DESIGN AND FABRICATION OF AN AUTOMATIC BOTTLE FILLING, COUNTING AND MISSING DETECTION SYSTEM

A Thesis
By

Md: Omar Faruk	ME2102024097
Md.Samiul Islam	ME2102024148
Shaleh Mahamud	ME2102024451
Md. Shipon Ali	ME2102024131
Md. Solayman Hossain	ME2102024155

Department of Mechanical Engineering
SONARGAON UNIVERSITY (SU)

January, 2025

DESIGN AND FABRICATION OF AN AUTOMATIC BOTTLE FILLING, COUNTING AND MISSING DETECTION SYSTEM

Submitted By

Md: Omar Faruk	ME2102024097
Md.Samiul Islam	ME2102024148
Shaleh Mahamud	ME2102024451
Md. Shipon Ali	ME2102024131
Md. Solayman Hossain	ME2102024155

Supervised By

Md. Mahafujul Islam

Lecturer
Department of ME

Department of Mechanical Engineering
SONARGAON UNIVERSITY (SU)

In partial fulfillment of the requirement for award of the degree
Of
Bachelor of Science in Mechanical Engineering

January, 2025

LETTER OF TRANSMITTAL

December, 2024

To

Name

Designation

Department of Mechanical Engineering.

Sonargaon University

Subject: Submission of Project Report**.**

Dear Sir,

We are pleased to submit the project report on "Automatic Bottle Filling, Counting and Missing Detection System". 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,

Md: Omar Faruk
ME2102024097

Md.Samiul Islam
ME2102024148

Shaleh Mahamud
ME2102024451

Md. Shipon Ali
ME2102024131

Md. Solayman hossain
ME2102024155

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.

Md: Omar Faruk
ME2102024097

Md.Samiul Islam
ME2102024148

Shaleh Mahamud
ME2102024451

Md. Shipon Ali
ME2102024131

Md. Solayman hossain
ME2102024155

ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. This thesis is accomplished under the supervision of Md. Mahafujul Islam**,** Lecturer, Department of Mechanical, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

The authors are also grateful to **Md. Mostofa Hossain,** Head of the Department of Mechanical Engineering and all respect teachers of the Mechanical Engineering Department for their co-operation and significant help for completing the thesis work successfully.

ABSTRACT

The field of automation has a notable impact in a wide range of industries beyond manufacturing. Automation plays an increasingly important role in the world economy. Filling is a task carried out by a machine that packages liquid products such as cold drinks or water. In past, humans were the main method for controlling a system. More recently, electricity has been used for control and electrical control is based on microcontrollers for various purposes like medicines, pharmaceutical plants, chemical plants etc. There microcontrollers control the complete working of the system. It is common to use microcontrollers to make simple logical control decision. The automation in bottle filling industry comes with increased electrical components. Essential requirements of each component in the system is important to be studied in ordered to understand how each part works in coordination with other parts in the system. This study mainly includes design, fabrication and control system for automated bottle filling system. The main part is control system which includes C programming in Arduino microcontroller to control various components in system. A conveyor system with sensors and electromagnetic valve is fabricated for this purpose. The entire sequence of operation is controlled by Arduino microcontroller. In small industries bottle filling operation is done manually. The manual filling process has many shortcomings like spilling of water while filling it in bottle, equal quantity of water may not be filled, delay due to natural activities of human etc. This problem faced by small industries compels to design this system. This proposed system is meant for small industries. It aims to eliminate problem faced by small scale bottle filling system. With this system which operates automatically, every process can be smooth and the process of refilling can reduce worker cost and operation cost.

TABLE OF CONTENTS

Letter of Transmittal		ii
Declaration		iii
Acknowledgement		iv
Abstract		v
Table of Contents		vi
Table of Figure		viii
List of Table		ix
CHAPTER 1	**INTRODUCTION**	
1.1	Background	01
1.2	Literature Review	02
1.3	Objective	04
1.4	Methodology	04
1.5	Block Diagram	05
1.6	Schematic Diagram	05
1.7	Working principle	06
1.8	Hardware Architecture	06
1.9	Complete Project View	07
CHAPTER 2	**HARDWARE COMPONENT ANALYSIS**	
2.1	Component List	08
2.2	SMPS	08
2.2.1	Basic Working Concept of an SMPS	10
2.2.2	Design Basic	10
2.2.3	Advantage of SMPS	11
2.2.4	Disadvantage	11
2.3	LCD display	13
2.4	IR Sensor	14
2.5	Pump Motor	16
2.6	Ultrasonic Sensor	17
2.7	Buck Converter	20

2.8	Motor Driver	22
2.9	Stepper Motor	24
2.10	Relay	26
CHAPTER 3	**SOFTWARE ANALYSIS**	
3.1	Arduino Software	29
3.2	Easy EDA	33
3.3	Experimental Data & Result:	34
CHAPTER 4	**DISCUSSION & CONCLUSION**	
4.1	Cost of the Project	35
4.2	Advantage	35
4.3	Application	36
4.4	Limitation	36
4.5	Discussion	36
4.6	Conclusion	37
4.7	Future scope of work	37
References		**38**

LIST OF FIGURES

FIGURE NO	FIGURE NAME	PAGE NO
1.1	Block Diagram Of Automatic Bottle Filing Machine	05
1.2	Schematic Diagram Of Automatic Bottle Filing Machine	05
1.3	Control Circuit	06
1.4	Bottle Stage	07
1.5	Project Image	07
2.1	SMPS	09
2.2	Switch Mode Power Supply Circuit	10
2.3	SMPS Circuit Diagram	12
2.4	DC power Supply	13
2.5	16*2 LCD display	14
2.6	IR Sensor	15
2.7	IR Sensor Reflection System	15
2.8	IR sensor Detection System	16
2.9	Pump Motor	17
2.10	Working of Ultrasonic sensor	18
2.11	DC-DC Buck Converter	21
2.12	Motor Driver	22
2.13	Stepper Motor	24
2.14	Stepper Motor Construction	25
2.15	Relay	26
2.16	Relay Module	27
2.17	Mains Voltage Connection	27
2.18	Voltage Connection	28
3.1	Easy EDA Software Interface	33

LIST OF TABLES

TABLE NO	TABLE NAME	PAGE NO
01	Ultrasonic Sensor Pin Configuration	19
02	Cost of this Project	35

Chapter 1
Introduction

1.1 Background

Industrial Automation plays an increasingly important part in the global economy and also in daily experience. At present, for companies, the purpose of automation has shifted from growing productivity and reducing costs to broader issues. This work takes the idea of automatic sorting and bottle filling. The control system uses microcontroller. Sorting of bottles is done on the conveyer belt via IR sensors and then these bottles are filled by actuating the solenoid valves. The conveyors are used in many automated industries for moving parts from one place to another. The second concern is the bottle filling. Once the bottle is sorted, conveyer belt transfers it under the water tank for filling.

The world is moving towards Automation, i.e., completion of processes without or with minimum human intervention. Automation involves remotely controlling processes and creating control loops, so that the operation can be carried out electronically with minimum human intervention. The whole process is controlled by microcontrollers, which act as the brain of the system. Microcontrollers are very compact integrated circuits with three main components, viz. processor, I/O peripherals and memory unit. These microcontrollers are generally used in embedded systems and are connected to other heavy components which carry out the actual work in the process. Examples of Microcontrollers include 8051, AVR microcontrollers, ATmega328 etc.

In large industries PLCs or Programmable Logic Controllers are used to automate the process. PLCs are large scale digital computers which are adapted to withstand rough industries conditions, which include humidity, dust, heat, vibrations and large number of I/O operations per unit time. They use Ladder logic, which has been used by engineers and technicians for a very long time. They are reliable and sturdy. The initial cost of a PLC is very high. Filling operation involves filling a predetermined amount of liquid precisely in a bottle. This operation was earlier carried out by humans and involved placing one bottle at a

time on the conveyor belt and filling it. The process then was slow, involved spilling of liquid and resulted in unequal quantities of liquid in bottles. In large scale industries like soft drinks and pharmaceuticals, filling is carried out by PLCs. But the very high initial cost of a PLC machine discourages small scale industries to automate. They still work manually which drives up their labor costs, increases wastages and decreases their overall efficiency. Therefore, these small-scale units should also be provided a cheap option for them to automate their units and save time, money and resources. This problem can be solved by using Arduino as a microprocessor. Arduino is a much cheaper option as compared to PLCs. It is a microcontroller board which has many I/O pins through which it can interact with outside elements. It also has a memory unit (flash memory, SRAM and EEPROM) and a processor. It is easily available and can be coded using an Arduino IDE (Integrated Development Environment). This project aims to design an automatic bottle filling system which uses Arduino Nano as base. This will reduce labor and operation costs in small scale industries.

1.2 Literature Review

Bipin Mashilkar, Pallavi Khaire and Girish Dalve [1] in their paper explain in detail have worked on an Automatic bottle filling machine. Their project aims to reduce the complexity and price of a bottle filling system. It uses Arduino as the microcontroller and details the design parameters of a system.

Sagar Dadhe, Rohit Maske, Rohit Kalukhe and Meghana Vare [2] in their research paper, expounds in detail the design process of an IoT Based Smart Energy Meter. Their project aims at reducing electricity theft in the country by giving electricity boards the power to remotely control energy meters. A small change is made to the existing meters converting them into smart meters. Their project uses IoT or Internet of things to actualize the process. The microcontroller used is Arduino which communicates continuously with the server using an ESP 3266 module. Arduino is used as it is energy-efficient and is fast in processing data.

Dr. A.S.C.S. Sastry, K.N.H. Srinivas, V S R G Krishna, Ch. Sesha Kiran Kumar [3] in their research paper go into detail to design and realize a temperature and volume based liquid

mixing system. Three low cost AT89S51 microcontrollers are used to develop electronic sub systems for controlling the system. The objective of the project is to mix different liquids in required ratios and different temperatures. The sensing of temperature is carried out by two LM35 sensors. The mechanical sub system through which the liquid is allowed in required ratios is powered by two geared DC motors.

Eka Cahva Primaa, Siti Sarah Munifahab, Robby Salamb, Muhammad Haidzar Azizb, Agustin Tia Survanic [4] designs an Automatic water tank filling system in their research paper. Their project is meant to be used in homes in Indonesia where groundwater is pumped up to fill a water tank. They aim to reduce wasteful electricity consumption and spilling of water which occurs in case of non-automated systems. For fulfilling this objective, they design an Arduino based sensor which detects water levels in the tank and cuts the circuit when the tank is filled.

Rahul Ambare, Swapnil R Lende, Prashant R Arote, Onkar B Pokharkar, Ganesh R Waykar [5] in their research paper design and implement a Programmable logic controller based Automatic bottle filling machine. It uses a Delta PLC (DVP 14 SS) as field controller. The system sequence of operation is designed by ladder diagram and programming of the project is done using programming software. Sensors are used as input signal transmitters for the PLC.

Pravin Kalubarme, Sushil Kumar Madane, Abhijeet Malve, Reshma Bagal, Shivaji Kamble [6] design an automatic bottle filling and counting unit. The unit fills and counts bottles without human intervention. The project counts bottles using IR sensors. Arduino is the microcontroller used in the project.

1.3 Objectives

The main goal of this project is to design and develop such a device by which we can measure bottle filling machine using Arduino. The main objectives are as follows:

- To study the **Automatic Bottle Filling, Counting & Missing Detection System**.
- To design and construct to find the **Automatic Bottle Filling, Counting & Missing Detection System.**
- To implement and study the ensure **bottle filling, counting and liquid tank monitoring**.

1.4 Methodology

Our used methodology for the project:

- Creating an idea for the design and construction of **"Automatic Bottle Filling, Counting & Missing Detection System"** And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the microcontroller to control our desired system.
- Setting up all the components in a PCB board & soldering. Then assembling all the blocks in a board and finally running the system to check if it actually works or not.

1.5 Block Diagram

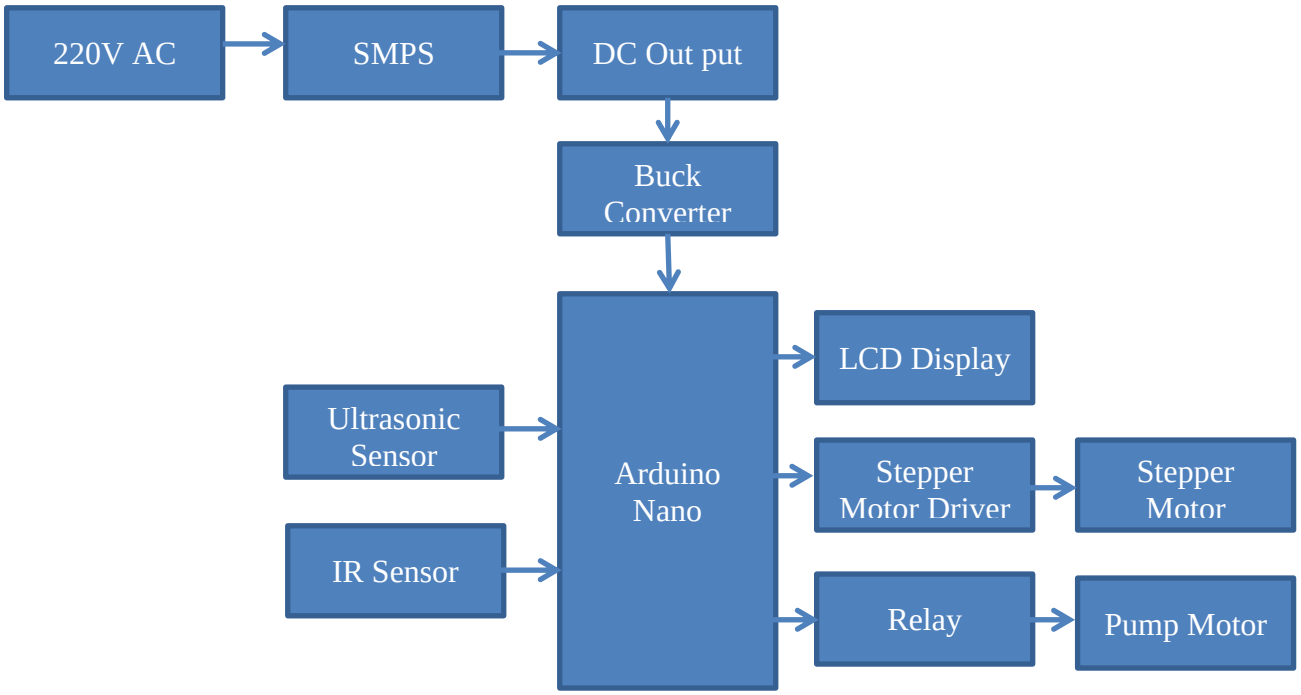


Figure 1.1: Block Diagram of automatic bottle filling machine using Arduino Nano.

1.6 Schematic Diagram

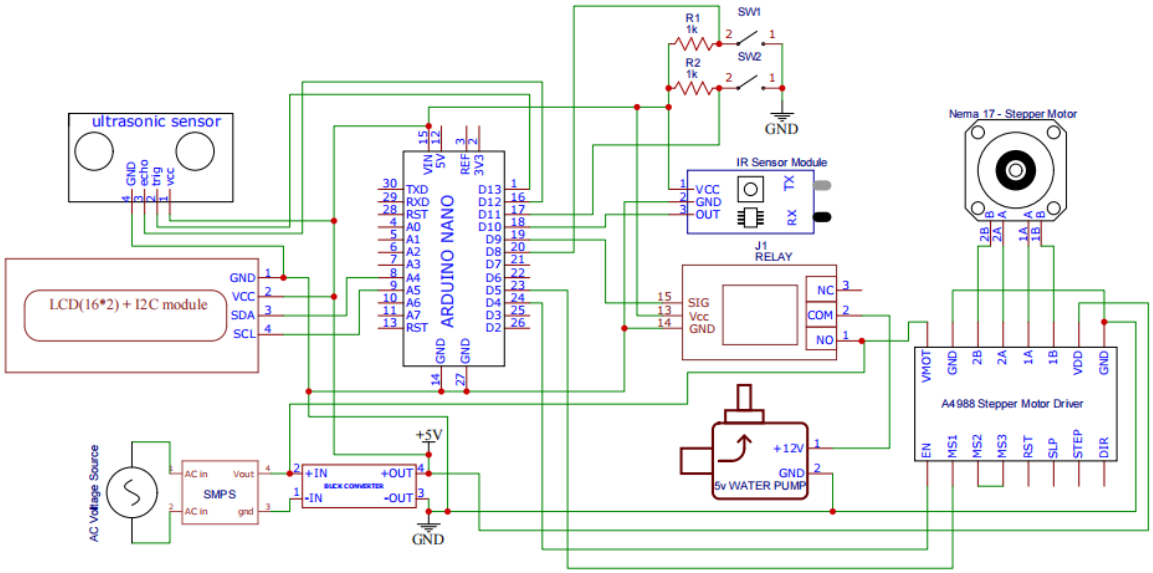


Figure 1.2: Schematic Diagram of Automatic Bottle Filling Machine using Arduino Nano

1.7 Working Principle

The way our **Automatic Bottle Filling Machine Using Arduino Nano** works is that we take the 220V rms from the supply voltage and then give it to the SMPS, the SMPS has a step-down transformer inside that stepped that voltage down to 5V. We feed this voltage to the Arduino Nano for it to run. The Arduino Nano is the main brain of this system. Once the system is on, the bottles will continue to rotate and the pump will fill the bottle with liquid with the help of a DC Pump motor. Here the bottles are moved by the used of stepper motors. After fill the bottle one by one and the motor will change the position of the bottle. In addition, the system is equipped with an IR sensor that will count the bottles, the empty space will not fill the liquid, turn the system to the next slot. Here an ultrasonic sensor with microcontroller is fitted which will check the amount of liquid in the liquid tank. This system has two buttons. After pressing 1st button system will fill the bottle with 100ml liquid, and pressing the 2nd switch system will fill 200ml of liquid. This is the main working procedure of our system.

1.8 Hardware Architecture

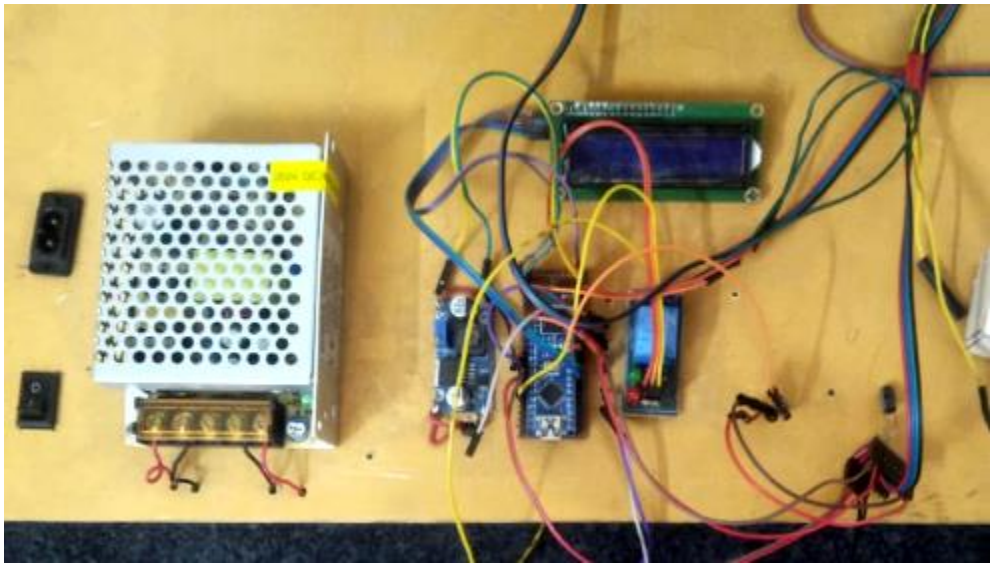


Figure 1.3: Control Circuit



Figure 1.4: Bottle Stage with Bottle

1.9 Complete Project view



Figure 1.5: Project Image

Chapter 2
HARDWARE COMPONENT ANALYSIS

2.1 Component List

1. Arduino Nano
2. Ultrasonic Sensor
3. SMPS
4. IR Sensor
5. Steeper Motor Driver
6. Transistor
7. Steeper Motor
8. Pump Motor
9. LCD Display

2.2 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 2.1: Switch Mode Power Supply (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. 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.

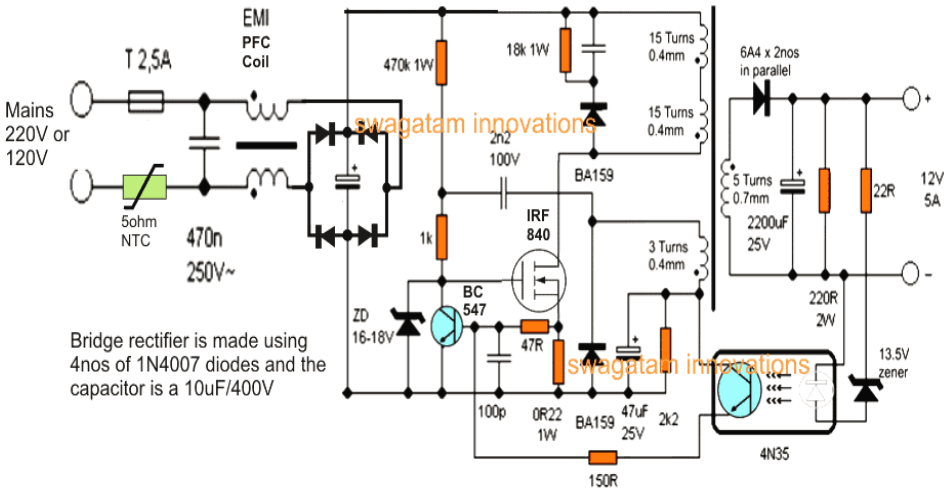


Figure 2.2: Switch Mode Power Supply circuit

2.2.1 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.

2.2.2 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 to 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.

2.2.3 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

2.2.4 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

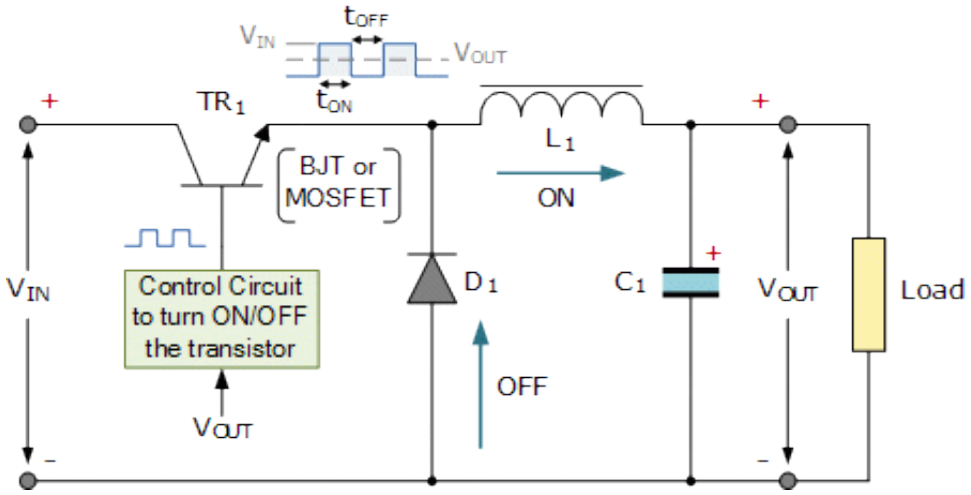


Figure 2.3: SMPS Circuit diagram

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

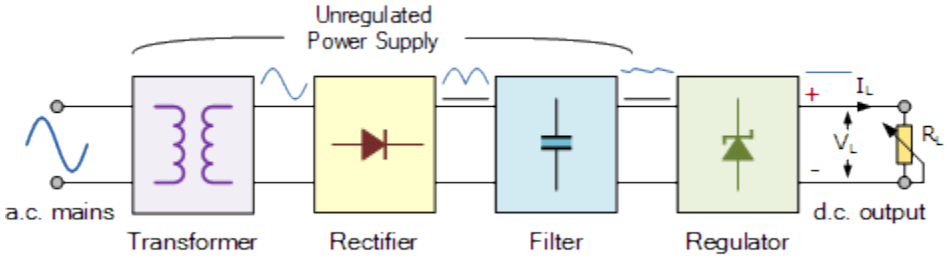


Figure 2.4 DC power Supply

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.

2.3 LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being LCDs are economical; easily programmable, have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command

instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc.

Features of LCD Display

5 x 8 dots with cursor

Built-in controller (KS 0066 or Equivalent) + 5V power supply (Also available for + 3V) 1/16 duty cycle B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED) N.V. optional for + 3V power supply.

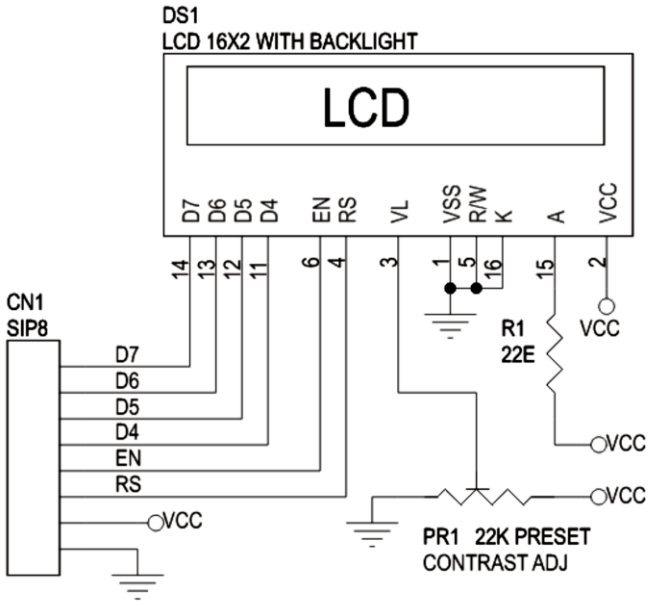


Figure 2.5: 16*2 LCD Display

2.4 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 2.6: IR Sensor

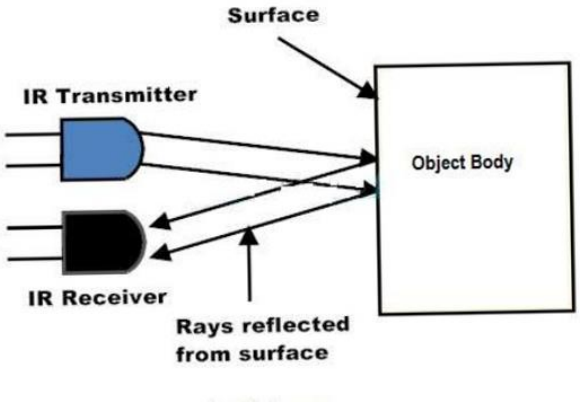


Figure 2.7: IR sensor reflection System.

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.

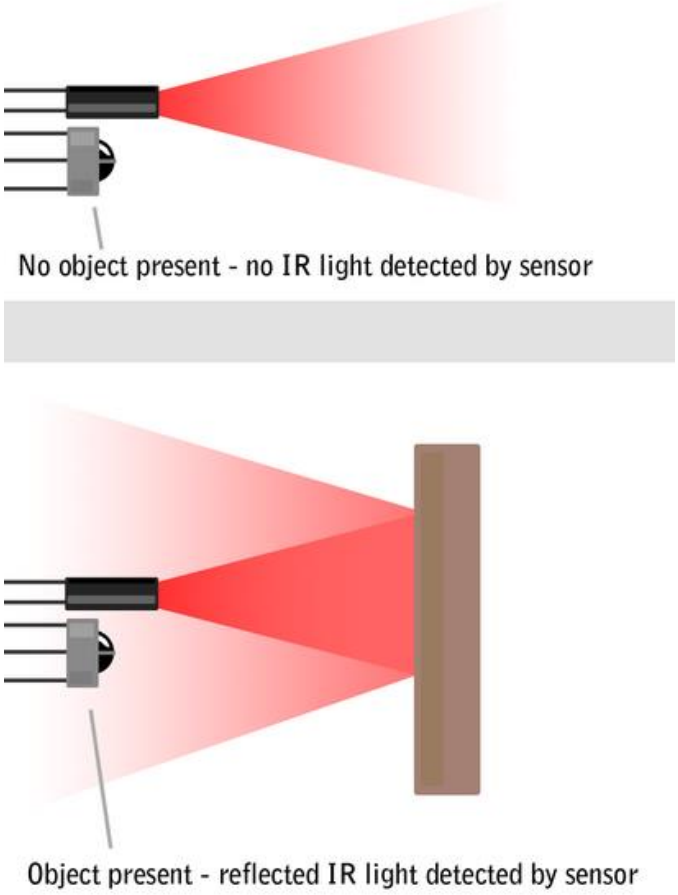


Figure 2.8: IR sensor Detection System.

2.5 Pump Motor

Introduction

This is a low cost, small size Submersible Pump Motor which can be operated from a 12V power supply. It can take up to 120 litters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.



Figure 2.9: Pump Motor

Feature:

- Operating Current: 130 ~ 220mA
- Flow Rate: 80 ~ 120 L/H
- Maximum Lift: 40 ~ 110 mm
- Continuous Working Life: 500 hours
- Driving Mode: DC, Magnetic Driving
- Material: Engineering Plastic
- Outlet Outside Diameter: 7.5 mm
- Outlet Inside Diameter: 5 mm

2.6 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

HC-SR04 Ultrasonic Sensor - Working

As shown above the **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that

Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the picture below-



Figure 2.10: Working of sensor

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller or microprocessor.

How to use the HC-SR04 Ultrasonic Sensor

HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it has to be followed irrespective of the type of computational device used.Power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor. The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information, the distance is measured as explained in the above heading.

Applications

- Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
- Used to measure the distance within a wide range of 2cm to 400cm
- Can be used to map the objects surrounding the sensor by rotating it
- Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water

Ultrasonic Sensor Pin Configuration

Table 1: Ultrasonic Sensor Pin Configuration

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a

		period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

HC-SR04 Sensor Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz

2.7 Buck Converter

A **buck converter** (**step-down converter**) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.



Figure 2.11: DC -DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply :

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Output current: Rated current is 2A, maximum 3A (Additional heat sink is required)
- Conversion Efficiency: Up to 92% (output voltage higher, the higher the efficiency)
- Switching Frequency: 150KHz

- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

2.8 Motor Driver

Dual Motor Controller Module 2A with Arduino. This allows you to control the speed and direction of two DC motors, or control one bipolar stepper motor with ease. The L298N H-bridge module can be used with motors that have a voltage of between 5 and 35V DC. There is also an onboard 5V regulator, so if your supply voltage is up to 12V you can also source 5V from the board. These L298 H-bridge dual motor controller modules are inexpensive and available from the Tronixlabs Australia store. Furthermore if you're completely new to the world of Arduino we highly recommend you review a copy of "Arduino Workshop", and if you have questions, ask in our customer forum.

Module pin outs

Consider the following image - match the numbers against the list below the image:

1. DC motor 1 "+" or stepper motor A+
2. DC motor 1 "-" or stepper motor A-
3. 12V jumper - remove this if using a supply voltage greater than 12V DC. This enables power to the onboard 5V regulator
4. Connect your motor supply voltage here, a maximum of 35V DC. Remove 12V jumper if >12V DC
5. GND
6. 5V output if 12V jumper in place, ideal for powering your Arduino (etc)
7. DC motor 1 enables jumper. Leave this in place when using a stepper motor. Connect to PWM output for DC motor speed control.
8. IN1
9. IN2
10. IN3
11. IN4
12. DC motor 2 enable jumper. Leave this in place when using a stepper motor. Connect to PWM output for DC motor speed control.

13. DC motor 2 "+" or stepper motor B+
14. DC motor 2 "-" or stepper motor B-

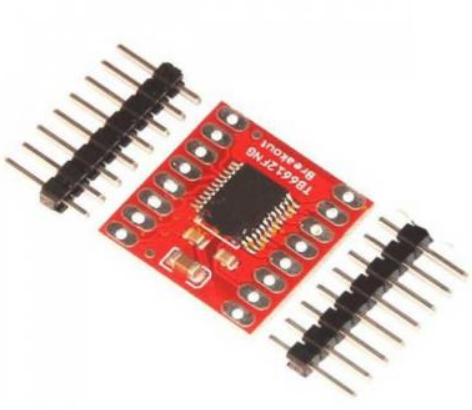


Figure 2.12: Motor Driver

Controlling DC Motors

To control one or two DC motors is quite easy. First, connect each motor to the A and B connections on the L298N module. If you're using two motors for a robot (etc) ensure that the polarity of the motors is the same on both inputs. Otherwise, you may need to swap them over when you set both motors to forward and one goes backward!

Next, connect your power supply - the positive to pin 4 on the module and negative/GND to pin 5. If you supply is up to 12V you can leave in the 12V jumper (point 3 in the image above) and 5V will be available from pin 6 on the module. This can be fed to your Arduino's 5V pin to power it from the motors' power supply. Don't forget to connect Arduino GND to pin 5 on the module as well to complete the circuit. Now you will need six digital output pins on your Arduino, two of which need to be PWM (pulse-width modulation) pins. PWM pins are denoted by the tilde ("~") next to the pin number, for example:

Finally, connect the Arduino digital output pins to the driver module. In our example we have two DC motors, so digital pins D9, D8, D7 and D6 will be connected to pins IN1, IN2, IN3 and IN4 respectively. Then connect D10 to module pin 7 (remove the jumper first) and D5 to module pin 12 (again, remove the jumper). The motor direction is controlled by sending a HIGH or LOW signal to the drive for each motor (or channel). For example for

motor one, a HIGH to IN1 and a LOW to IN2 will cause it to turn in one direction, and a LOW and HIGH will cause it to turn in the other direction.

However, the motors will not turn until a HIGH is set to the enable pin (7 for motor one, 12 for motor two). And they can be turned off with a LOW to the same pin(s). However, if you need to control the speed of the motors, the PWM signal from the digital pin connected to the enable pin can take care of it.

2.9 Stepper Motor

A stepper motor is an electromechanical device it converts electrical power into mechanical power. Also, it is a brushless, synchronous electric motor that can divide a full rotation into an expansive number of steps. The motor's position can be controlled accurately without any feedback mechanism, as long as the motor is carefully sized to the application. Stepper motors are similar to switched reluctance motors. The stepper motor uses the theory of operation for magnets to make the motor shaft turn a precise distance when a pulse of electricity is provided. The stator has eight poles, and the rotor has six poles. The rotor will require 24 pulses of electricity to move the 24 steps to make one complete revolution. Another way to say this is that the rotor will move precisely 15° for each pulse of electricity that the motor receives.

Construction & Working Principle

The **construction of a stepper motor** is fairly related to a DC motor. It includes a permanent magnet like Rotor which is in the middle & it will turn once force acts on it. This rotor is enclosed through a no. of the stator which is wound through a magnetic coil all over it. The stator is arranged near to rotor so that magnetic fields within the stators can control the movement of the rotor.



Figure 2.13: Stepper Motor

The stepper motor can be controlled by energizing every stator one by one. So the stator will magnetize & works like an electromagnetic pole which uses repulsive energy on the rotor to move forward. The stator's alternative magnetizing as well as demagnetizing will shift the rotor gradually &allows it to turn through great control.

The **stepper motor working principle** is Electro-Magnetism. It includes a rotor which is made with a permanent magnet whereas a stator is with electromagnets. Once the supply is provided to the winding of the stator then the magnetic field will be developed within the stator. Now rotor in the motor will start to move with the rotating magnetic field of the stator. So this is the fundamental working principle of this motor.



Figure 2.14: Stepper Motor Construction

In this motor, there is a soft iron that is enclosed through the electromagnetic stators. The poles of the stator as well as the rotor don't depend on the kind of stepper. Once the stators of this motor are energized then the rotor will rotate to line up itself with the stator otherwise

turns to have the least gap through the stator. In this way, the stators are activated in a series to revolve the stepper motor.

Types of Stepper Motor

There are three main types of stepper motors, they are:

- Permanent magnet stepper
- Hybrid synchronous stepper
- Variable reluctance stepper

2.10 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.

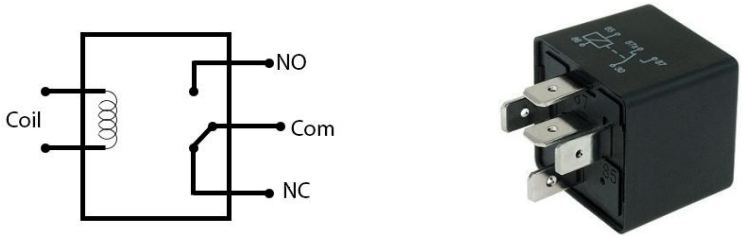


Figure 2.15: Relay

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. The relay module is the one in the figure below.

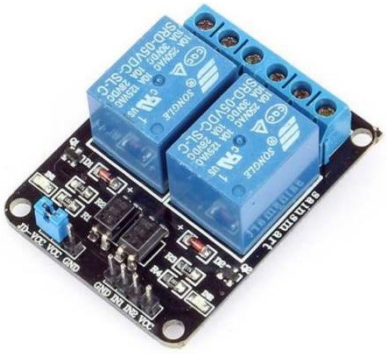


Figure 2.16: Relay Module.

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

Main’s voltage connections.

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

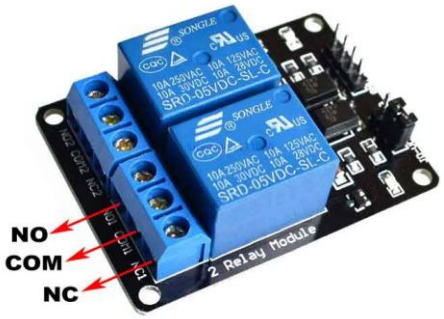


Figure 2.17: Main's voltage connections.

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.

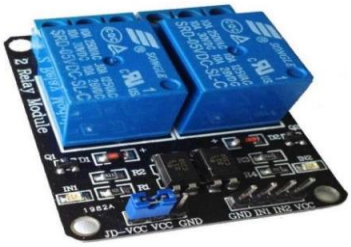


Figure 2.18: Voltage Connections

Pin wiring

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

GND: goes to ground

IN: 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

Chapter 3
SOFTWARE ANALYSIS

3.1 Arduino software

The digital microcontroller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the microcontroller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the microcontroller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:
On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

The Arduino Nano is one of the latest digital microcontroller units and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-

serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Sketchbook

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog. Beginning

with version 1.0, files are saved with a .ino file extension. Previous versions use the .pde extension. You may still open .pde named files in version 1.0 and later, the software will automatically rename the extension to .ino.

Tabs, Multiple Files, and Compilation

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h).

Uploading

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 (for an Uno or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or /dev/tty.USA19QW1b1P1.1 (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be /dev/ttyACMx , /dev/ttyUSBx or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

When you upload a sketch, you're using the Arduino bootloader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory. For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

Serial Monitor

This displays serial sent from the Arduino or Genuino board over USB or serial connector. To send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will rerun your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters; if your sketch needs a complete management of the serial

communication with control characters, you can use an external terminal program and connect it to the COM port assigned to your Arduino board.

3.2 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

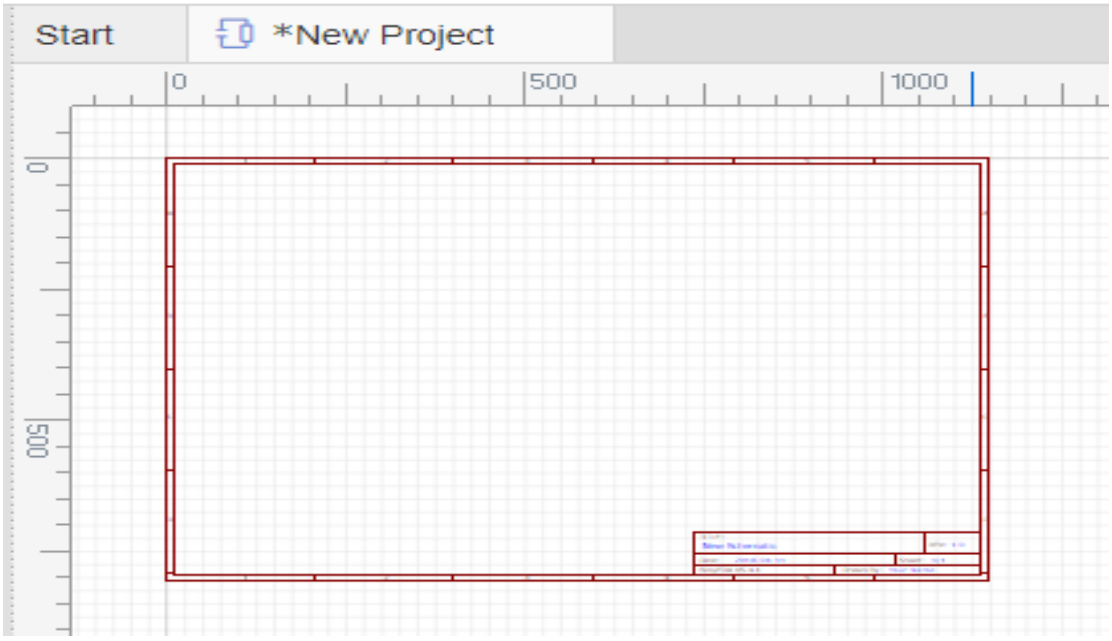


Figure 3.1: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription. Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

3.3 Experimental Data & Result:

Name Of Experiment	Design and fabrication of an automatic bottle filling, counting and missing detection system.
Total quantity of bottle	10
Capacity of per bottle	200 ml
Bottle filling time	8 Sec.
Next bottle moving duration	3 Sec.
All bottle filling duration	1 Min 50 Sec.
Detection performance	84 %

Chapter 4

DISCUSSION & CONCLUSION

4.1 Cost of the project

Table 02: Cost of this project

Sr. No	Product Name	Specification	Quantity	Unit Price (Taka)	Total Price (Taka)
1	Arduino Nano	ATMega328P	1	4000	4000
2	SMPS	5V, 7Amp	1	1847	1847
3	Ultrasonic Sensor	HCSR04	1	650	650
4	IR Sensor		1	500	500
5	Motor Driver	L298N	1	540	540
6	Stepper Motor		1	3192	3192
7	Transistor	TIP122	1	125	125
8	Pump Motor	DC	1	1100	1100
9	LCD Display	16*2	1	650	650
10	Others				7000
Total					**19602/=**

4.2 Advantages

There are many advantages of the project. Some of these are given below:

- Better utilization of electrical machineries.
- Consistency good.
- Increase production speed.
- Simple operation System.
- Filling Versatility.
- Scalable.
- Use low energy.

4.3 Applications

This project has applications in many fields due its necessity. We have selected a few of them and they are given below:

- It can be use in industrial area.
- Medicine factory.
- Food Factory

4.4 Limitations

Though this project has many advantages but it has some limitations as well and they are listed below:

- The system is demo purpose so in real life we need to more modification in this system.

4.5 Discussion

With the world increasingly moving towards Automation due to its various benefits, efforts should be made to make this technology more accessible to various small and medium scale industries. It can eventually help them in diversifying the fruits of the endeavor to the general public and contribute to the overall growth of the country's economy. Filling is an important operation carried out in various stage of the process in many industries. This process is carried out by PLC machine in large scale industries. While PLCs are efficient, adapted to industrial conditions and easy to use, their initial costs and maintenance costs are very high. Thus, many small-scale industries continue to work manually as they cannot afford a PLC. This project attempts to solve that problem by using an Arduino board as the microcontroller in the system. An Arduino is efficient, robust and widely available microcontroller. An interface circuit has to be constructed to facilitate the operation using an Arduino board. This substantially reduces the cost of the machine. At the first stage we phase some problem but after through team efforts we have been able to run the system successfully. Overall, our Automatic Bottle Filling Machine is efficient, economically friendly and accurate.

4.6 Conclusion

The automated bottle filling system using Arduino concept was successfully implemented and studied. Various observations were taken which closely resembled the actual volume to be filled. The reason for deviations of the readings is studied accordingly. The automated bottle filling system was beneficial in reducing work, time and cost of filling. The fabricated model of automated bottle filling system can be used where high precision is not necessary and time limits not bound. Hence it must be used application specific and must not be used in places where faster and more accurate methods of filling are available.

4.7 Future Scope of Work

The project certainly has some limitations which we have briefly discussed in the previous section. The limitations are not severe to hamper our goals but it's always good to build a full proof system. So, there's opportunity for future work in our project and we have pointed out a few of them below:

- In future we will develop in an IoT Based Bottle Filling system where we will able to control and monitor this project through a mobile app.
- In future we will add more sensor for more accuracy and safety.
- We will add an extra power supply for extra support.

References

[1] Bipin Mashilkar, Pallavi Khaire and Girish Dalve, “Automated Bottle Filling System,” International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, p-ISSN: 2395-0072; Volume 02, Issue 07; October 2015.

[2] Sagar Dadhe, Rohit Maske, Rohit Kalukhe and Meghana Vare, “IOT Based Smart Energy Meter,” International Journal of Innovations in Engineering Research and Technology (IJIERT), ISSN: 2394-3696; 2nd National Conference on Modern Trends in Electrical Engineering (NCMTEE-2018): 30-31st March 2018.

[3] Dr. A.S.C.S. Sastry, K.N.H. Srinivas, V S R G Krishna, Ch. Sesha Kiran Kumar, “ An Automated Microcontroller based Liquid Mixing System,” International Journal on Computer Science and Engineering (IJCSE), ISSN: 2648-2651; Volume 02 No. 08; 2010.

[4] Eka Cahva Primaa, Siti Sarah Munifahab, Robby Salamb, Muhammad Haidzar Azizb, Agustin Tia Survanic, “Automatic Water Tank Filling System controlled using ArduinoTM based Sensor for Home Application,” Procedia Engineering 170 (2017) 373-377; Published by Elsevier Ltd.; Engineering Physics International Conference, EPIC 2016; 2017.

[5] Rahul Ambare, Swapnil R Lende, Prashant R Arote, Onkar B Pokharkar, Ganesh R Waykar, “Design and Development of Automatic Bottle Filling Machine,” International Journal of Innovations in Engineering Research and Technology (IJIERT), ISSN: 2393-3696; in association with Novateur Publications; Proceedings of Conference on Advances on Trends in Engineering Projects (NCTEP-2019): Febraury 15th and 16th, 2019.

[6] Pravin Kalubarme, Sushil Kumar Madane, Abhijeet Malve, Reshma Bagal, Shivaji Kamble, “Automatic Water Bottle Filling System,” International Journal of

Innovations in Engineering Research and Technology (IJIERT), ISSN:2394-3696; Novateur Publications; 2nd National Conference on Modern Trends in Electrical Engineering (NCMTEE-2018): 30-31st March 2018.

[7] Asutkar, Sachin More(2013), “Automated bottle filling using microcontroller volume correction”, International journal of engineering research and technology (IJERT). (vol 2, Issue 3, march-2013). [8] Rajesh G. Khatod, Chandrashekhar Sakhale(2012), “Design & Fabrication of liquid dispensing machine using automatic control for engg. Industry”, International journal of innovative technology and exploring engineering (IJITEE). (Vol I, Issue 5, October 2012).

[9] A.S.C.S. Sastry, K.N.H. Srinivas (2010), “An automated microcontroller based liquid mixing system”, International journal on computer science and engineering. (Volume II, Issue 8, August 2010).

[10] T. kalaiselvi, R. Praveena(2012), “plc based automatic bottle filling and capping system with user defined volume selection”, International journal of emerging technology and advanced engineering. (Vol 2, Issue 8, August2012).

END