are proximity sensor and IR Sensor .This proximity sensor and IR sensor are useful for sensing the product. The IR sensor senses the object and the proximity sensor detects whether it is metal or not. If the conveyor belt rotates, the belt will stop when the object comes in front of the IR sensor. Then check the object, if it is metal then a Pneumatic cylinder will push it in a specific box. In this way we can easily distinguish between metal and non-metal objects in this machine.

2.6 Complete Project Prototype Image :

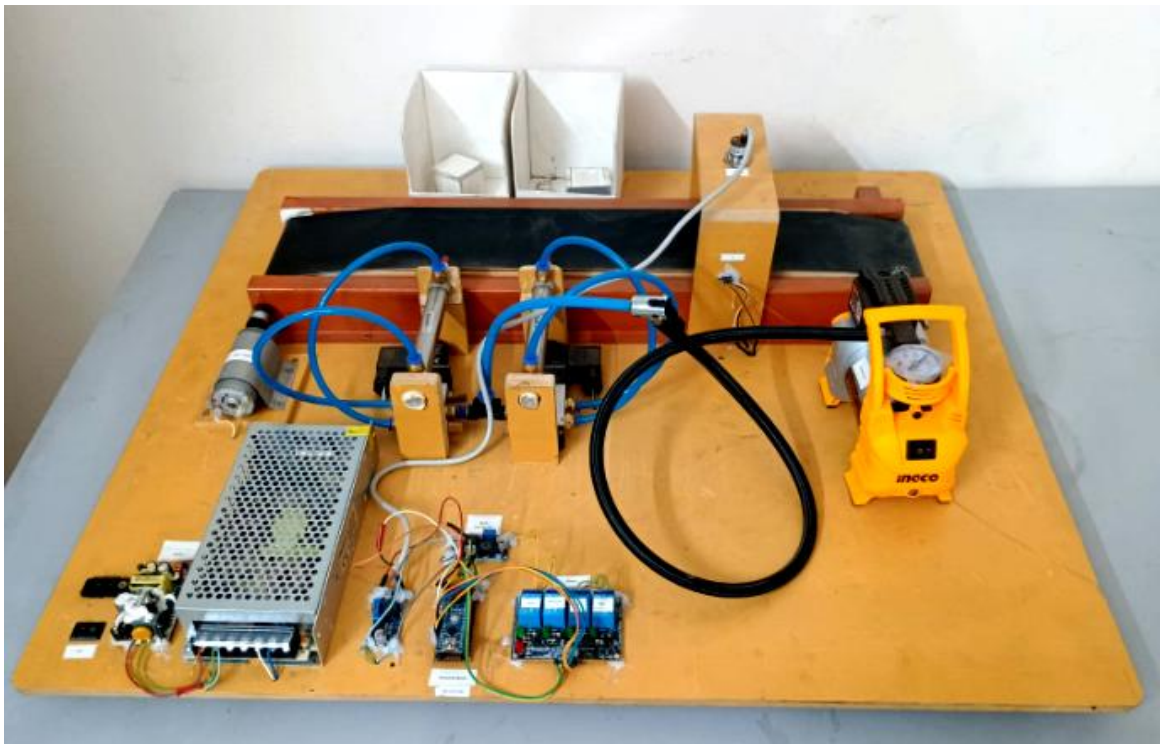


Figure 2.4: Project Prototype Image .

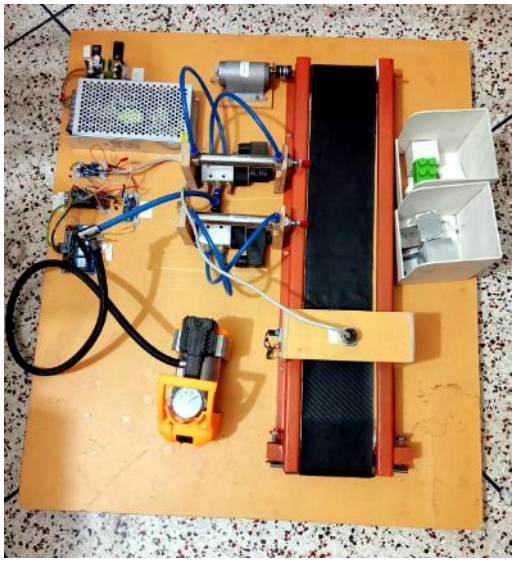


Figure 2.5: Project Prototype Top View .

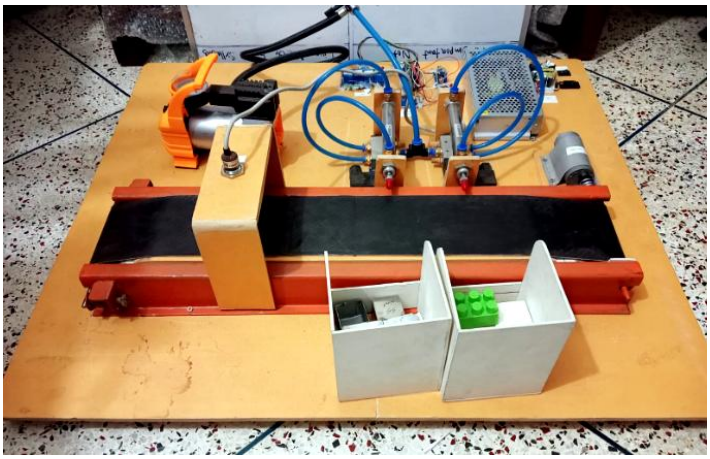


Figure 2.6: Project Prototype Right Side View .

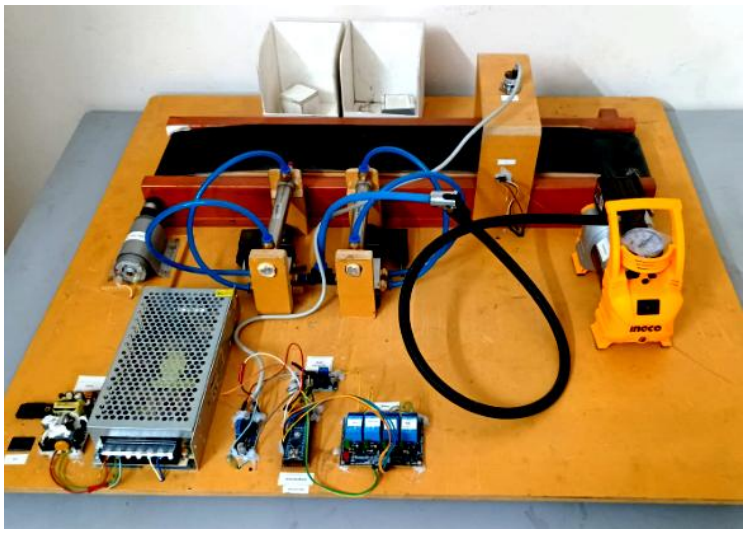


Figure 2.7: Project Prototype Left Side View .

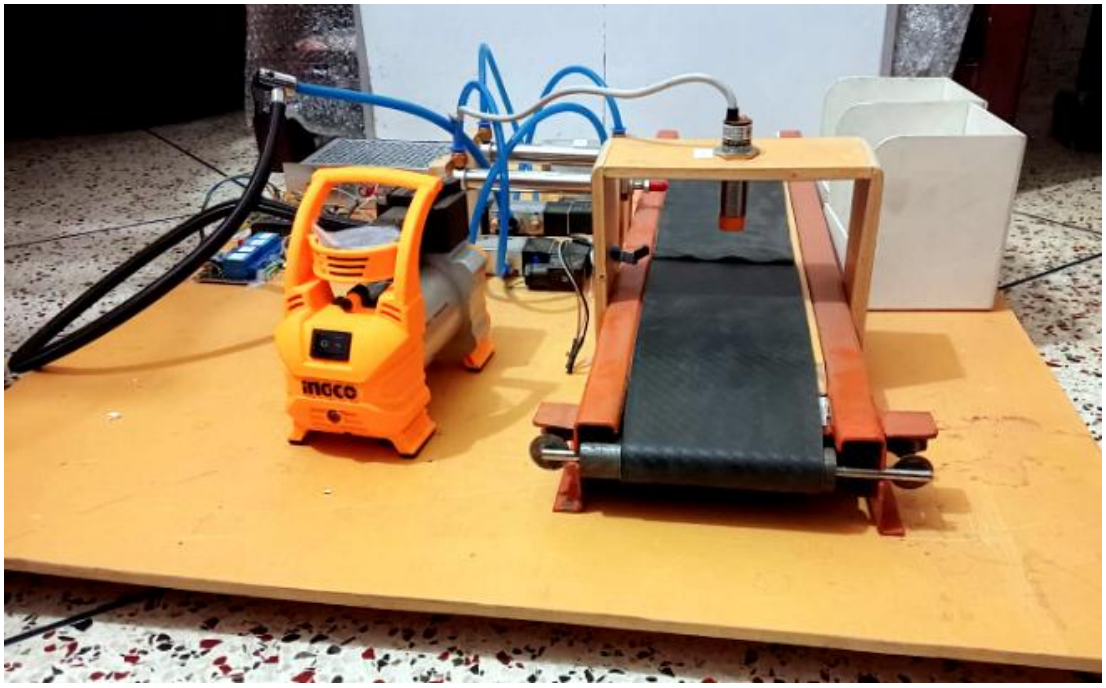


Figure 2.8: Project Prototype Fornt Side View .

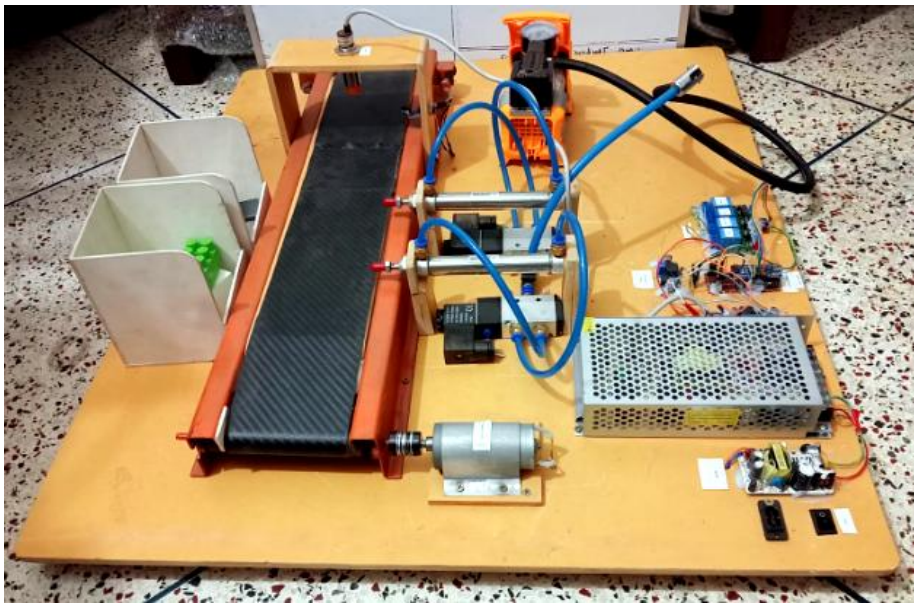


Figure 2.9: Project Prototype Back Side View .

2.7 Components List:

1. DC Gear Motor.
2. IR Sensor.
3. Proximity Sensor.
4. Air Cylinder.
5. Air Compressor.
6. SMPS
7. Relay
8. Pneumatic Solenoid Valve .
9. Arduino Nano .

2.8 Cost Analysis:

Table : Cost Analysis

No	Product Name	Spec.	Qty	Unit Price	Total Price	Market Price
01.	Arduino	Nano	1	480	480	
02.	SMPS	12V	1	650	650	
03.	IR sensor	DC	1	180	180	
05.	Gear Motor	12V DC	1	700	700	
06.	Air Cylinder		2	1850	3700	
07.	Solenoid Valve	Pneumatic	2	250	500	
08	Relay		4	100	400	
09.	Proximity Sensor	PNP 6-30	1	290	290	
10.	Air Compressor		1	2500	2500	
11.	Others				1500	
					10,900/=	15,000/=

2.9 Arduino Nano:

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.



Figure 2.10: Arduino Nano

The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Max MSP).

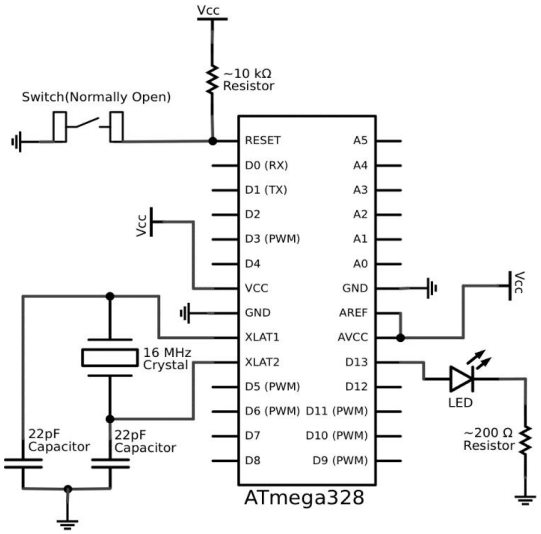


Figure 2.11: Arduino schematic diagram

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a smallest, complete, and breadboard friendly. It has everything that Diecimila / Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano is automatically sense and switch to the higher potential source of power. Nano's got the breadboard-ability of the Boarduino and the Mini+USB with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp

(TX, RX, ATN, GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It is two layers. That make it easier to hack and more affordable.

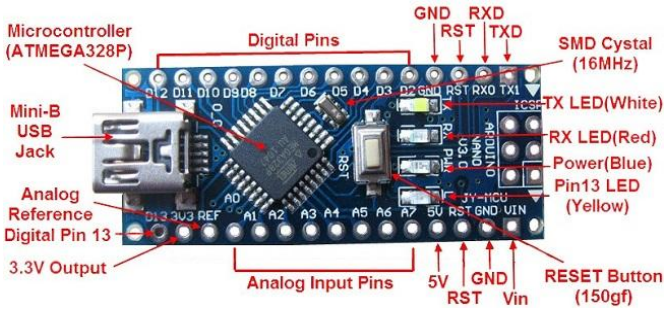


Figure 2.12: Section of Arduino Nano.

Specifications:

- Microcontroller: Atmel ATmega328
- Operating Voltage (logic level):5 V
- Input Voltage (recommended):7-12 V
- Input Voltage (limits):6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70” x 1.70”

Features:

- Automatic reset during program download.
- Power OK blue LED.
- Green (TX), red (RX) and orange (L) LED.
- Auto sensing/switching power input.
- Small mini-B USB for programming and serial monitor.

- ICSP header for direct program download.
- Standard 0.1 spacing DIP (breadboard friendly).
- Manual reset switch.

Microcontroller IC ATmega328p:

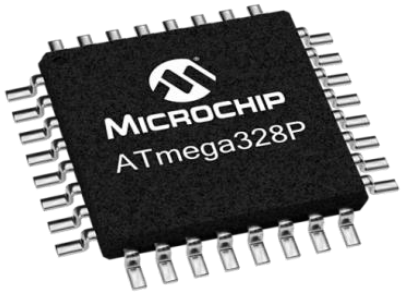


Figure 2.13: Micro-controller IC AT mega 328p.

The high-performance Microchip pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

2.10 Switch Mode Power Supply (SMPS):

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply

regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.



Fig 2.14: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

12V 5A Industrial SMPS Power Supply – 60W – DC Metal Power Supply – Good Quality – Non Waterproof with Aluminium casing.

- Input Voltage: AC 100 – 264V 50 / 60Hz.
- Output Voltage: 12V DC, 0-5A.
- Output voltage: Adjustment Range: ±20%.
- Protections: Overload / Over Voltage / Short Circuit.
- Auto-Recovery After Protection.
- Universal AC input / Full range.
- 100% Full Load Burn-in Test.
- Cooling by Free Air Convection.
- High Quality and High Performance.
- LED power supply with a metal body for hidden installation for LED lighting.

- Design with Built-in EMI Filter, improve signal precision.
- Certifications: CE & RoHs.
- No Minimum Load.
- Compact Size Light Weight.
- High Efficiency, Reliabiltiy & low energy consumption.
- Category – Switch Mode Power Adaptor (SMPS).

Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC.
- DC to DC.
- DC to AC.
- AC to AC.

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter.
- Inverter consisting of switching devices such as MOSFETS.
- Transformer.
- Output rectifier and filter.
- Feedback and control circuit.

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

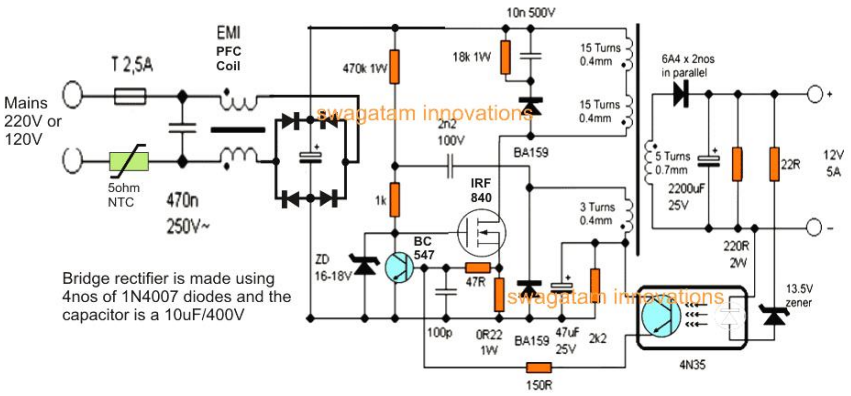


Fig 2.15: SMPS Circuit Design

Basic working concept of an SMPS:

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics:

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electro technical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up o the manufacturer. There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%.
- Regulated and reliable outputs regardless of variations in input supply voltage.
- Small size and lighter.

- Flexible technology.
- High power density.

Disadvantages:

- Generates electromagnetic interference.
- Complex circuit design.
- Expensive compared to linear supplies.

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency.

Switch Mode Power Supply:

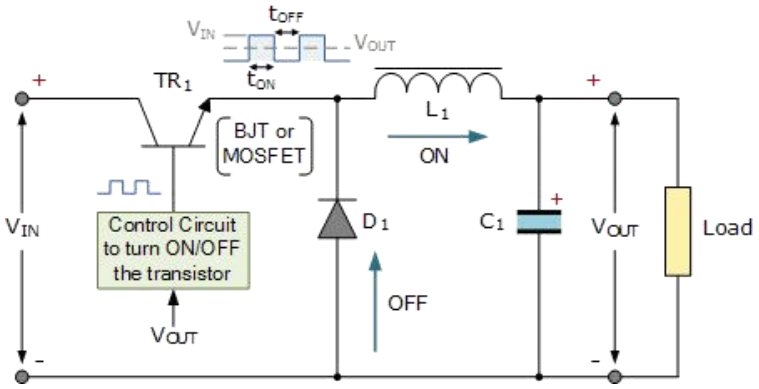


Fig 2.16: Power Supply Connection

Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.

The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series. These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.

There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabilizer circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

Typical DC Power Supply :

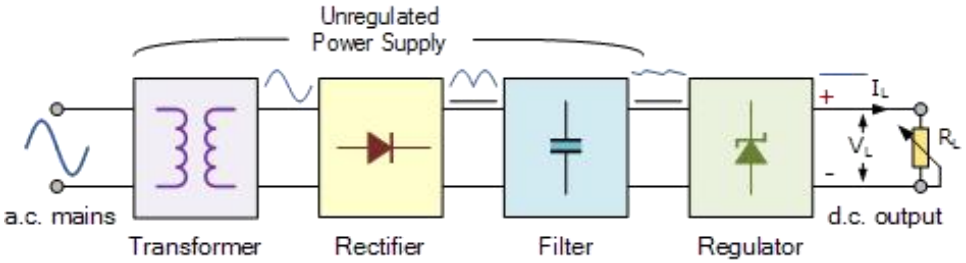


Fig 2.17: DC Power Supply Step

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

2.11 IR Sensor:

An infrared sensor is an electronics device that emits certain features around it and / or detects infrared radiation. Infrared sensors are capable of measuring the heat emitted by an object and detecting motion. In this project we will control the fan and light automatically through the closed loop system so the IR sensor for the system is definitely needed as a response. Here the fan will turn on and the light will turn on when the IR sensor detects an object and the fan and light will switch off automatically when an object leaves the house.



Figure 2.18: IR Sensor

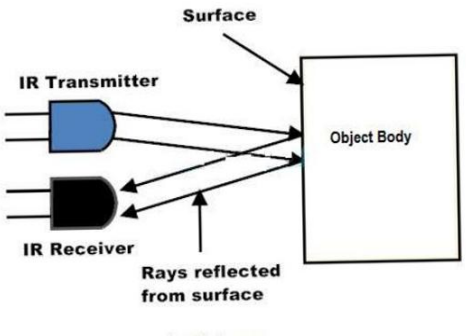


Figure 2.19: IR sensor reflection System.

Principles of operation:

Sensor works with sense. When an object intersects the sensor light then the sensor detects something .Some infrared ray is deflected from the object and scene the length of this distance. In this sensor we can make a fixed length light and detect our exact object. If some object comes in front of this sensor then the sensor detects it and sends a signal in LED.

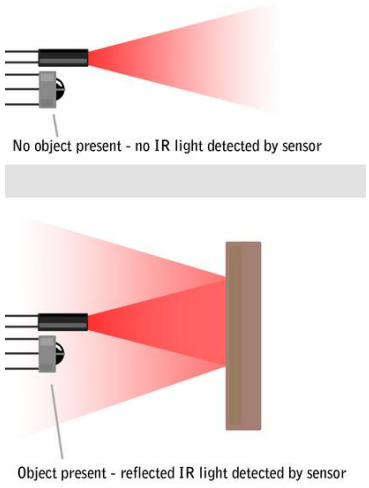


Figure 2.20: IR sensor Detection System.

2.12 Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

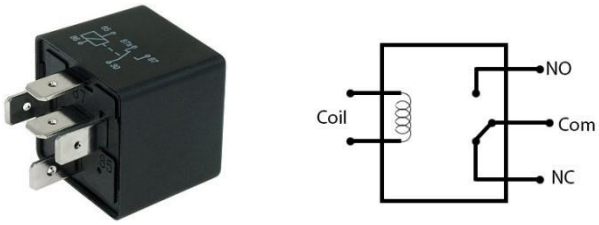


Figure 2.21: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

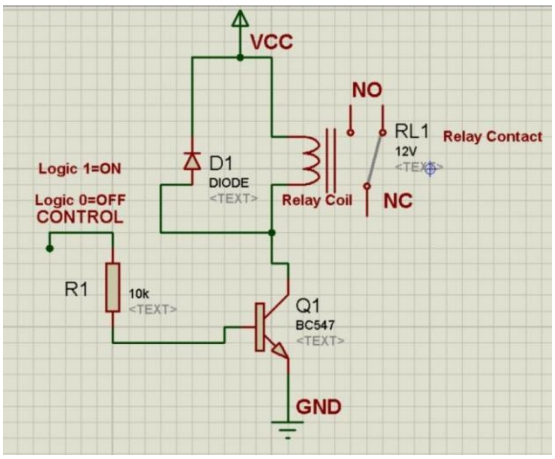


Figure 2.22: Transistor Switching Circuit.

The circuit above is called a low-side switch, because the switch – our transistor – is on the low (ground) side of the circuit. Alternatively, we can use a PNP transistor to create a high-side switch: Similar to the NPN circuit, the base is our input, and the emitter is tied to a constant voltage. A relay is an electrically operated switch of mains voltage. It means that it can be turned on or off, letting the current go through or not. Controlling a

relay with the Arduino is as simple as controlling an output such as an LED. The relay module is the one in the figure below.



Figure 2.23: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Mains voltage connections:

In relation to mains voltage, relays have 3 possible connections:

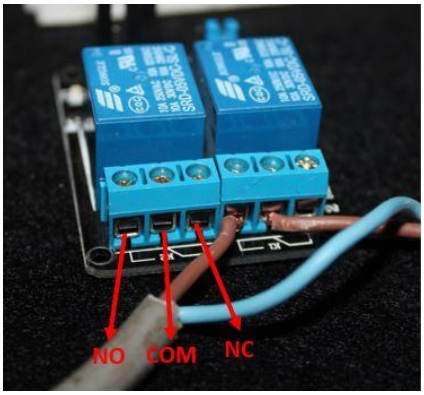


Figure 2.24: Pin diagram of Relay Module

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.

If you want to control a lamp for example, it is better to use a normally-open circuit, because we just want to light up the lamp occasionally.

Pin wiring: The connections between the relay module and the Arduino are really simple:



Figure 2.25: Main Voltage Connection

GND: goes to ground.

IN1: controls the first relay (it will be connected to an Arduino digital pin).

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it).

VCC: goes to 5V.

2.13 DC Gear Motor:

Description:

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. ... A 12v DC motor is small and inexpensive, yet powerful enough to be used for many applications.

Specification:

- Voltage: 12V DC.
- Gear ratio: 1/31.
- No-load speed: 200RPM.
- Rated Speed: 140RPM.
- Rated torque: 10kg.cm.
- Rated current: 2.5Amp.
- Length of Motor(including spindle): 106mm/4.17″..
- Diameter: 37mm/1.45″.

- Shaft length: 21mm/0.82″.
- Shaft diameter: 6mm/0.24″.



Fig: 2.26: DC Gear Motor

2.14 Proximity Sensor:

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive proximity sensor or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between the sensor and the sensed object. Proximity sensors are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings.

Types of Proximity Sensor:

- Inductive Proximity Sensor.
- Optical Proximity Sensor.
- Capacitive Proximity Sensor.
- Magnetic Proximity Sensor.
- Ultrasonic proximity Sensor.



Fig 2.27: Proximity Sensor

Proximity sensors are suitable for damp conditions and wide temperature range usage, unlike your traditional optical detection. Proximity sensors are also applicable in phones as well, be it your Andriod or IOS devices. It consists of simple IR technology that switches on and off display accordingly to your usage. Proximity sensors are used in phones, recycling plants, self-driving cars, anti-aircraft systems, and assembly lines. There are many types of proximity sensors, and they each sense targets in distinct ways.

- Model: LJ12A3-4-Z/BY .
- Wire Type - Cylindrical DC 3 Wire Type.
- Switch Appearance Type - Cylinder Type.
- Theory - Inductive Sensor.
- Output Type - PNP NO(Normal Open)..
- Diameter of Head - 12mm .
- Detecting Distance - 4mm .
- Supply Voltage - DC 6-36V .
- Current Output - 300mA .
- Response Frequency - 0.5KHz .
- Detect Object - Iron.
- Operating Temperature -25°C to +55°C (Non-freezing Condition) .
- Size 6.2 x 2cm/2.4" x 0.8" (L*Max. Dia).
- Cable Length 110cm/43.3".
- External Material Plastic, Alloy .
- Net Weight 46g.

2.15 Solenoid Valve:

A solenoid valve, also known as an electrically-operated valve, is a valve that uses electromagnetic force to operate. When an electrical current is passed through the solenoid coil, a magnetic field is generated which causes a ferrous metal rod to move. Solenoid valves are controlled by the action of the solenoid and typically control the flow of water or air as a switch. If the solenoid is active (current is applied), it opens the valve. If the solenoid is inactive (current does not exist), the valve stays closed.

Product Specification:

- Port Size 1/8" 1/4" 3/8" 1/2" M5
- Material Aluminum Alloy
- Brand Festo
- Response Time 0.05Second
- Protection Class IP65
- Voltage Range -10%~+10%

Description:

- Pneumatic Solenoid valves are shut-off, divert, reverse-acting, valves, having unique sealing design for total hygienic operations.
- It's ball shaped valve body is designed for optimum flow and CIP cleaning.
- These valves can be supplied with control head for operation with solenoid valve and micro switches.



Fig: 2.28: Pneumatic solenoid valve

2.16 Air Cylinder :

Pneumatic cylinder(s) (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.[1] :85 Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tiki Room, pneumatics are used to prevent fluid from dripping onto people below the puppets.

Different types of hydraulic cylinder:

- Single – Acting Cylinder. This type of cylinder is named due to the fluid only having one access point or port into the cylinder.
- Double- Acting Cylinder.
- Non-differential Cylinder.
- Telescoping, Ram-type, actuating Cylinder.
- Balanced, Double-acting, Piston-type Cylinder.
- Cushioned Cylinder.
- Single Acting, Spring Loaded.

Pneumatic Cylinder Specifications:

Model	ATO-CP-MSA
Bore Size	20mm, 25mm, 32mm, 40mm
Stroke	25mm, 50mm, 75mm, 100mm, 200mm, 350mm, 500mm
Acting Type	Single Acting
Working Medium	Air
Max Pressure	0.1-0.9 Mpa
Working Temperature	-5~+70℃

Speed Range	50-800 mm/s
Cushion Type	Rubber Buffer
Port Size	M5 X 0.8", G 1/8"

Cylinder Works:

Pneumatic actuators are mechanical devices that use compressed air acting on a piston inside a cylinder to move a load along a linear path. ... Double-acting cylinders have an airport at each end and move the piston forward and back by alternating the port that receives the high pressure air.



Fig: 2.29: Air Cylinder

2.17 Air Compressor:

An air compressor is a pneumatic device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When the tank's pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes.

Air Compressor can also be classified according to the design and principle of operation:

1. Single-stage reciprocating compressor.
2. Two-stage reciprocating compressor.

3. Compound compressor.
4. Rotary-screw compressor.
5. Rotary vane pump.
6. Scroll compressor.
7. Turbo compressor.
8. Centrifugal compressor.

Function of Air Compressor:

An air compressor is a pneumatic device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure.

Product Specification:

Horse Power	5 HP
Brand	ESYEXPRESS ELECTRIC AIR PUMP
Maximum Flow Rate	0-20 cfm
Power Source	Electric DC
Voltage	12V
Minimum Order Quantity	1 Piece

Product Description:

Your Brand Electric Portable DC12V Tire Inflator Mini Car Compressor Pump.

Description:

- This portable air compressor has a small electric motor that compresses the air in a small attached tank.
- It can be plugged into a 12V car system for on-the-go repairs or inflation.
- It's ideal for car and bicycle tyres, sports balls etc.
- It can be powered through a cigarette lighter in your vehicle and is very versatile.

Specification:

- Maximum Pressure - 260 PSI.
- Brand new and high quality.
- Material: ABS.
- Color: Black.
- Compact and portable.
- easy to use.
- Provide pressure gauge and 3 nozzle adapters.
- Ideal for inflating tires, balls, rubber floater, hovercraft and so on.
- Can also inflate Bicycle/Scooter/Moped tyres and also allows inflation of many other inflatable.
- leisure items using Flow rate: 35 L /Min.
- Voltage: DC 12 V.



Fig : 2.30: Air Compressor

CHAPTER 3
RESULTS & DISCUSSION

3.1 Result:

We have been able to build our system by following all the objects and methodologies. At first we have set up the all components well for our system. Here the proximity sensor and IR sensor are used to detect metal and non-metal objects. Here, if an object is first placed in the conveyor belt, then it goes in front of the IR sensor and the system will take 2 seconds to decide whether it is an object or something else. If it is an object then it will go forward. After that, when it will go in front of the proximity sensor, it will sense whether it is a metal or a non-metal product. It will take 1-2 seconds to detect it. After that, compressor will separate the products into separate boxes through the air cylinder. The efficiency of this project is very good. It is capable of working for a long time. We are satisfied its performance.

The metal and nonmetal product sorting system using a conveyor belt and pneumatic technology has delivered effective and reliable results. The system integrates IR sensors to detect objects placed on the conveyor and proximity sensors to classify the material type as metal or nonmetal. Once an object passes the IR sensor, the system takes 2 seconds to confirm its identity, followed by 1-2 seconds for the proximity sensor to distinguish the material. Upon detection, the compressor activates pneumatic cylinders to separate the products into specific bins. This method ensures fast and accurate sorting, with minimal error in classification. The system's efficiency allows it to handle products continuously for extended periods, making it highly suitable for industrial applications. It combines durability with low maintenance, ensuring long-term, consistent performance. The pneumatic actuation system further adds to its reliability, as it provides consistent and precise separation. Overall, this sorting system has demonstrated excellent accuracy, efficiency, and robustness, significantly improving product sorting and waste management processes in various manufacturing and recycling environments.

Table 1: Metal Performance Test

Sl	Metal	Diemension(mm)	Weight (gm)	Time(s)
1	MS Sheet	38*40*40	25.73	6
2	SS Sheet	30*39*40	21.81	4.5
3	Aluminium Sheet	35*38*37	23.31	5.5
4	GP Sheet	30*40*28	24.62	4

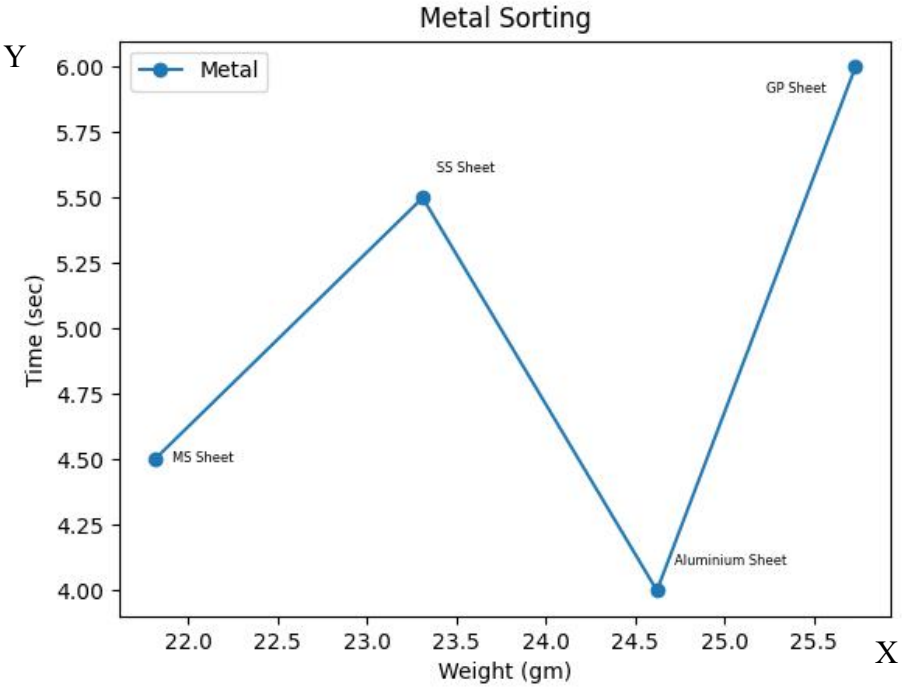


Figure 3.1 : Metal Performance Graph

Describe:

The graph titled "Metal Sorting" shows the relationship between the weight of different metal sheets (in grams) and the time required (in seconds) for sorting. The metals include:

- MS Sheet (22 gm, 4.5 sec)
- SS Sheet (23.5 gm, 6 sec)
- Aluminum Sheet (24.5 gm, 4 sec)
- GP Sheet (25.5 gm, 5.8 sec)
- The time increases and decreases depending on the metal type and weight.

Table 2: Non Metal Performance Test

Sl	Non Metal	Diemension(mm)	Weight (gm)	Time(s)
1	Paper	30*40*28	11.5	4.5
2	Rubber	35*38*37	13.5	4.2
3	Plastic	30*39*40	14.95	3.8
4	Teflon	38*40*40	17	4.2

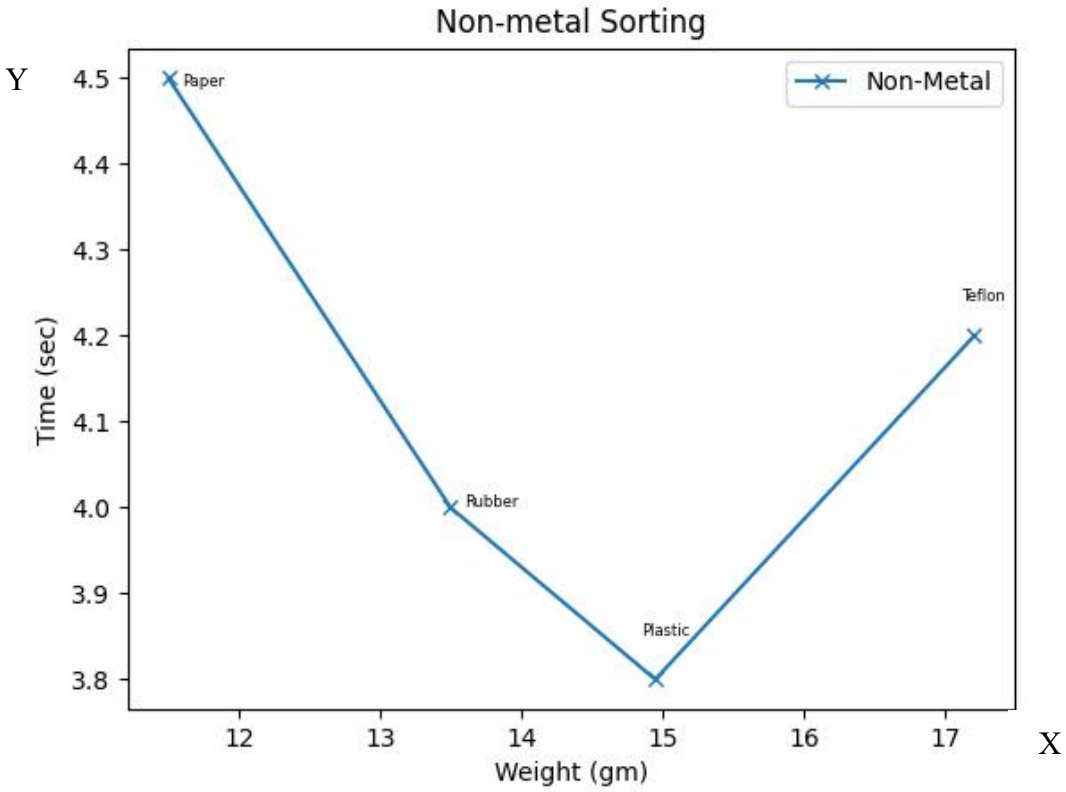


Figure 3.2 : Non Metal Performance Graph

Describe:

This graph titled "Non-metal Sorting" shows the relationship between the weight (in grams) of non-metal materials and the time (in seconds) taken for sorting.

- Paper: Corresponds to a weight of approximately 11.5g, with the highest sorting time (~4.5 seconds).
- Rubber: Weighs around 13 g and has a sorting time near 4 seconds.
- Plastic: Weighs around 15 g and has the lowest sorting time (~3.8 seconds).
- Teflon: Weighs around 17 g and has the lowest sorting time (~4.2 seconds).

Table 3: Metal-Non Metal Performance Test

Product		Times(s)		Distance Between 1st And 2nd Object (mm)	Detect & Shorting Object	
1st Object	2nd Object	1st Object	2nd Object		1st	2nd
$SS_{(metal)}$ ---$Teflon_{(Non\ metal)}$		6	5	230-260 mm	Yes	Yes
$MS_{(metal)}$---$Plastic_{(Non\ metal)}$		4.5	4	230-260 mm	Yes	Yes
$GP_{(metal)}$---$Rubber_{(Non\ metal)}$		5.4	5	230-260 mm	Yes	Yes
$Al_{(metal)}$ --- $Paper_{(Non\ metal)}$		4	4.2	230-260 mm	Yes	Yes

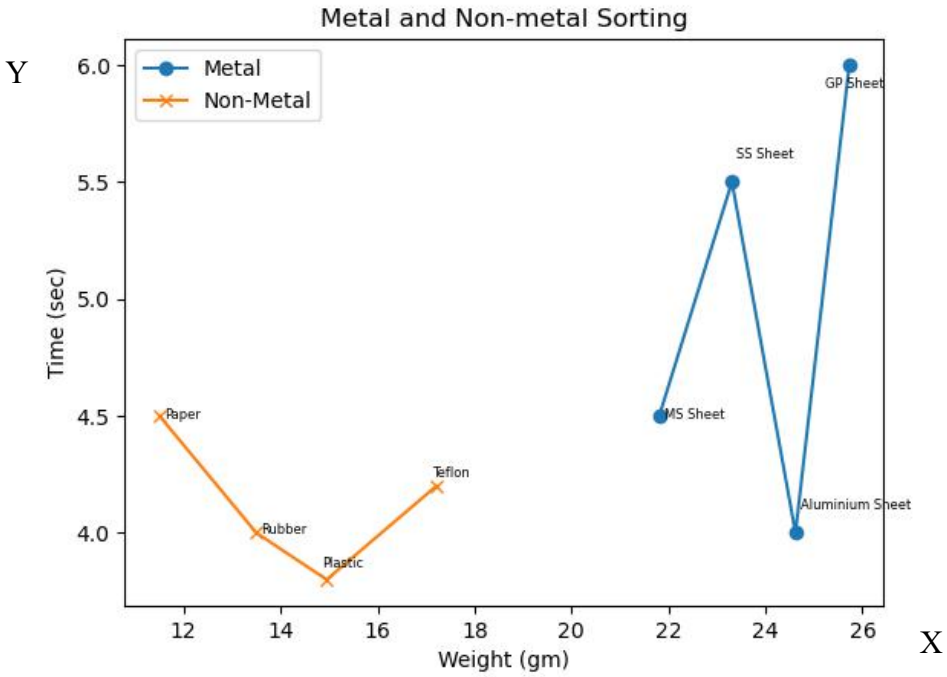


Figure 3.2 : Metal-Non Metal Performance Graph

Describe:

This graph compares Metal and Non-Metal Sorting based on weight (12–26 g) and time (4.0–6.0 sec).

Non-Metals: Sorting time decreases from Paper (12 g, ~4.5 sec) to Plastic (15 g, ~4.0 sec) and rises for Teflon (17 g, ~4.5 sec).

Metals: Sorting time increases sharply for MS Sheet (22 g, ~5.2 sec), SS Sheet (24 g, ~5.5 sec), and peaks with GP Sheet (26 g, ~6.0 sec).

Aluminum Sheet (23 g) shows a dip (~5.0 sec).

The graph shows distinct patterns for metals (increasing time) and non-metals (U-shaped trend).

❖ **Project Specification :** Distance Between Metal and Non Metal -230 & 260 mm Position still sensor detect the object then pneumatic cylinder push the objects through bucket.

3.2 Discussion

A Metal and Nonmetal Product Sorting System with a conveyor belt using pneumatic technology is an innovative solution for industrial automation. The system employs sensors like inductive proximity sensors to detect metallic items and capacitive sensors for nonmetallic ones. As items travel on the conveyor belt, sensors identify their material composition, and pneumatic actuators swiftly segregate them into designated bins.This technology ensures high-speed, accurate sorting, reducing manual labor and operational costs. Pneumatic systems offer reliability, durability, and efficiency, powered by compressed air for seamless operation. The integration of a PLC (Programmable Logic Controller) enhances system control and flexibility, allowing adjustments for diverse materials.Such a system is widely applicable in recycling plants, manufacturing units, and packaging industries, promoting streamlined operations and sustainability. The compact design and energy efficiency of pneumatic technology further make it a cost-effective and environmentally friendly solution for material handling challenges.

3.3 Advantages

- Good accuracy to find metal and non-metal object.
- Time saving machine for industrial work.
- Very effectively work for product peak and place.
- Reduce energy waste.
- No Oil consumption.
- Less skill technicians is sufficient to operate.
- Installation is simplified very much.
- Less time and more profit.
- Simple construction
- Reduced weight of the system.
- Ease of operation.

3.4 Applications

The project has a major application in the

- It can be used for Industrial work.
- It can be used in factories for peak and place.
- It can be used in pharmacy.
- It can be used for metal no-metal separator.

3.5 Limitations

It is a demo project so we found some limitation. In future we will work for reduce this kind of limitation. These limitations are –

- It is a demo project so its accuracy is 85%.
- This compressor have no extra air chamber.
- Our project may delay in work .

CHAPTER 4

CONCLUSION

4.1 Conclusion:

The main objective of this project was to develop an object sorting system based on certain specifications. This was successfully implemented. We consider this project as a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report. Arduino was used to control the various operations. More features can be added to this system as follows: depending on the size, shape and weight of the objects, sorting operations can be implemented. Sorting operation can be improvised using a piston arrangement.

4.2 Future Scope:

The model can be improved by making some changes in the program and components. Some suggestions are given below-

- We can add a monitoring based control to automate control.
- We will increase its working accuracy level.
- We will add an air reserve tank.
- We can also add a counter for counting the number of products.
- We will add Counting Sensor.

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APPENDIX

```
#include <Servo.h>
Servo myservo;
Servo myservo1;

const int Pin = A0;
int relay = 3;
int irsen=4;
int ir;
void setup() {
  pinMode(Pin, INPUT);
  pinMode(irsen, INPUT);
  pinMode(relay, OUTPUT);
  myservo.attach(9);
  myservo1.attach(8);
  myservo.write(50);
   myservo1.write(50);
  Serial.begin(9600);
}

void loop() {
 digitalWrite(relay,HIGH);
 int ir = digitalRead(irsen);
 int sensorValue = digitalRead(Pin);
    Serial.println(sensorValue);
    delay(1000);
 if(sensorValue==LOW && ir==LOW){
    Serial.println("metal Detected");



    myservo.write(90);
        delay(5000);
    myservo.write(50);
        delay(500);

    }
     if(sensorValue==HIGH && ir==LOW ){
        Serial.println("no metal Detected");


         myservo1.write(10);
         delay(5000);
        myservo1.write(60);
         delay(500);
     }
}
```