Design and Construction of a Pneumatic Metal Detection & Sorting System Using Micro-controller

A report submitted to the Department of Mechanical, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Mechanical Engineering.

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CERTIFICATION

This is to certify that the whole work submitted as a thesis work entitled **"Design and Construction of a Pneumatic Metal Detection & Sorting System Using Micro-controller"** to the Faculty of Science and Engineering, Sonargoan University (SU) for the degree of Bachelor of Science in Mechanical Engineering was carried out under the superintendence of **Md. Istiaque Zahur** sir. This study has been carried out in the Mechanical Engineering, Sonargoan University Dhaka, Bangladesh. This is also to certifying that the research work presented here is an original work for the partial fulfillment of the degree of Bachelor of Science in Mechanical Engineering. To the best of our knowledge this thesis has not been submitted elsewhere.

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DECLARATION

This dissertation has been submitted as thesis entitled **"Design and Construction of a Pneumatic Metal Detection & Sorting System Using Micro-controller"** to the Sonargoan University (SU) in partial fulfillment to the requirements for the degree of Bachelor of Science in Mechanical Engineering, Sonargoan University Dhaka, Bangladesh. No part of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Abstract

This project presents the design and construction of a Pneumatic Metal Detection and Sorting System utilizing a microcontroller. The system is designed to automatically detect metallic objects from a conveyor belt based on their material composition. This automated machine controlled by an Arduino Pro Mini and Proximity Sensor, efficiently separates metal & non-metal pieces, placing them in a bucket. Results demonstrate accurate sorting with a reasonable good average time. Components include SMPS, Relay, IR Sensor, DC Gear Motor, Air Cylinder, Air Compressor and Pneumatic Solenoid Valve. The system offers potential applications in recycling plants, manufacturing facilities and quality control processes. This project showcases the integration of electronics, sensors and automation to enhance industrial processes and reduce manual labor, contributing to increased productivity and efficiency.

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INTRODUCTION

1.1 General:

In our day to day life many products are manufactured in large and small-scale industries. Usage of these products are getting increased which results in increased productivity. After manufacturing, arrangement of these products is a hectic task which further increases the product completion time. The main difficulty faced after the manufacturing is sorting the manufactured product. It is done according to the weight, size, colour, shape, etc of the project. Another time-consuming process is providing identification to the product which is called stamping or labeling. The stamping is also done to provide product information like price, quantity, mechanical and electrical parameters. This project work focuses on the study of product sorting and stamping using pneumatic cylinders.

The purpose of this process is to save the time for inspection and to reduce the effort of the workers. The stamping and sorting process can be more economical when it is automated. This system also transfers the product from one point to another. The design is quite simple and of flexible use, which indicates a single conveyor belt is sufficient for material handling. The conveyor has sensors and actuators to make it an intelligent conveyor. Packaging is an essential step in production processes. It provides basic safety to the products and also adds value for marketing the product. The stamping and sorting process are incorporated in packaging operation to identify and to confirm some important data like product registration number, manufacturing date and expiry date that meets all legal and statutory requirements of the food industries [1].

In this modern era of advanced technologies, every process needs to be highly perfect and should be produced in less time. The present practice in food packaging industries is that, stamping and sorting is done separately by operators and may require up to seven operators per line to achieve a higher productivity. This separated action is time consuming, generates higher expenditure and also results in poor finishing. In order to achieve higher productivity in small scale industries there is a need for automatic stamping and sorting. Automation has been defined as the use of various systems such as pneumatics, hydraulics, electrical,

electronics and computers to control industrial machinery and processes, thereby reducing the use of human intervention [2].

1.2 Objective:

The objectives of this project are:

a) To study about a Pneumatic Metal Detection & Sorting System Using Micro-controller.
b) To design and construct a Design and Construction of a Pneumatic Metal Detection & Sorting System Using Micro-controller.
c) To test the performance of the Design and Construction of a Pneumatic Metal Detection & Sorting System Using Micro-controller.

CHAPTER 2
LIRERATURE REVIEW

2.1 Introduction

In this section topics related to Pneumatic Metal Detection & Sorting Using Micro-controller are included. These provide a sampling of problems appropriate for application of a Pneumatic Metal Detection & Sorting Using Micro-controller. The references are summarized below.

2.2 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 colors 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 Micro-controller. 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]

CHAPTER 3
THEORY & WORKING PRINCIPLE

3.1 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 –

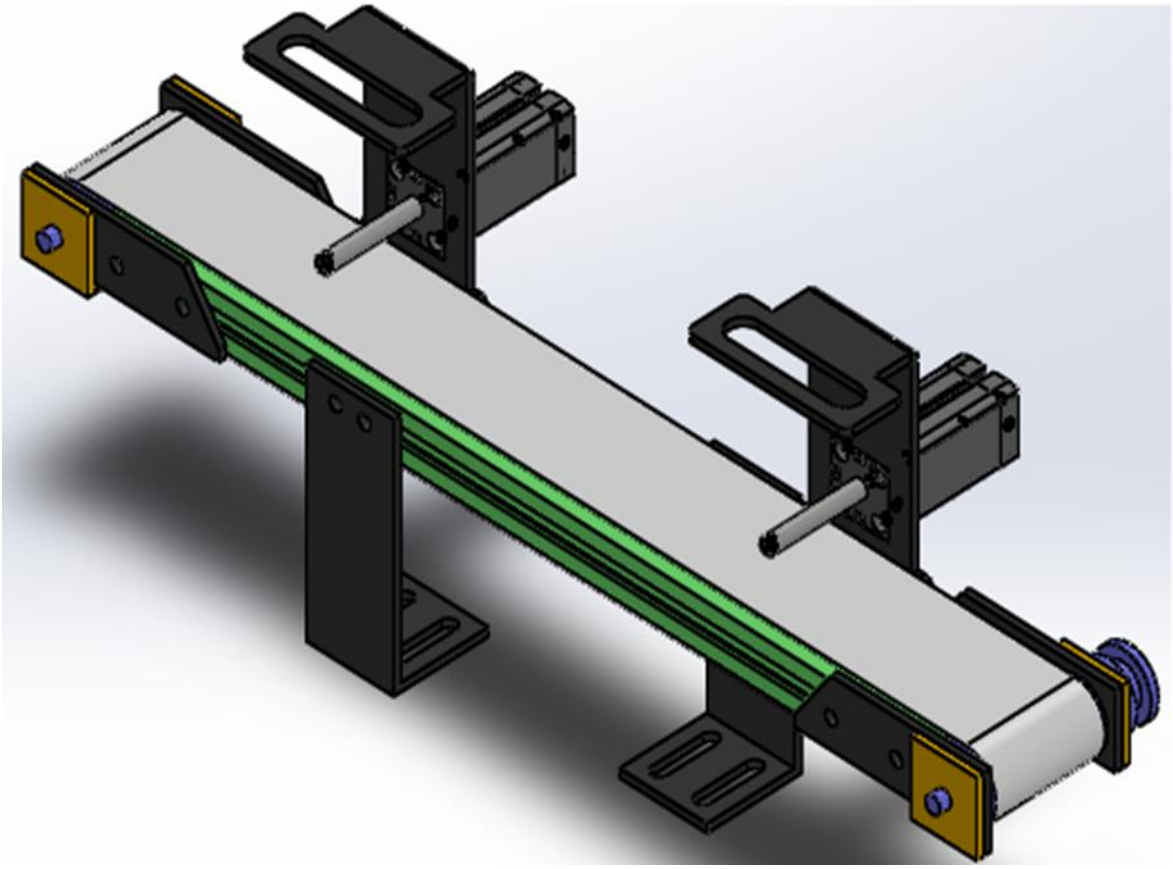

Fig: 3.1: Metal Non-metal sorting system with conveyor belt 3d image. [13]

3.2 Methodology

Here the current from AC is entering the circuit at 12 volts via SMPS. The Arduino Pro Mini is equipped with two sensors. The proximity sensor and this 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 sensor. Then check the object if it is metal then a Pneumatic cylinder will put it in a specific box.

3.3 Block Diagram:

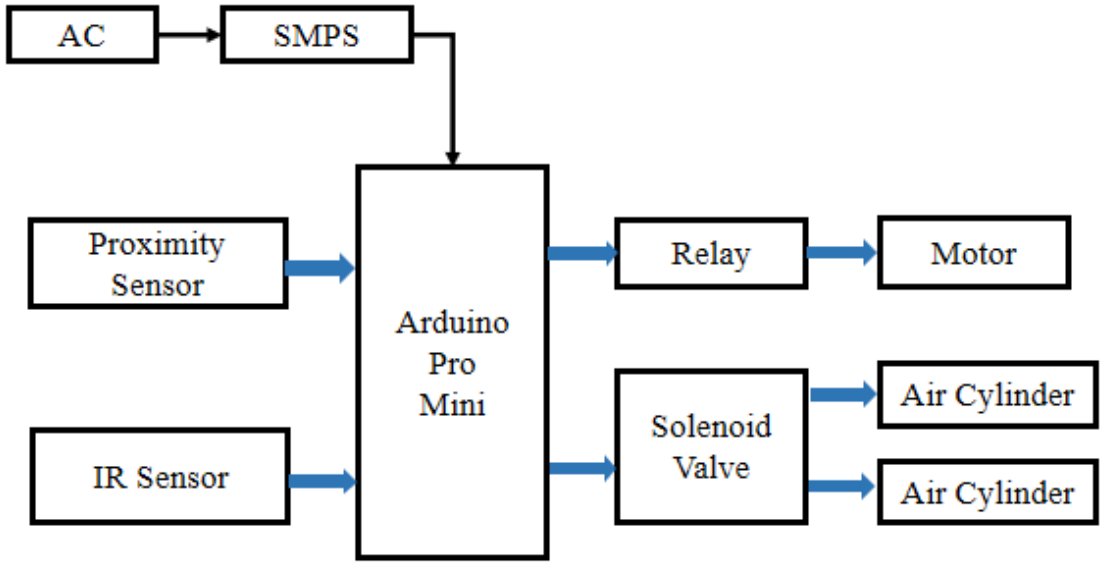

Figure 3.2: Block Diagram of Pneumatic Metal Detection & Sorting System Using Micro-controller

3.4 Working Principle

Our project is designed to separate metal non-metal objects. We are using Arduino Pro Mini for controlling our project, which is acting as the main controller here. Also used here IR 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 Pro Mini 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.

3.5 Complete Project Prototype Image:

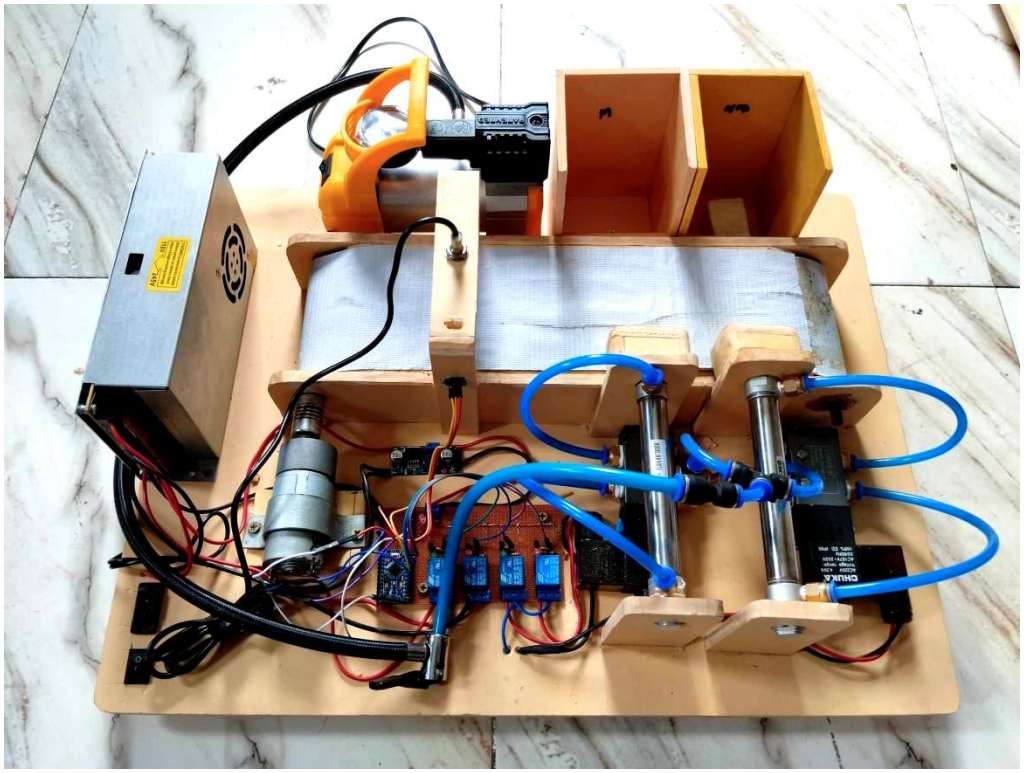

Figure 3.3: Project Prototype Image.

3.6 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 Pro Mini

3.7 Cost Analysis:

No	Product Name	Specification	Qty	Unit Price	Total Price	Market Price
01.	Arduino	Pro Mini	1	480	480	650
02.	SMPS	12V	1	650	650	850
03.	IR sensor		1	180	180	450
05.	Gear Motor	12V DC	1	700	700	1300
06.	Air Cylinder		2	1850	3700	4800
07.	Solenoid Valve	Pneumatic	2	250	500	900
08.	Proximity Sensor	PNP 6-30	1	290	290	400
09.	Air Compressor		1	2500	2500	3500
10.	Others				1500	2150
					10,500/=	15,000/=

Table :1 : Cost Analysis

3.8 Arduino Pro Mini

The Arduino Pro Mini is a micro-controller board based on the ATmega168. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable to provide USB power and communication to the board.

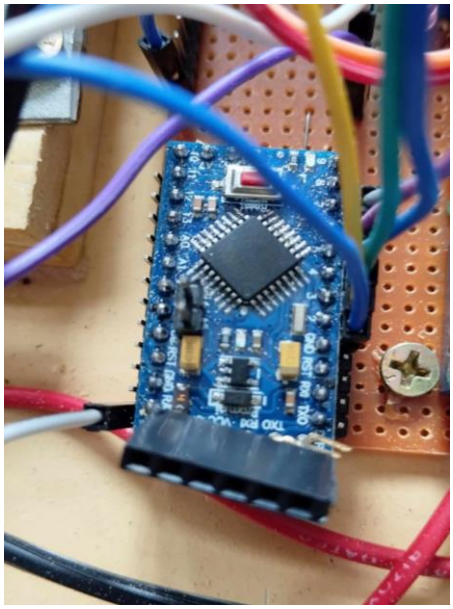

Figure 3.4: Arduino Pro Mini

Pin Out

Each of the 14 digital pins on the Pro Mini can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 3.3 or 5 volts (depending on the model). Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the TX-0 and RX-1 pins of the six pin header.

- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt() function for details.

- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write() function.

- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

  The Pro Mini has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). Four of them are on the headers on the edge of the board; two (inputs 4 and 5) on holes in the interior of the board. The analog inputs measure from ground to VCC. Additionally, some pins have specialized functionality:

There is another pin on the board:

- Reset. Bring this line LOW to reset the micro controller. Typically used to add a reset button to shields which block the one on the board.

  See also the mapping between Arduino pins and ATmega168 ports.

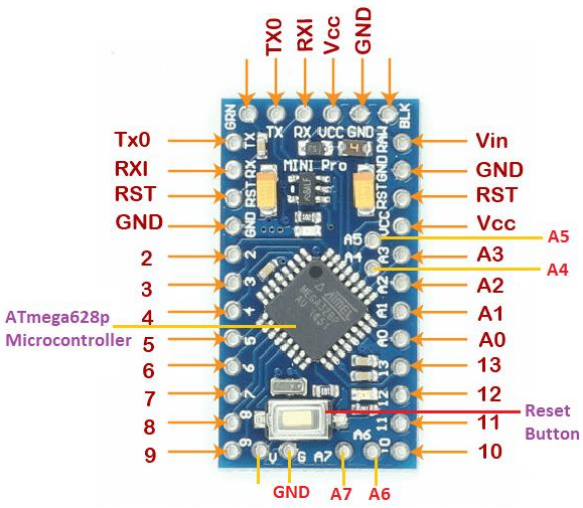

Figure 3.5: Arduino Pro Mini Pin Out [14]

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro controller 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.

Micro controller IC ATmega328p

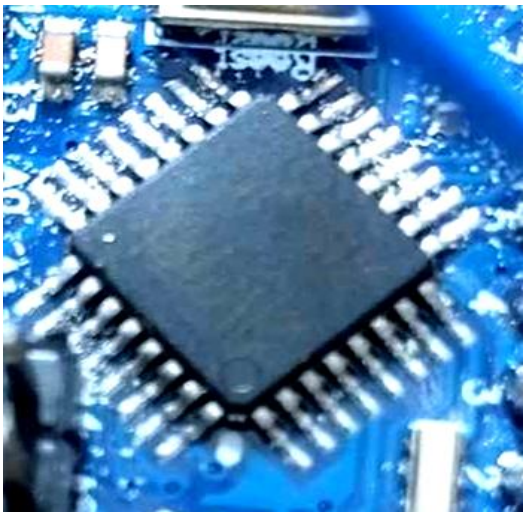

Figure 3.6: Micro controller IC AT Mega 328p

3.9 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. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. 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.

Figure 3.7: 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 Aluminum casing.

- Input Voltage: AC 110 – 245V 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, Reliability & 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.

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 fly back, 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

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 DC 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 DC producing a suitably smooth DC 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 DC power supply would look something like this:

Typical DC Power Supply

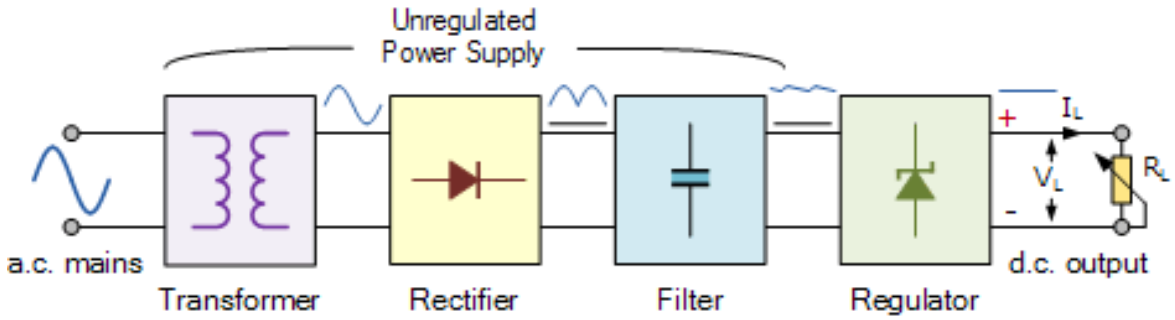

Fig 3.8 : DC Power Supply Step

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.

3.10 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.

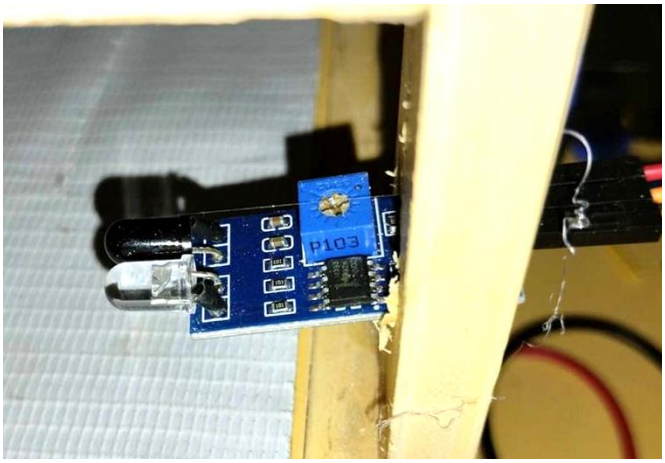

Figure 3.9 : IR Sensor

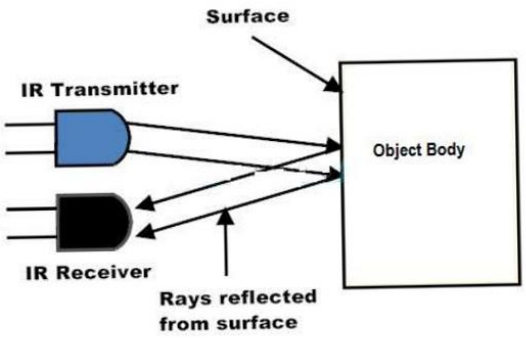

Figure 3.10: IR sensor reflection System [15]

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.

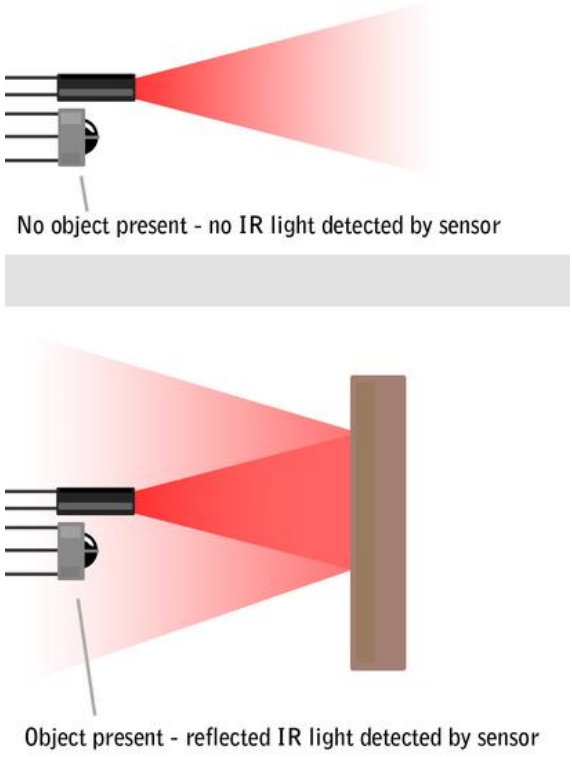

Figure 3.11: IR sensor Detection System.

3.11 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.

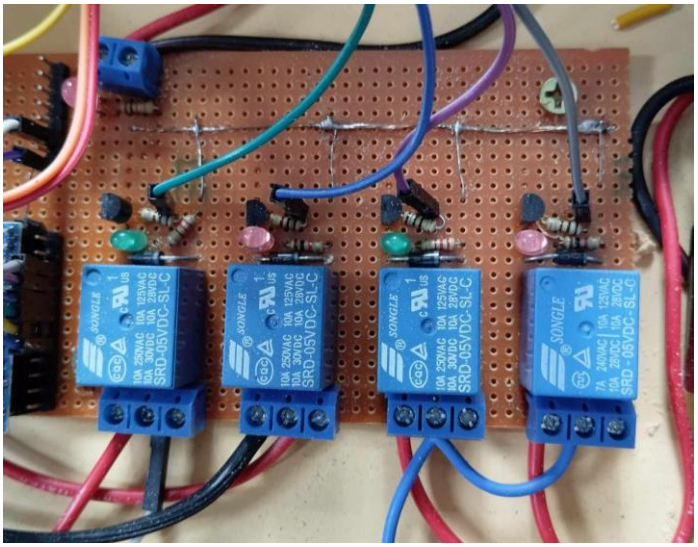

Figure 3.12: Relay

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.

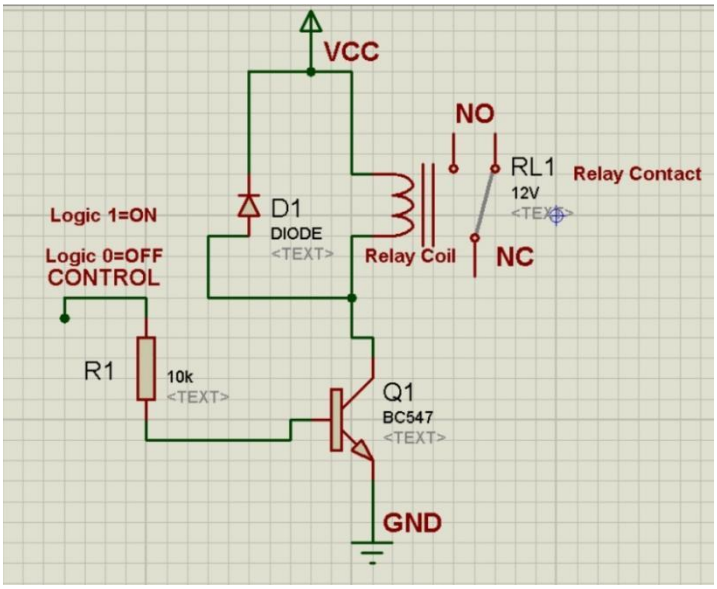

Figure 3.13: Transistor Switching Circuit

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.

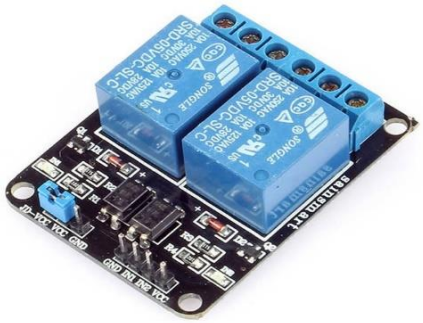

Figure 3.14 : Relay Module

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:

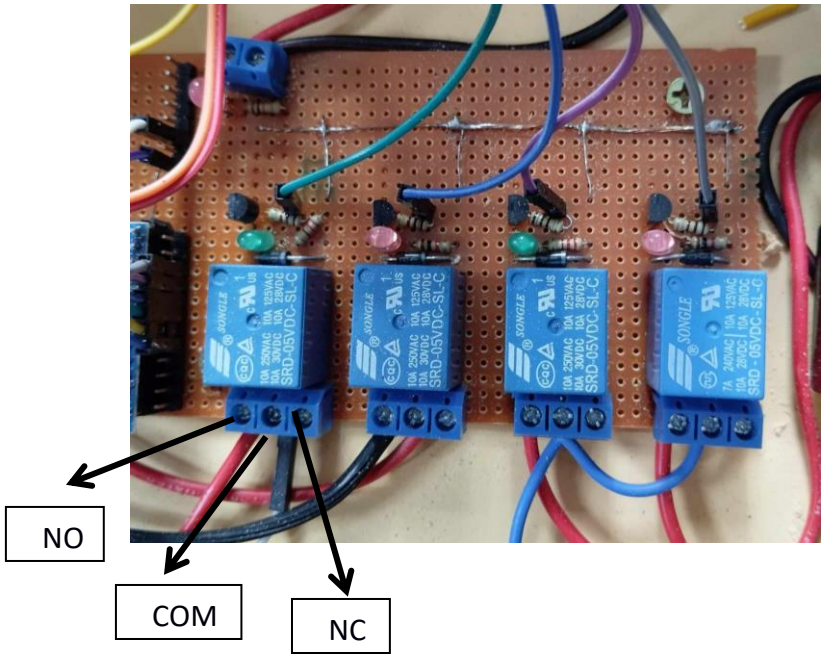

Figure 3.15: Pin diagram of Relay Module

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:

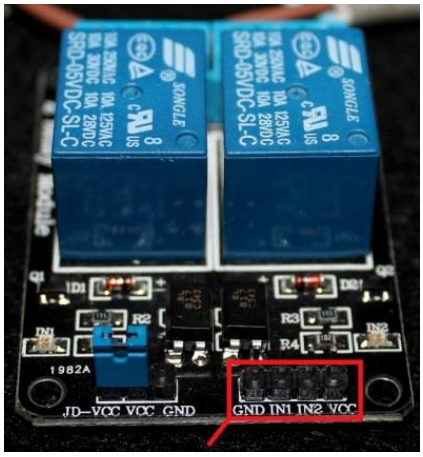

Figure 3.16: Main Voltage Connection

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

3.12 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.

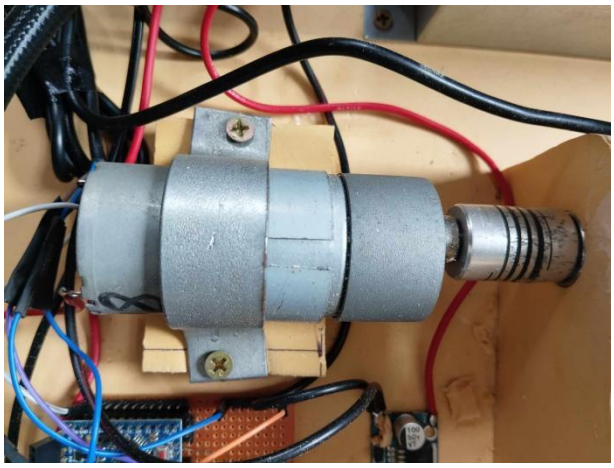

Figure: 3.17: DC Gear Motor

3.13 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.

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 Android 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

Figure 3.18: Proximity Sensor.

3.14 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 CHUKA
- 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: 3.19: Pneumatic solenoid valve

3.15 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 pneumatic more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tiki Room, pneumatic 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	MA16X75
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.

Figure 3.20 : Air Cylinder.

3.16 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.

They 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	INGCO ELECTRIC AIR PUMP
Maximum Air Flow Rate	35L/min
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.
- With the tyre shape the cord and cigarette cord fit into it for compact design.

Fig : 3.21: Air Compressor

CHAPTER 4

RESULT & DISCUSSION

4.1 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. The efficiency of this project is very good. It is capable of working for a long time. We are satisfied its performance.

Test Box:

Operation 1	Response
Operation 2	Accuracy
Operation 3	Repeatability

Case 1: Response Test

Machine	Object	Outcome
ON	Metal/Non-Metal	Successfully detected

The Proximity Sensor will detect the object and if it is Metal, it will take 1.1 seconds for the metal to reach the solenoid valve.

Case 2: Accuracy Test

Machine	Object	Outcome
ON	Metal/Non-Metal	Successfully sorted

The IR Sensor detect the object and if it is Non-Metal, it takes 1.9 seconds to reach the non-metal solenoid valve.

Case 3: Repeatability Test

Machine	Object	Outcome
ON	Metal	Successfully sorted
ON	Non-Metal	Successfully sorted

Our Project Accuracy is 90% and Repeatability is 99%.

4.2 Discussion

Our Project Accuracy is 90% and Repeatability is 99%. Metal detect in 1.1 second and Non-Metal detect in 1.9 second to reach the solenoid valve. While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

4.3 Advantage

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

4.4 Application

The project has a major application in the

- It can be used for Industrial work.
- It can be used in factories for pick and place.
- It can be used in pharmacy.
- It can be used for metal non-metal separator.

4.5 Limitation

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 90%.
- This compressor have no extra air chamber.
- Our project may delay in work.

CHAPTER 5
CONCLUSION

5.1 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.

5.2 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.

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APPENDIX

Programming Code:

```
const int proximitySensorPin = 2; // Pin for the proximity sensor
const int irSensorPin = 3;        // Pin for the IR sensor
const int belt = 4;
const int air_compressure = 5;
const int metal_valve = 6;
const int nonmetal_valve = 7;

void setup() {
  Serial.begin(9600);
  pinMode(proximitySensorPin, INPUT);
  pinMode(irSensorPin, INPUT);
  pinMode(belt, OUTPUT);
  pinMode(air_compressure, OUTPUT);
  pinMode(metal_valve, OUTPUT);
  pinMode(nonmetal_valve, OUTPUT);
}

void loop() {
  int proximityValue = digitalRead(proximitySensorPin);
  int irValue = digitalRead(irSensorPin);
    Serial.println(irValue);

  if (proximityValue == HIGH && irValue == LOW) {
    Serial.println("Non-Metal detected.");
    digitalWrite(belt, LOW); // Stop the conveyor belt
    // Activate pneumatic mechanism for metal sorting
      digitalWrite(air_compressure, HIGH); // Activate air compressor
```

```
    delay(500); // Wait for 2 secondsmetal valve
    digitalWrite(air_compressure, LOW); // Deactivate air compressor
     digitalWrite(belt, HIGH);
    delay(1900); // Wait for 2 secondsmetal valve
    digitalWrite(belt, LOW);
    digitalWrite(metal_valve, HIGH); // Activate the
    delay(2000); // Wait for 2 secondsmetal valve
   digitalWrite(metal_valve, LOW); // Deactivate the metal valve


  digitalWrite(belt, HIGH); // Start the conveyor belt again


 }  if (proximityValue == LOW && irValue == LOW){
  digitalWrite(belt, LOW); // Stop the conveyor belt
  // Activate pneumatic mechanism for metal sorting
    digitalWrite(air_compressure, HIGH); // Activate air compressor
    delay(500); // Wait for 2 secondsmetal valve
    digitalWrite(air_compressure, LOW); // Deactivate air compressor
     digitalWrite(belt, HIGH);
    delay(1100); // Wait for 2 secondsmetal valve
    digitalWrite(belt, LOW);
    digitalWrite(nonmetal_valve, HIGH); // Activate the
    delay(2000); // Wait for 2 secondsmetal valve
   digitalWrite(nonmetal_valve, LOW); // Deactivate the metal valve
 }
if (irValue == HIGH){
  digitalWrite(belt, HIGH);
 }
 delay(100); // Delay for stability and readability
}
```