

Design and Construction of Automatic Bottle Filling and Counting and Liquid Tank Level Monitoring

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.

Submitted by

Md. Rubel Hosen	ID: BME-1903019485
Ala Uddin	ID: BME-1903019498
Md. Sohel Rana	ID: BME-1901017513
Md. Sekandar Badsha Bhuiyan	ID: BME-1901017368



Supervised by

Nuruzzaman Rakib
Lecturer
Department of Mechanical Engineering
Sonargaon University (SU)
Dhaka-1215, Bangladesh

May, 2022

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.

[Authors]

Md. Rubel Hosen
BME-1903019485

Ala Uddin
BME-1903019498

Md. Sohel Rana
BME-1901017513

Md. Sekandar Badsha Bhuiyan
BME-1901017368

Supervisor

Nuruzzaman Rakib
Lecturer

Department of Mechanical Engineering
Sonargaon University (SU)

ACKNOWLEDGEMENT

First we started in the name of almighty Allah. This thesis is accomplished under the supervision of **Nuruzzaman Rakib**, 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 author 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.

[Authors]

Md. Rubel Hosen
BME-1903019485

Ala Uddin
BME-1903019498

Md. Sohel Rana
BME-1901017513

Md. Sekandar Badsha Bhuiyan
BME-1901017368

Abstract

The world is increasingly moving towards Automation, the process of performing various tasks without or with minimum human intervention. It increases the overall efficiency and output of a process. It involves establishing control loops using microcontrollers like Arduino or PLCs, which control the working of the entire plant. Filling is an operation in which a predetermined amount of liquid needs to be precisely filled in the bottle. It is used by soft drinks industry, packaged water industry and various pharmaceuticals. The 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 unequal quantities of liquid in bottles. The process is now we try to do carried out by PLCs in large manufacturing units now. PLC machines are very expensive. Due to their high costs, filling is still carried out manually in small manufacturing units. This results in shortcomings in the operation and it drives up labor costs. This problem compels us to design a system with reduced costs. This can be achieved by using Arduino as a microcontroller. The proposed project will reduce cost for small scale industries and help them in setting up automated plants. In this project, we aim to study the industrial process as carried out by a microcontroller, then design a bottle filling, counting and liquid tank level monitoring system.

TABLE OF CONTENTS

Letter of transmittal	ii
Declaration	iii
Acknowledgement	iv
Abstract	v
CHAPTER-1	INTRODUCTION
1.1 Introduction	1-2
1.2 Proposed Method	2
1.3 Objective	2
CHAPTER-2	LITERATURE REVIEW
2.1 Arduino	3-6
2.2 SMPS	6-12
2.3 IR Sensor	12-14
2.4 Relay	14-18
2.5 DC Gear Motor	19
2.6 LCD Display	20
2.7 Mini Pump	21
2.8 Ultrasonic Sensor	22-24
CHAPTER-3	DESIGN
3.1 History	25
3.2 Block Diagram	26
3.3 Components List	26
CHAPTER-4	

4.1 Methodology	METHODOLOGY	27
4.2 Complete Project Prototype		27
4.3 Working Principle		28
4.4 Cost Analysis		29

CHAPTER-5

RESULT AND DISCUSSION

5.1 Result		30-32
5.2 Discussion		32
5.3 Limitation		33

CHAPTER-6

CONCLUSION

6.1 Conclusion		34
6.2 Future Scope		34

Reference		35-36
------------------	--	--------------

LIST OF FIGURES

FIGURE NO	FIGURE TITLE	PAGE NO
2.1	Arduino Nano	3
2.2	Arduino Schematic Diagram	4
2.3	Section Of Arduino Nano	4
2.4	Microcontroller IC	6
2.5	SMPS	7
2.6	SMPS Circuit Diagram	9
2.7	Power Supply Connection	11
2.8	DC Power Supply Step	12
2.9	IR Sensor	13
2.10	IR Sensor Refection System	13
2.11	IR Sensor Detection System	14
2.12	Relay	15
2.13	Transistor Switching Circuit	16
2.14	Relay Module	16
2.15	Pin Diagram of Relay Module	17
2.16	Main Voltage Connection	18
2.17	DC Gear Motor	19
2.18	LCD Display	20
2.19	Mini Pump	21
2.20	Ultrasonic Sensor Working Procedure	22
2.21	Ultrasonic Sensor 2D model	23
2.22	Ultrasonic Sensor	24
3.1	Our System Structure Image	25
3.2	Block Diagram	26
4.1	Complete Project Prototype	27
5.1	1 st IR Sensor Reading Graph	31
5.2	2 nd IR Sensor Reading Graph	32

LIST OF TABLES

TABLE NO		PAGE NO
Table 01	Cost Analysis	29
Table 02	1 st IR Sensor Reading	30
Table 03	2 nd IR Sensor Reading	31

CHAPTER 1

INTRODUCTION

1.1 Introduction

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 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 Proposed Method / System

In the time of speedy running technology, the automation is gone to a higher-level development. In this project the system is proposed to develop a bottle filling system with conveyor belt which can able to detect bottle, filling this bottle, counting it and liquid tank level with automatic system. The working of this project is easy to explain and less costly. This project is developed for bottle filling system with small. Where logic is controlled by Arduino Nano microcontroller depending on various sensors.

1.3 Objective:

The objectives of this project are:

- a) To study about bottle filling, counting and liquid tank level monitoring system.
- b) To design and construct a bottle filling, counting & liquid level monitoring automatic system.
- c) To test the performance of the bottle filling, counting and liquid tank level monitoring system.

CHAPTER 2

LITERATURE REVIEW

2.1 Arduino Nano:

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

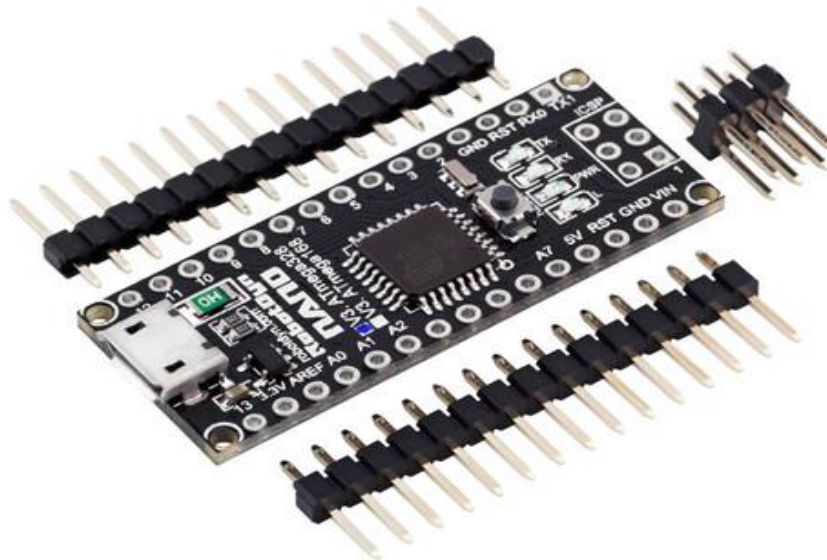


Figure 2.1: Arduino Nano

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

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a smallest, complete, and breadboard friendly. It has everything that Diecimila / Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it

is missing power jack. The Nano is automatically sense and switch to the higher potential source of power.

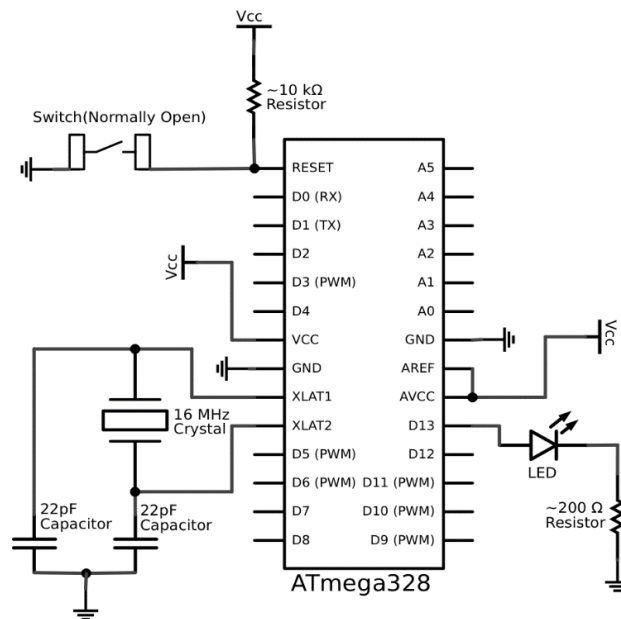


Figure 2.2: Arduino schematic diagram

Nano's got the breadboard-ability of the Boarduino and the Mini+USB with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It is two layers. That make it easier to hack and more affordable.

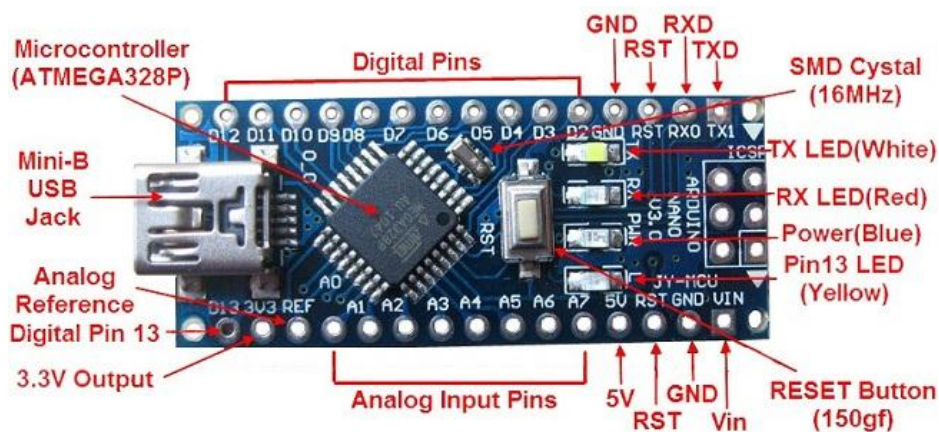


Figure 2.3: Section of Arduino Nano.

Specifications:

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

Features:

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Standard 0.1 spacing DIP (breadboard friendly)
- Manual reset switch

Microcontroller IC ATmega328p:



Figure 2.4: Microcontroller IC AT mega 328p.

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

2.2 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 2.5: 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 100 – 264V 50 / 60Hz
- Output Voltage: 12V DC, 0-5A
- Output voltage: Adjustment Range: $\pm 20\%$
- 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.

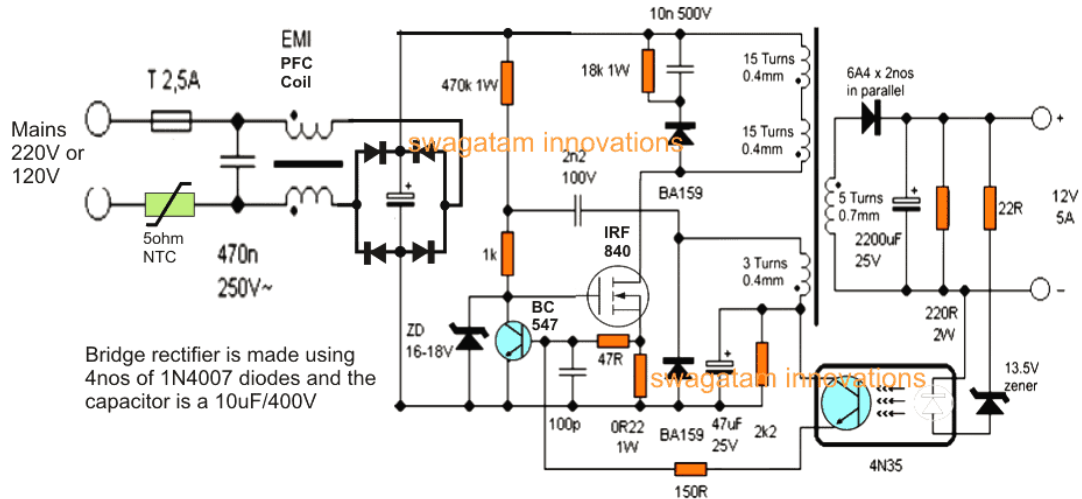


Figure 2.6: SMPS Circuit Design

Basic working concept of an SMPS

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

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electro technical Commission (IEC) style input connector.

As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up 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 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

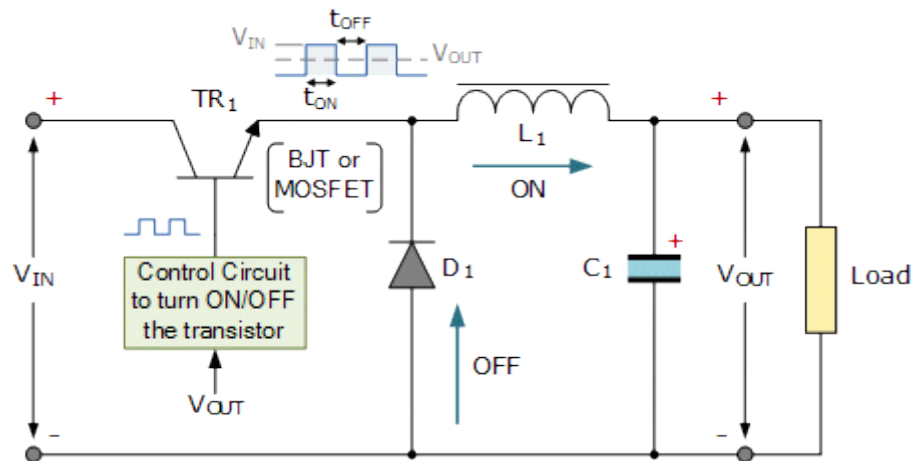


Figure 2.7: Power Supply Connection

Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output.

Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such as 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

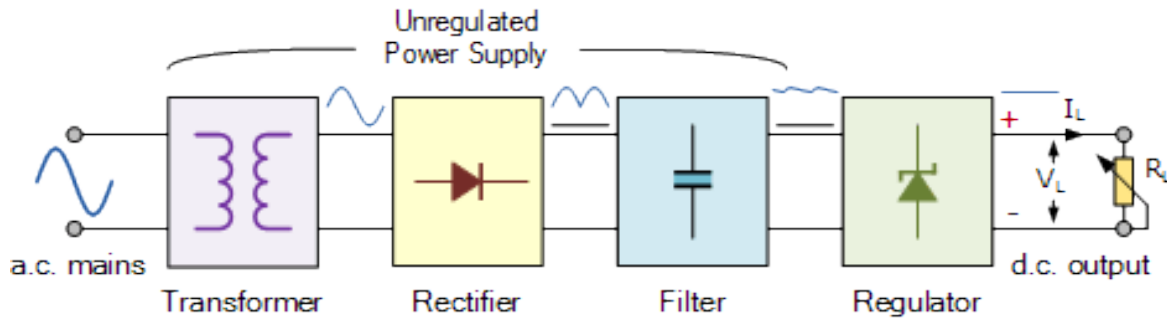


Figure 2.8: DC Power Supply Step

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.

2.3 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 2.9: IR Sensor

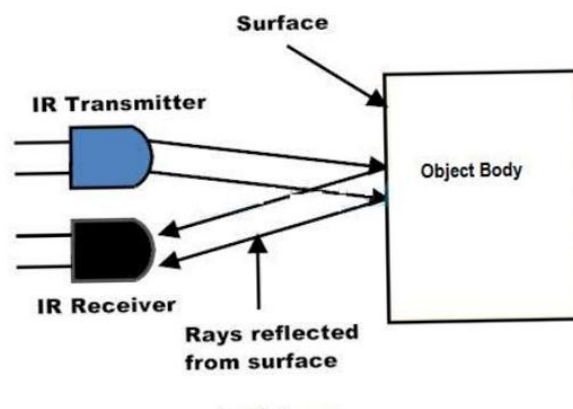


Figure 2.10: IR sensor reflection System.

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.

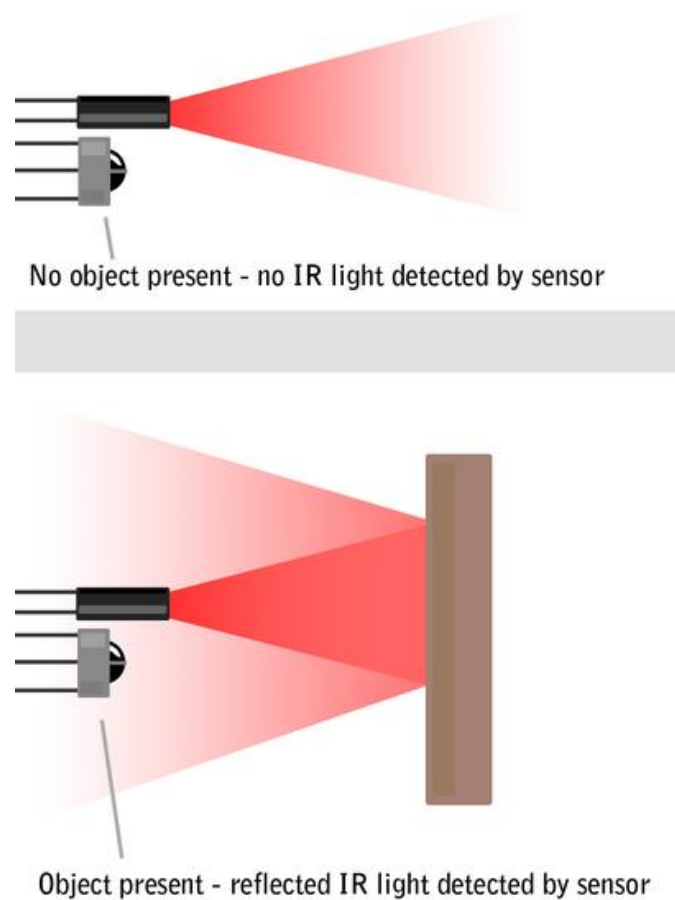


Figure 2.11: IR sensor Detection System.

2.4 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.

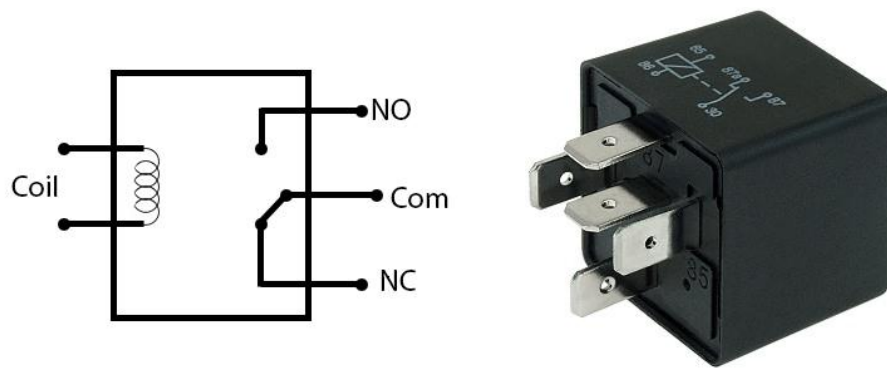


Figure 2.12: Relay

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.

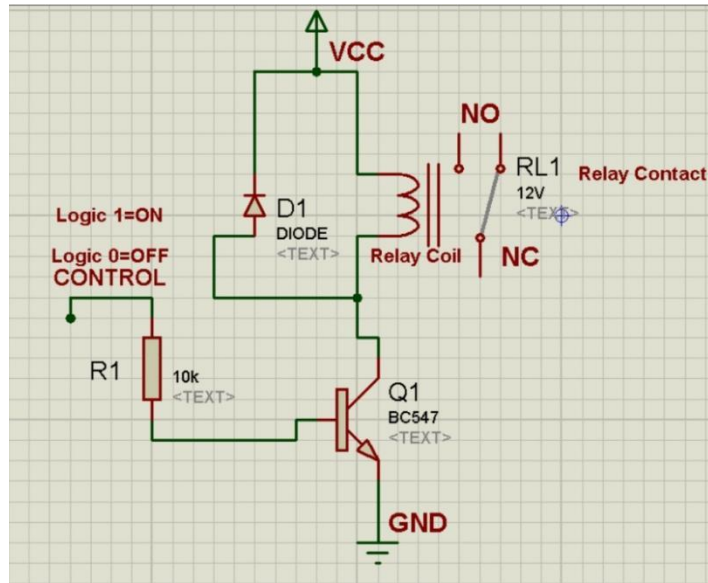


Figure 2.13: Transistor Switching Circuit.

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.

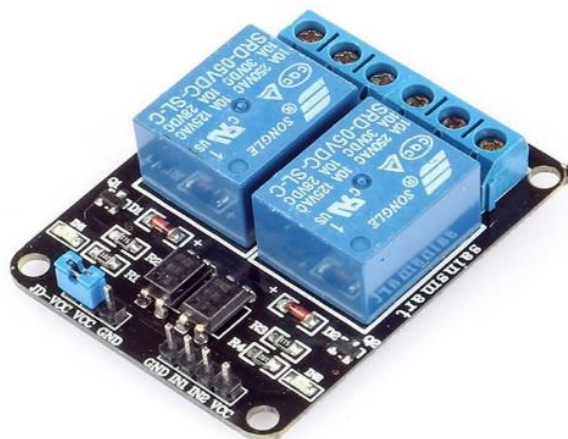


Figure: 2.14: Relay Module

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:

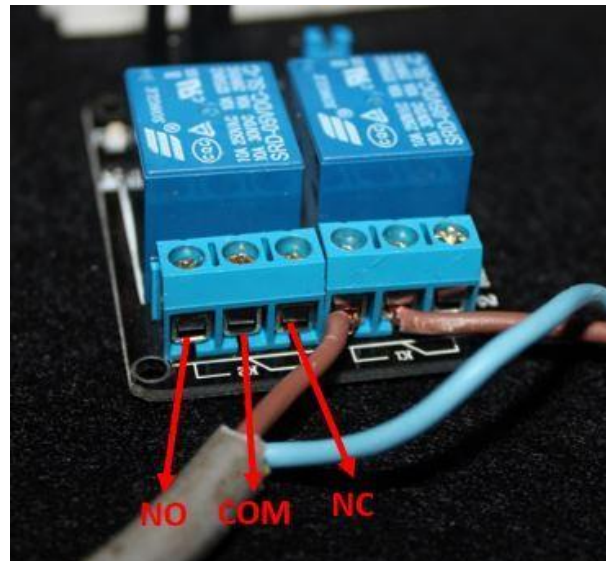


Figure 2.15: Pin diagram of Relay Module

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 2.16: 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

2.5 DC Gear Motor

Description:

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

Specification:

- Voltage: 12V DC
- Gear ratio: 1/31
- No-load speed: 200RPM
- Rated Speed: 140RPM
- Rated torque: 10kg.cm
- Rated current: 2.5Amp
- Length of Motor(including spindle): 106mm/4.17"
- Diameter: 37mm/1.45"
- Shaft length: 21mm/0.82"
- Shaft diameter: 6mm/0.24"



Figure 2.17: DC Gear Motor

2.6 LCD Display

LCD (Liquid Crystal Display) screen is an electronics 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.

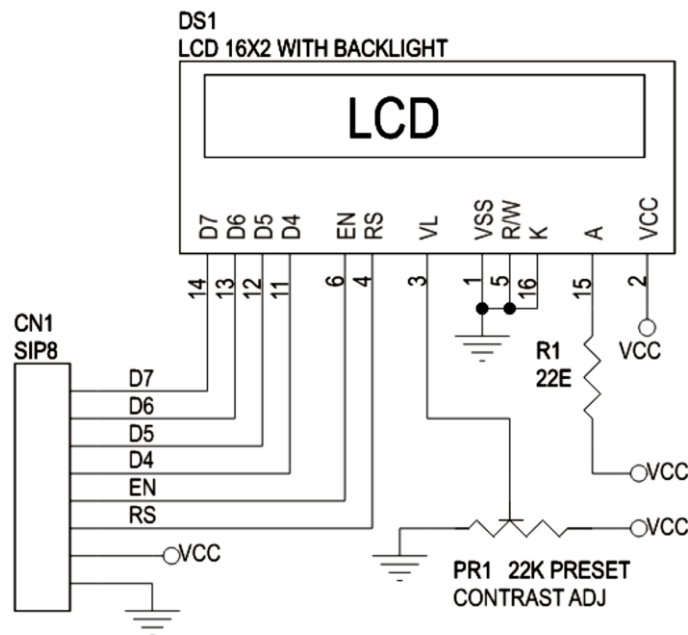


Figure 2.18: 16*2 LCD Display

2.7 Mini Pump:

Description:

DC 3-6V Mini Micro Submersible Water Pump for fountain, garden and controlled water hydroponic systems.

Technical Specifications:

- DC Voltage: 2.5-6V
- Maximum lift: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outside diameter of water outlet: 7.5mm / 0.3"
- Inside diameter of water outlet: 5mm / 0.2"
- Diameter: Approx. 24mm / 0.95"
- Length: Approx. 45mm / 1.8"
- Height: Approx. 30mm / 1.2"
- Material: engineering plastic

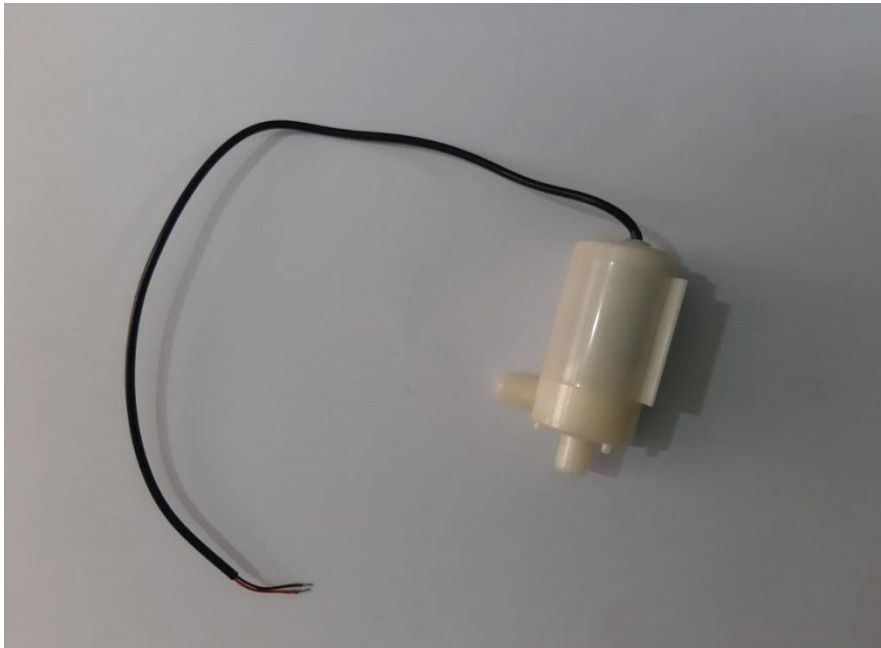


Figure 2.19: Mini Pump

2.8 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.

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 –

$$\text{Distance} = \text{Speed} \times \text{Time}$$

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 2.20: Ultrasonic Sensor Working Procedure

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.

2D model of the component

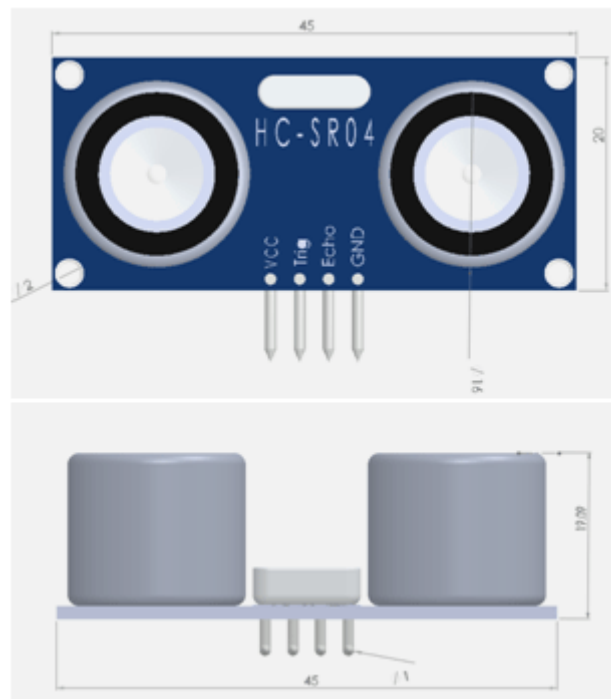


Figure 2.21: Ultrasonic Sensor 2D model

HC-SR04 Sensor Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: $<15^\circ$
- Operating Current: $<15\text{mA}$
- Operating Frequency: 40Hz

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.

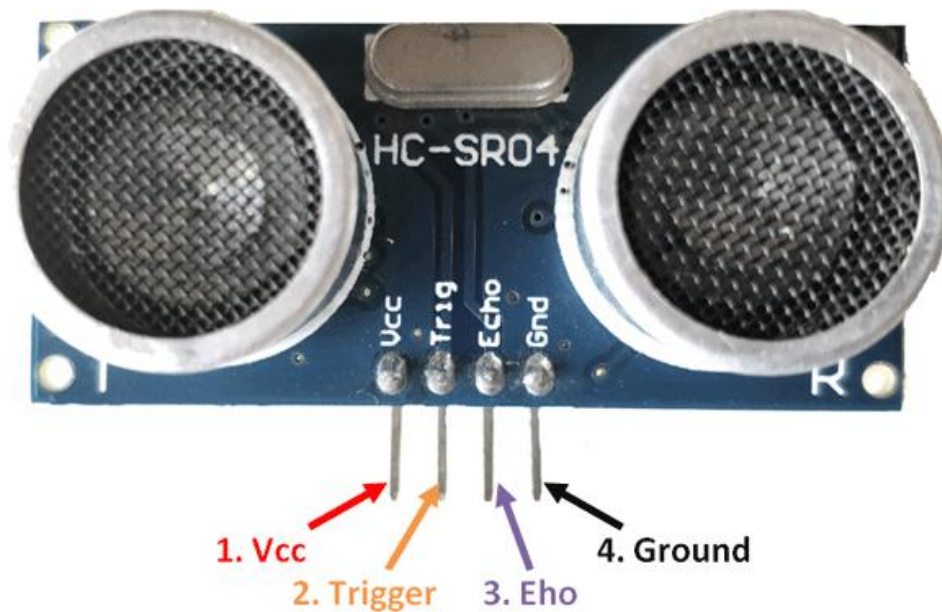


Figure 2.22: Ultrasonic Sensor Pin Out

CHAPTER 3 DESIGN

3.1 History

This bottle filling, counting & liquid tank level monitoring system is so effective, accurate 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. This machine is very easy to use and it works very effectively and accurately. A relevant picture is added below –

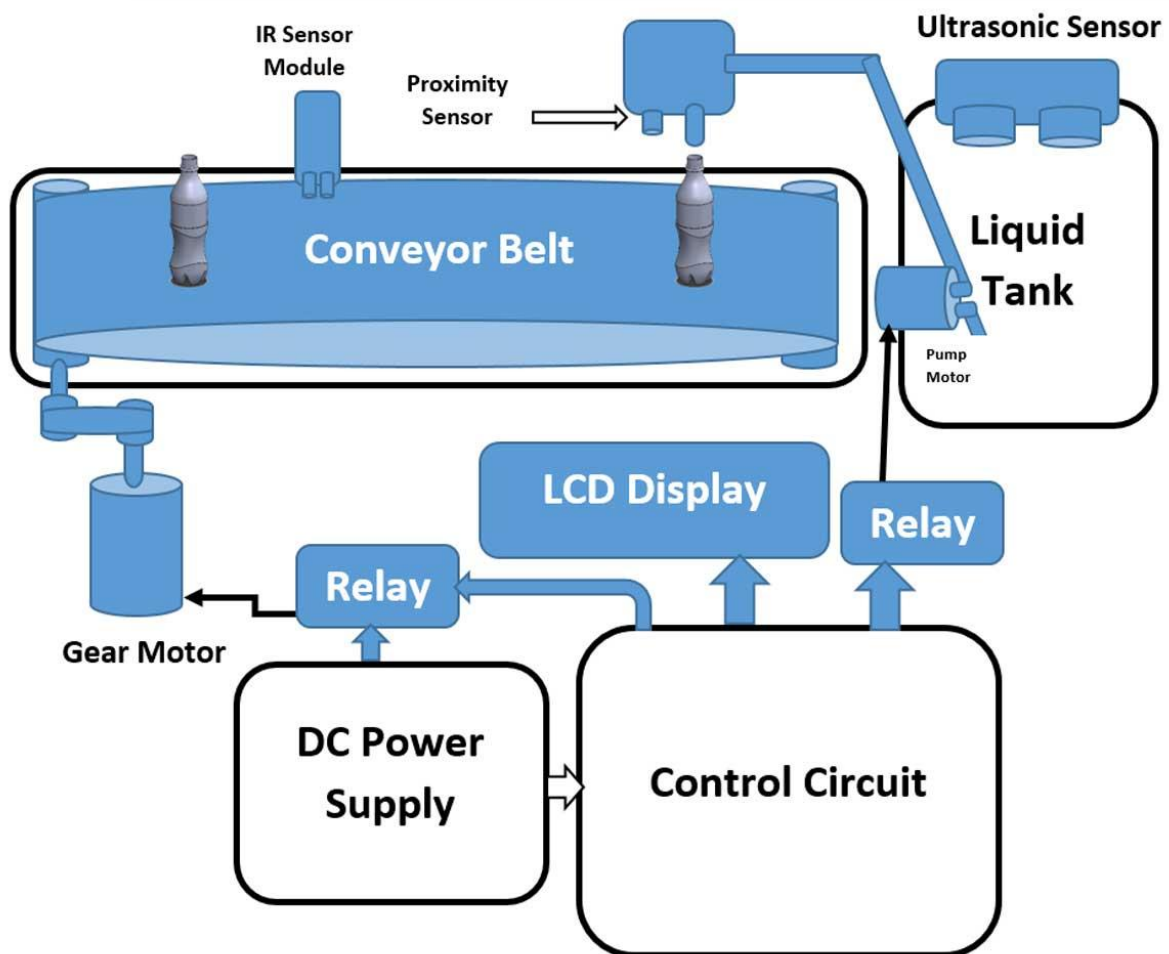


Figure 3.1: Our System Structural Image.

3.2 Block Diagram:

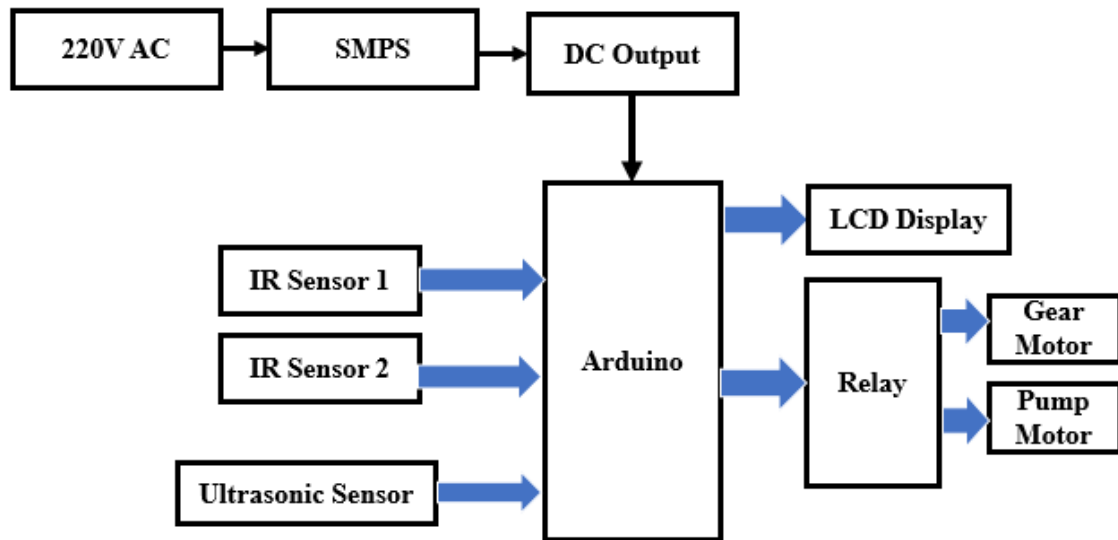


Figure 3.2: Block Diagram of Automatic Bottle Filling, Counting and Liquid Tank level Monitoring System.

3.3 Components List:

1. SMPS.
2. Arduino Nano
3. IR Sensor Module
4. Ultrasonic Sensor.
5. LCD Display.
6. Relay.
7. Gear Motor.
8. Pump Motor.
9. Motor Pulley.
10. Timing Belt.
11. Conveyor Belt.

CHAPTER 4

Methodology

4.1 Methodology

Creating an idea for Design and construction of automatic bottle filling, counting and liquid tank level monitoring system. And drawing and listed of components/materials to know which components / materials need to construct it. Collecting the all components / materials for construct the system. Finally, we constructed this system & checked it finally that working very well.

4.2 Complete Project Prototype Image :

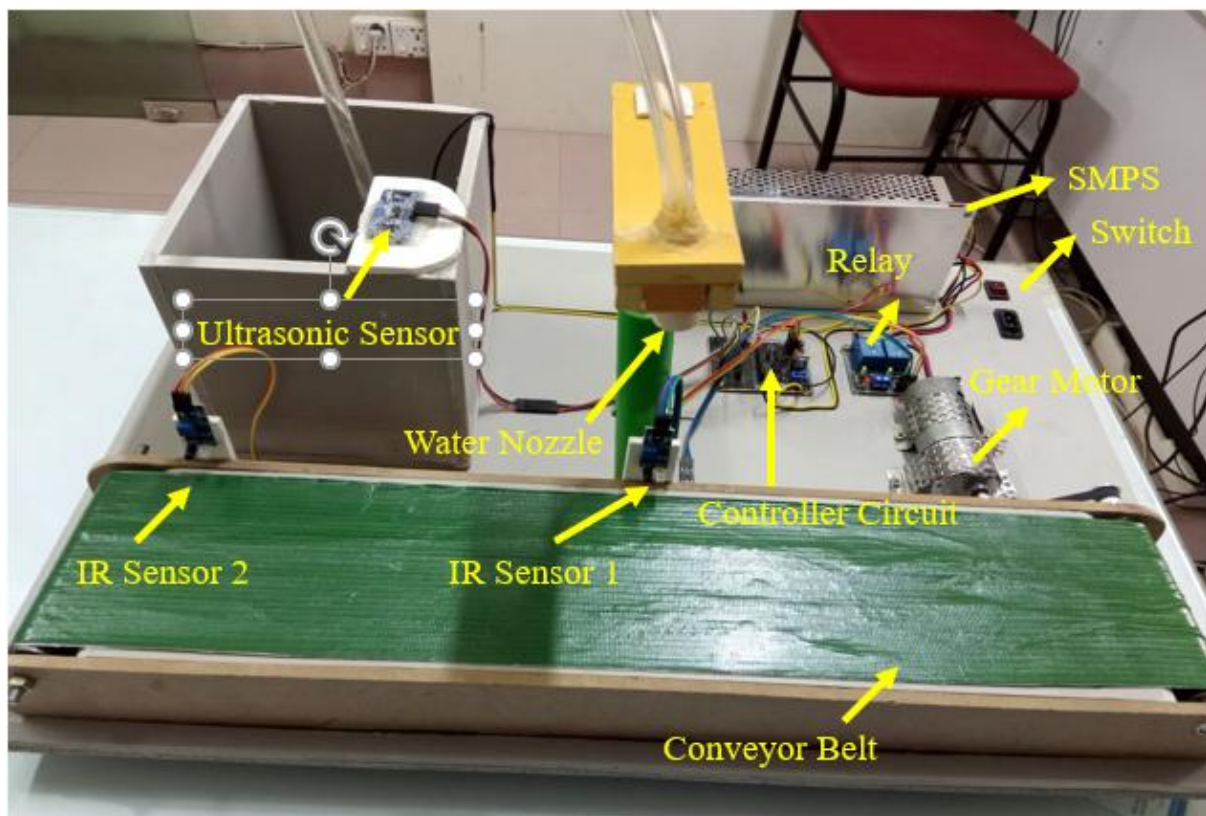


Figure 4.1: Complete Project Picture

4.3 Working Principle

The way the whole project works is that we take 220V ac power from the supply voltage and then feed it to a Switch Mode Power Supply or in short SMPS module. Basically, inside the SMPS what we have is a 12V Step Down Transformer, Diodes formed in Full Wave Bridge Rectifier formation, some Capacitors, Voltage Regulator ICs and Resistors. The SMPS simply converts the 220V ac to a pure dc of 12V. We will use this 12V dc output from the SMPS to run our Arduino Nano, the main processing brain of the circuit and the LCD Unit, Sensor, transistor are going to take voltage from the Arduino to power themselves.

Our project is designed to bottle filling, counting and liquid tank level monitoring purpose. We are using Arduino Nano for controlling our project, which is acting as the main controller here. Also used here sensors, relays, mini water pump motors and gear motor. Everything comes connected with Arduino. Here the current from AC is entering the circuit at 12 volts via SMPS. The Arduino Nano is equipped with two sensors. The IR sensor are useful for sensing the bottle. When it sense the bottle then stop conveyer belt and fill the bottle with liquid in a fixed delay time. After filling this bottle conveyer belt will be start and when the bottle will be in front of second IR sensor then conveyer belt will stop and count bottle number. On the other side an ultrasonic sensor sense the tank liquid level by using ultrasonic sound. In this process we will filling a bottle, counting bottle number and sensing liquid tank level.

4.4 Cost Analysis:

Table 1: Cost Analysis.

No	Product Name	Specification	Qty.	Unit Price (BDT)	Total Price (BDT)	Market Price
01.	Arduino	Nano	1	480	480	
02.	SMPS	12V	1	650	650	
03.	IR sensor		2	180	360	
04.	Gear Motor	12V DC	1	700	700	
05.	Ultrasonic Sensor	HC SR04	1	180	180	
06.	Mini Pump	DC	1	180	180	
07.	LCD Display	16*2	1	180	180	
08.	Relay	5V 5Amp	2	35	70	
09.	Others				1500	
Total =					4300/=	10,000/=

CHAPTER 5

RESULT AND DISCUSSION

5.1 Result

After followed all objectives and plan to build our project. We finally establish our project. In this project first we create our project circuit with sufficient equipment. After that a conveyor belt we make for object moving smoothly. After making all the structure then we upload our code in Arduino microcontroller. All the setup is working well with our accurate implementation and plan.

Table 02: 1st IR Sensor Reading

Reading	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
1 st IR Sensor (Second)	2.30	2.18	2.30	2.00	2.07	2.00	2.19	2.15	2.20	2.24	2.10	2.00	2.13	2.30	2.28

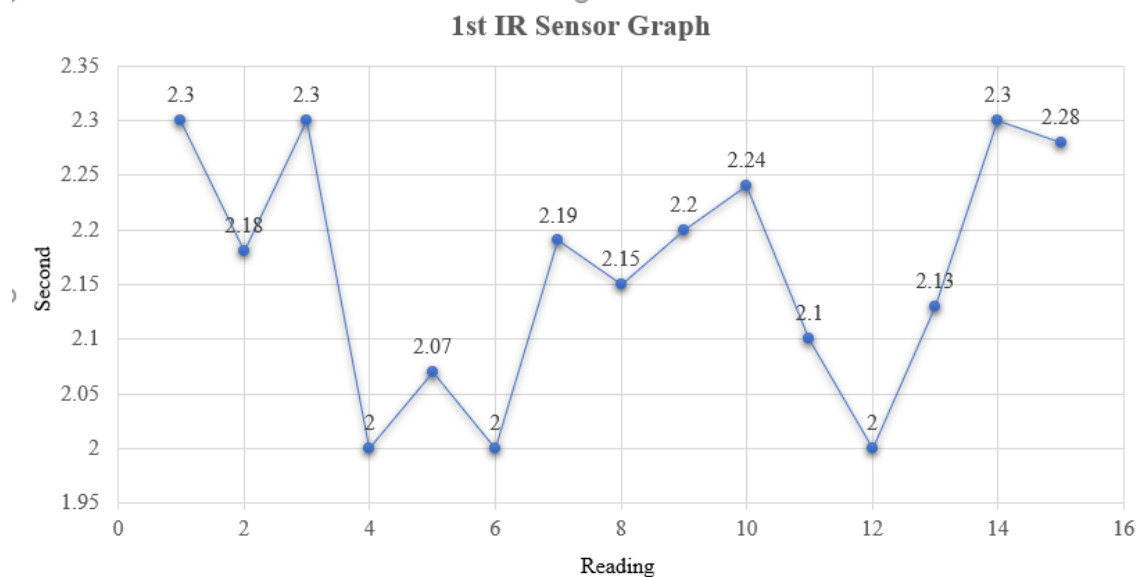


Figure 5.1: 1st IR Sensor Reading Graph

Table 03: 2nd IR Sensor Reading

Reading	Liquid Nozzle to Counting Sensor (Second)
01	2.66
02	2.60
03	2.58
04	2.56
05	2.59
06	2.60
07	2.62
08	2.60
09	2.58
10	2.57
11	2.59
12	2.56
13	2.62
14	2.66
15	2.65

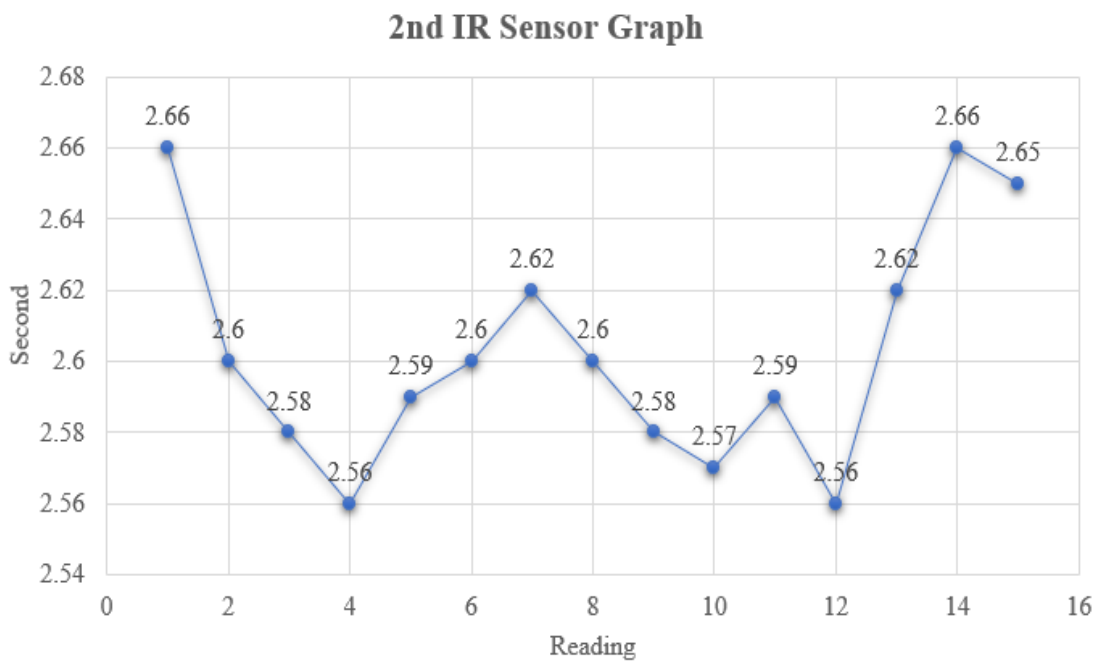


Figure 5.2: 2nd IR Sensor Reading Graph

After we place the bottle on the conveyor belt here, it takes a maximum of 2.30 seconds to reach the first IR sensor. Which we measured manually with the help of stopwatch. It takes 9 seconds to fill the bottle with water. It is fixed through this program of microcontroller. And when the liquid is full, it will take maximum of 2.66 seconds for the second IR sensor to reach. Here, Filling Accuracy is 99% cause if the motor gets less or more current then the motor will draw less or more water. But it will fill minimum 250ml liquid in 9 seconds. And counting accuracy is 100 %. Bottled water refilled time and the bottle counting is done correctly, we have agreed with everyone that the accuracy of our system is 99%.

5.2 Discussion

The Automatic bottle filling, counting and liquid tank level monitoring system works accurately, effectively and makes bottle filling system process easy, more precise and reliable and is more advantageous than the conventional methods reducing manual efforts, errors and being much efficient. The proposed prototype allows achieving an economical and a low-cost automation. The automation system can be made flexible according to the industrial needs. In case of any breakdown, the system can be easily restored and commissioned upon diagnosis.

5.3 Limitation

It is a demo project so we found some limitation. In future we will work for reduce this kind of limitation. It is a demo project so its accuracy is 99%. Our project may delay in work because it's a demo project. After filling liquid in bottle there is no option of capping. After counting bottle, we collect the bottle manually.

CHAPTER 6

CONCLUSION

6.1 Conclusion:

The main objective of this project was to develop a bottle filling, counting and liquid tank level monitoring 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, bottle filling, count & liquid tank level monitoring operations can be implemented.

6.2 Future Scope

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

- We can add in future, automatic capping system.
- We can add in future, automatic collecting system.
- We can add an IoT automatic monitoring system.
- We will increase its working accuracy level.

Reference:

- [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. Sessa 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 Prima, Siti Sarah Munifahab, Robby Salamb, Muhammad Haidzar Azizb, Agustin Tia Survanic, “Automatic Water Tank Filling System controlled using Arduino™ 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] Hong-bo Liu; Li-zhong Wang; Zhen-yu Hou; Guang-de Wang, "Research on system of liquid automatic filling," in Electric Information and Control Engineering (ICEICE), 2011 International Conference on, vol., no., pp.2525-2527, 15-17 April 2011
- [8] Al-Hawari, T.; Aqlan, F.; Al-Buhaisi, M.; Al-Faqeer, Z, "Simulation-Based Analysis and Productivity Improvement of a Fully Automatic Bottle-Filling Production System: A Practical Case Study," in Computer Modeling and Simulation, 2010. ICCMS '10. Second International Conference, vol.4, no., pp.195-199, 22-24 Jan. 2010
- [9] Asutkar, Sachin More, "Automatic Bottle Filling Using Microcontroller Volume Correction," in International Journal of Engineering Research & Technology, Vol.2 - Issue 3 (March - 2013)
- [10] Rajesh G.Khatod, Chandrashekhar N. Sakhale, "Design and Fabrication of Liquid Dispensing Machine Using Automatic Control for Engg. Industry," in International Journal of Innovative Technology and Exploring Engineering(TM), Volume-1 Issue-5 (October-2012)