PROJECT REPORT

On

Design and Development of Liquid Level Indicator System

A project report submitted in fulfillment of the requirements for the

Degree of Bachelor of Science

In

Electronics and Communication Engineering

National University of Bangladesh

Prepared by

Roll No. : 1300014

Registration No. : 1213018

Session : 2012-13

DECLARATION

I hereby declare that the project entitled "Design and Development of Liquid Level Indicator System" submitted by me, has been written based only on the works and result found by me. Material of the works or research or thesis by other researchers is mentioned by their research. This thesis, neither in whole nor in part, has been previously submitted by any degree.

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ABSTRACT

The drinking and using of water crisis in Bangladesh and along all over the World is reaching alarming proportions. More than 1.2 billion people around the world lack access to clean drinking water. It might very soon attain the nature of global crisis. Water is the main source of life. It is the most required and important part of all living beings. On our planet earth only 2% of water source is usable. Hence it is very important to preserve water. In many houses there is unnecessary wastage of water due to overflow in overhead tanks. Automatic water level controller can provide a solution to this problem. This concept is quite useful to monitor the occupancy of the tank-for instance, place like petrol, oil, water tanks and other places. It is quite easy and profitable to monitor the liquid level by transistor and microcontroller in both ways: economical and technical.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

On our planet earth, 71% of part is occupied by water. Only 2% of water source is useable and rest of 95% of water is salty water which has no use for human and all living beings except in sea. The total amount of water available on earth has been estimated 1.4 billion cubic kilometers enough to cover the planet with a layer of about 3 kilometer. About 4% is locked in the polar ice caps, and the rest 1% constitutes all fresh water found in rivers streams and lakes which is suitable for our consumption.

A study estimated that a person consumes an average of 135 liters per day [1]. This consumption would rise by 40% by the year 2025[2]. 750 million people around the world lack to safe water[3]. This signifies the need to preserve fresh water resources. Water is the main source of life. It is the most required important and individual part of all living beings. We cannot imagine life without water.

The country Bangladesh such a populated one is facing such a big problem of water. If proper precautions are not taken for preserving the most valuable natural resource then it may lead to disastrous situation.

This project is based on the theme that water should be controlled to such a level that it can be utilized with proper use. Due to implementation of this project, water level can be controlled automatically and hence large amount of water is saved. In future, Bangladesh will have not faced such problem and there will be a vast progress in the development of country.

Liquid level indicator may be defined as a system by which we can get the information of liquid level in the tank. Liquid level indicator system is quite useful to reduce the wastage of liquid in any tank, while filling such tank.

1.2 Literature Review

Before proceeding with our work, a literature survey has been conducted. Among them the following topics, which are closely related with our work, are given below. As our project based on Transistor and Arduino on liquid level indicator system, it is difficult to match with the technique is used to make such system.

Related works are:

1. Project on: PORTABLE WATER LEVEL INDICATOR

MUHAMMAD SYAFIQ BIN YUSUF

, University Teknikal Malaysia Melaka, Malaysia .

June 2013

2. Project on: AUTOMATIC WATER LEVEL TNDICATOR

Md.Shahrukh Javed, Mohammed Amir

T JOHN INSTITUTE OF TECHNOLOG, Bangalore.

1.3 Motivation

The motivation of this project is to build a circuit which can be able to detect the level of a liquid element. This system is mainly designed to determine the liquid level of industrial tanks or reservoir. Two systems have been designed based upon human demands. This circuit is designed to determine the level of liquid element. This system illustrate about a fluid level indicator with transistor and microcontroller.

1.4 Chapter Outlines

This project is divided into 6 chapters:

Chapter 1: In this chapter the necessity of the liquid level indicator are described due to people's awareness and demands. So recent works related to our project are studied. The basic elements of the proposed system are described in short.

Chapter 2: The project theoretical background studies and project block diagrams are described in this chapter.

Chapter 3: The basic hardware equipment's with proper diagram are described in this chapter in details.

Chapter 4: The project circuit diagrams are described with proper information in this chapter.

Chapter 5: The project implementation of the system, hardware implementation, testing and result are described in this chapter.

Chapter 6: The project discussion, conclusion and future works are included in this chapter.

1.5 Objective

- To construct an electronic device that can automatically detect water level with high precision.
- To control the supply of water. The following objectives are likely to be focused an achieved at the end of the project.
- To make the most commercial and reliable liquid level controller using as less resources as possible.
- To study the controller model and observe its characteristics.
- To compare the controller with the conventional controller available in market.
- To propose any ideas or improvements that can lead to future development of the controller.
- To automatically shut down when the reservoir is filled up

CHAPTER 2: BACKGROUND STUDY

2.1 Introduction

In most house, industries and commercial complexes, water and liquid element is fast stored in an underground tank (UGT) and from there it is pumped up to the overhead tank located on the roof. People generally switch on the pump when their taps go dry and switch off the pump when the overhead tank starts overflowing. This results in the unnecessary wastages and sometimes none-availability of water in the case of emergency. The liquid level indicator system is use to monitor liquid level to prevent the waste of liquid element. It switches on when the liquid level in the tank goes low and switches it off when the liquid level reaches a pre-determined level. We will investigate both transistor based liquid level indicator and microcontroller based liquid level indicator system using wire sensor and sonar sensor. Liquid level management approach would help in reducing the power consumption as well as liquid element overflow.

2.2 Block Diagram of the System

2.2.1 Block diagram of transistor based liquid level indicator system

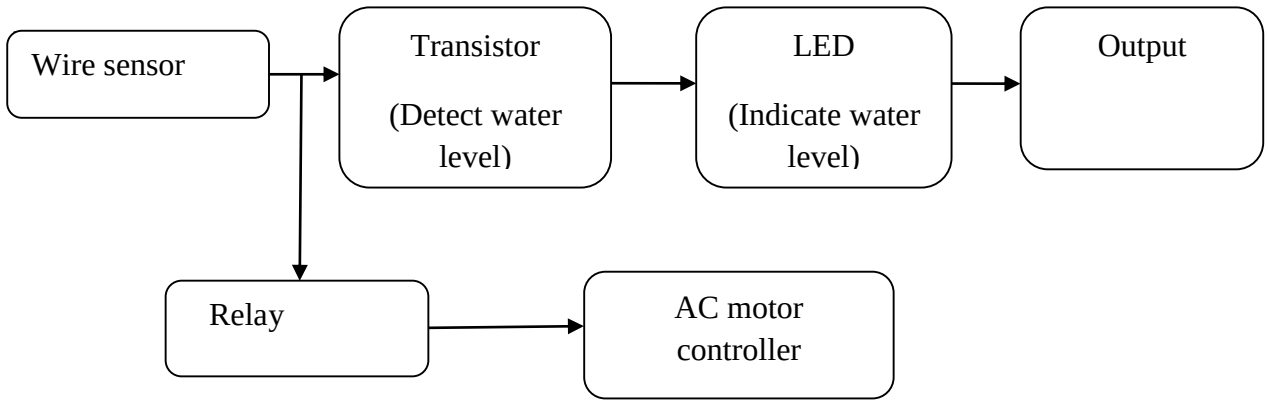


Figure (1): Block diagram of Transistor based liquid level indicator.

In this system at first the wire sensor detects the level of liquid element in the tank or reservoir then it sends the sensing result to the transistor, and transistor act as a switch. When a small voltage is applied to the base of transistor through water it gets biased. When transistor get its ON state, current start flowing from collector to emitter and LED glows according to water level. Relay is an electromagnetic switch. It is used to turn ON and turn OFF the AC motor by a low power signal. When the liquid level of tank gets empty the relay turns ON the AC motor and when the liquid level of tank gets full the relay turns OFF the AC motor.

2.2.2 Block Diagram of Microcontroller Based Liquid Level Indicator System

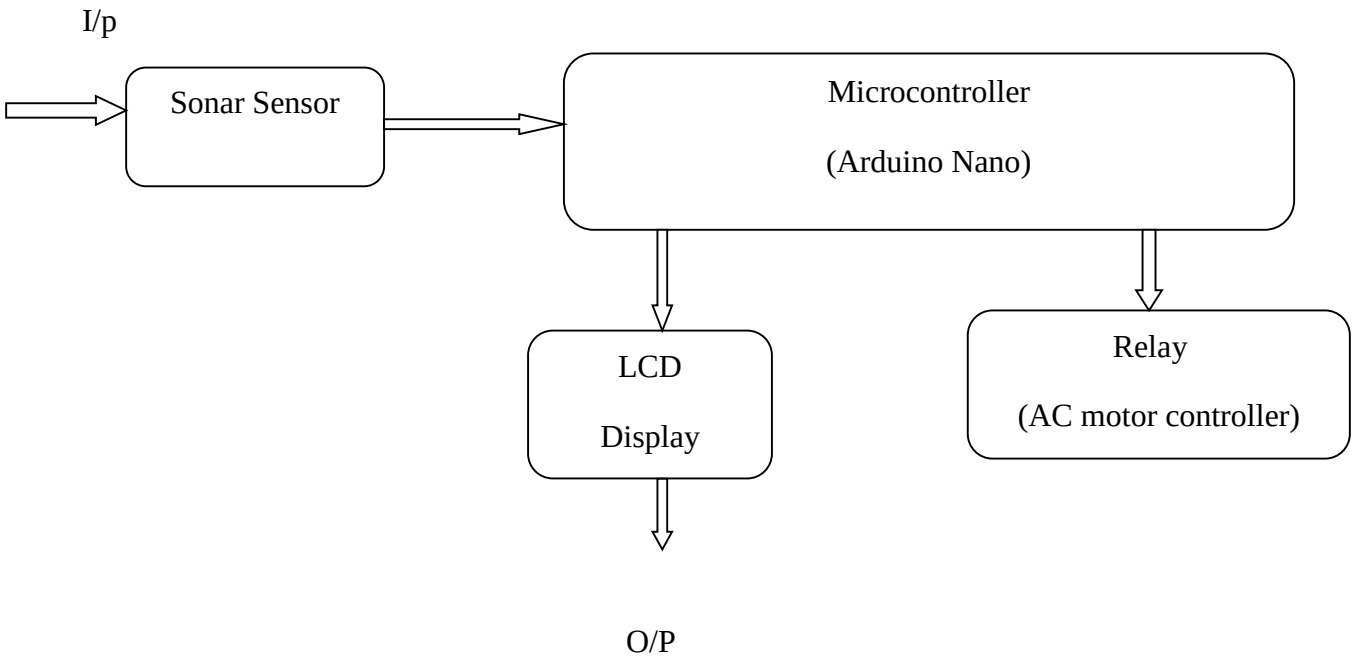


Figure (2): Block diagram of Microcontroller based liquid level indicator

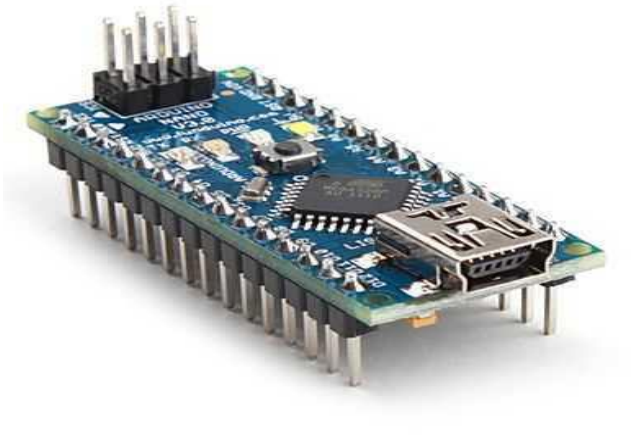
In this system the sonar sensor sensing the level of liquid element by sending its ultrasonic sound wave to the liquid element. Then it gives the signal as input to the Arduino Nano Microcontroller. After getting input if the liquid level of the tank or reservoir becomes low it sends the signal to the relay. After getting the signal it turns ON the AC motor. And when the level of liquid element of the tank becomes high at the same process occurs. The microcontroller again sends signal to the relay and the relay turns OFF the AC motor. This system will help to indicate the liquid level and automatically controlling the water motor by sensing the water level in a tank. This system explains how to detect and control the liquid level in an overhead tank or any other container. This system monitors the water level of the tank and automatically switches ON the motor whenever tank is empty.

The motor is switched OFF when the overhead tank or container is full. Here the water level of the tank is indicated on LCD (Liquid Crystal Display).

CHAPTER 3: BASICS OF HARDWARE EQUIPMENT

3.1 Microcontroller (Arduino Nano)

Microcontroller is an integrated circuit that is programmed to do a specific task. Microcontrollers are really just minicomputer. Microcontroller is a computer on a chip that is programmed performs almost any control sequencing monitoring and display the function. It's great advantage is no other external components are needed for its application because all necessary peripherals are already built into it, thus we can save the time, space and cost which is needed to construct low cost device.[3]ATmega328. It has more or less the same functionality of the Arduino Duemilanove but in Arduino Nano is a small, complete and breadboard-friendly board based on the different a package. It lakes only a DC power jack and works with a mini-B USB cable instead of a standard one. Arduino Nano is a function module which very small but has a lot of advantages. It is a surface mount breadboard embedded version with integrated USB.



Figure(3): Arduino Nano ATmega-328

Features of Arduino Nano ATmega-328:

- Microcontroller ATmega-328
- Operating voltage: 5V
- Supply voltage (recommended): 7-12V
- Supply voltage (limits): 6-20V
- Number of digital I/O pins: 14

- Number of PWM pins: 6
- Number of analog pins: 8
- Max DC current for each I/O pins: 40 mA
- DC current for 3.3 volt out :50 mA
- Flash memory: 32 kB
- SRAM: 2kB
- EEPROM :1kB
- Clock speed 16 MHz
- Length:45 mm

3.2 Ardiuno Nano Core Architecture

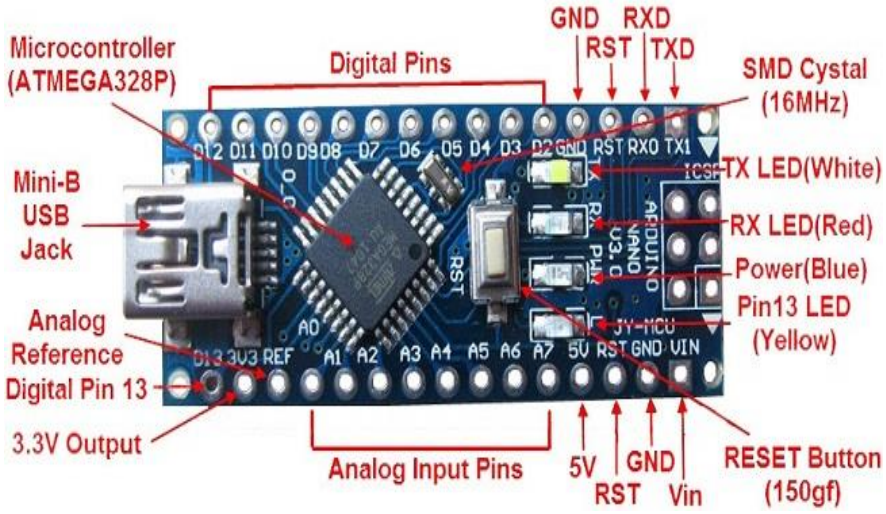


Figure (4): Arduino Nano core architecture

The AT-MEGA328 is single chip microcontroller created by Atmel in the mega AVR family.

3.3 Transistor

The transistor was invented by three scientists at the Bell laboratories in 1948[4],and its first discovery announcement, in a press release on July 4, 1951.[5] .and it rapidly replaced the vacuum

tube as an electronic signal regulator. Transistor is a semiconductor device that can either amplify an electronic signal or act as an electronic switch. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. Transistor stands for transfer of resistance. It is basically an electrically controlled switch. Transistor has three terminal and these are emitter, base and collector. Two types of transistor are NPN and PNP.

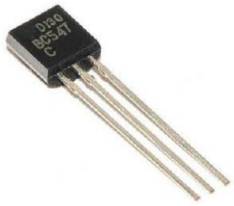


Figure (5): Diagram of Transistor

3.3.1 NPN Transistor:

NPN is one of the two types of bipolar transistor, consisting of a layer of P-doped semiconductor between two N-doped layers. A small current entering the base is amplified to produce a large collector and emitter current. The NPN transistor is designed to pass electrons from the emitter to the collector. The emitter emits electrons into the base, which controls the number of electrons the emitter emits.

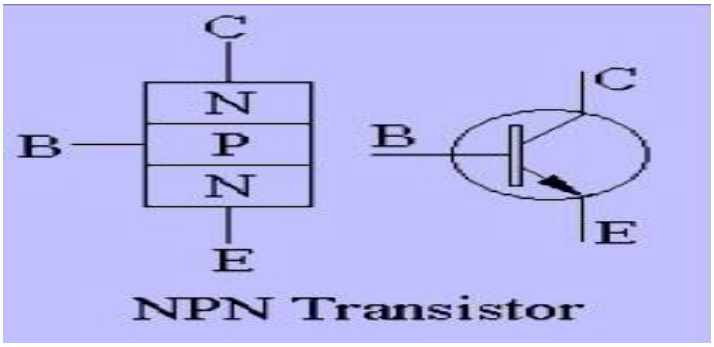


Figure (6): Symbol of NPN transistor

3.3.2 PNP Transistor:

PNP transistor is another type of Bipolar Junction Transistor (BJT) transistor. The structure of the PNP transistor is completely different from the NPN transistor. Here, two P-type doped semiconductor materials are separated by an N-type material. The two PN-junction diodes in the

PNP transistor structure are reversed with respect to the NPN transistor. In PNP transistor the majority current carriers are holes and electrons are the minority current carriers. All the supply voltage polarities applied to the PNP transistor are reversed.

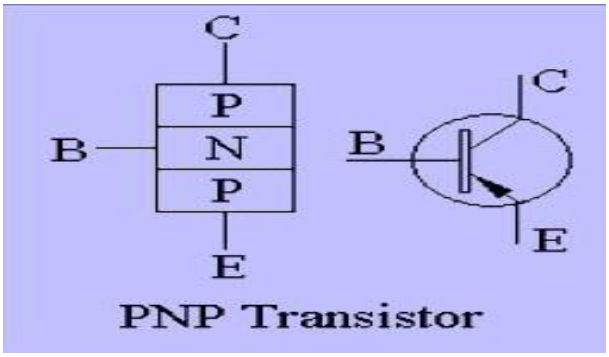


Figure (7): Symbol of PNP transistor

3.4 Relay

In 1833 Carl Fried Rich Gauss and Wilhelm Weber developed an electromagnetic relay. [] Relay is an electrically operated switch that is used in an application to turn on and off a circuit by a low power signal electromagnetically and electrically. There are four parts of relay and these are electro magnets, moveable armature, switch point contacts, spring. In relay there are two circuits, control circuit and load circuit. A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a moveable iron armature and one sets of contacts. When an electric current is passed through the coil generates a magnetic field that active the armature and the consequent movement of the moveable contacts. Either makes or breaks a connection with a fixed contact. Relays allow one circuit to switch a second circuit which can be completely separate from first. The coil of a relay passes a relatively large current typically 30 mA for a 12V relay.

Figure (8): Diagram of Relay

3.5 Resistor

According to William L. Faissler (1991), resistors are components that obey Ohms law, i.e. there resistance is depending on the current flowing throw them. Resistor is an electrical component that limits or regulates the flow of electrical current in an electrical circuit. Whenever current flows throw a resistor heat is dissipated in the component. This property is called resistance and the unit of measurement is in Ohms (Ω). An Ohm is the resistance that occurs when a current of 1Amp passes through a resistor with a 1Volt drop across its terminals.The current is proportional to the voltage across the terminal across. Resistors are the most commonly used electronic components, are usually manufactured as either carbon composition or carbon film. The resistor is a passive electrical component to create resistance in the flow of electric current. In almost all electrical networks and electronics circuits they can be found.

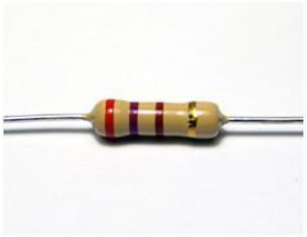


Figure (9): Diagram of Resistor

3.6 LCD Display

A liquid crystal display (LCD) is a flat- panel display or other electrically modulated optical device that uses the light modulating properties of liquid crystal. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour. A 16X2 LCD display is used in liquid level indicator system. A 16X2 LCD means it can display 16 characters and there are 2 such lines.

Figure (10): LCD Display

In this LCD each character is displayed in 5X7 pixel matrix. This LCD has two resistors, namely, command and data. The command resister stors the command instruction given to the LCD. The data resister stores the data to be displayed on LCD display.

3.7 Buzzer

The electric buzzer was invented in 1831 by Joseph Henry. A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, piezoelectric. Typically uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. This device may be early devices were based on an electromechanical system identical to an electric bell. A piezo electric buzzer can be driven electronic device commonly used to produce sound. Piezo buzzer is based on the inverse principle of piezo electricity.

Figure (11): Diagram of Buzzer

3.8: LED

A Light Emitting Diode (LED) is two lead semiconductors light source. It is a PN junction diode that emits light when active. When a suitable voltage is applied to the leads electrons are able to recombine with electronic holes within the device, releasing energy in the form of photons. This effect is called electroluminescence. And the color of the light is determined by the energy band gap of the semiconductor. LEDs are typically small and integrated optical component may be used to shape the radiation pattern. A PN junction can convert absorbed light energy into a proportional electric.The same process is reversed here i.e. the PN junction emits lights when electrical energy applied to it. The first commercial LEDs commonly used as replacement for non indicator lamps and in seven segment display.

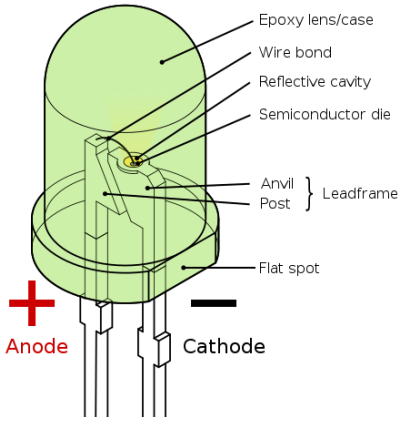


Figure (12): Diagram of LED

3.9 Ultrasonic Sensor (HC-SR04)

A HC-SR04 Ultrasonic ranging Sensor is a device that can measure the distance to an object by using sound wave. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. It emits an ultra sound at 40000Hz which travels through the air and sound travels through air at about 344 m/s and can take the time for the sound wave to return and multiply it by 344 meters to find the total round-trip distance of the sound wave. Round-trip means that the sound wave traveled 2 times the distance to the object before it was detected by the sensor.To find the distance to the object, simply divide the round-trip distance in half. The Ultrasonic sensor sends out a high frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has two opening on its front. One opening transmits ultrasonic waves (like a tiny speaker), the other receives them (like a tiny microphone). It uses the following mathematical equation:

Distance = Time X Speed of sound divided by 2

Time = the time between when an ultrasonic wave is transmitted and when it is received.

Divide this number by 2 because the sound wave has to travel to the object and back to the receiver.

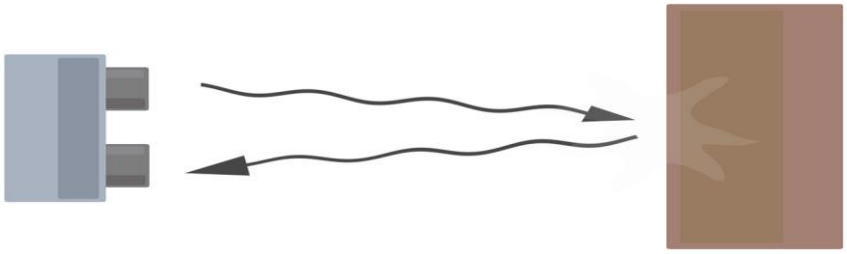


Figure (13): Sending and receiving waves

In figure, one opening sends out ultrasonic sound wave to the object and the other opening receiving the obstacle wave. Then it measure the distance between them.

Figure (14): Diagram of HC-SR04 Ultrasonic sensor

HC-SR04 Ultrasonic Sensor has four pins:

- VCC- 5V of the power supply
- TRIG- Trigger pin
- ECHO- Echo pin
- GND- to ground

TRIG and ECHO pins can be used to interface this module with microcontroller unit.

3.10 GSM

GSM (Global system for mobile communication) is a standard developed by the European Telecommunication Standards Institute (ETSI) to describe the protocols for second-generation digital cellular networks used by mobile device, first developed in Finland in December 1991.[3] As of 2014, it has become the global standard for mobile communications- with over 90% market share, operating in over 219 countries.[4].2G networks developed as areplacement for first

generation (1G) analog cellular networks, and the GSM standard originally described as a digital circuit switched network optimiged for full duplex voice telephony.

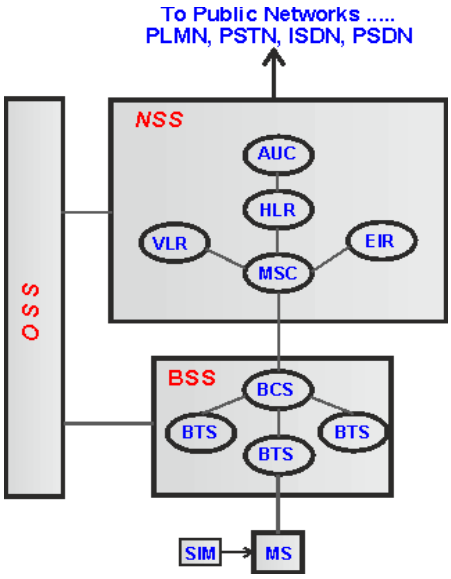


Figure (15): GSM Network Architecture.

The GSM network architecture as define in GSM specification can be grouped into four main areas:

- Mobile station(MS)
- Base-station subsystem(BSS)
- Network and Switching subsystem(NSS)
- Operation and Support Subsystem(OSS)

A basic diagram of overall GSM system architecture with these four major elements is shown below:

Mobile Station:

Mobile Station (MS), mobile equipment (ME) they are most widely known, cell or mobile phones are the station of a GSM cellular network that the user sees and operates.

Base Station Subsystem (BSS):

Base station Subsystem manages radio sources for BTS. It Assigns frequency and time slots for all MSs in its area. It communicates with MSC and BTS.

Mobile Switching Center (MSC):

MSC is the heart of the network. It manages communication between GSM and other networks. It controls mobility management. Such as registration, location updating.

3.11 Mobile Phone

A mobile phone, known as a cell phone in North America, is a portable telephone that can make and receive calls over a radio frequency link while the user is moving within a telephone service area. A handheld mobile radio telephone service was envisioned in the early stages of radio engineering. In 1917, Finnish inventor Eric Tigerstedt fields a patent for a “pocket size folding telephone with a very thin carbon microphone. The race to create truly portable phone devices began after World War II, with developments taking place in many countries. The radio frequency link established a connection to the switching system of a mobile phone operator, which provides access to public switching telephone network (PSTN). Modern mobile telephone service uses cellular network architecture, and mobile telephones are called cellular telephones or cell phones, in North America.

Figure (16): Diagram of cellular mobile phone.

3.12 SIM (Subscriber Identity Module):

SIM was initially specified by the European Telecommunications standers institute in the specification with the number TS 11:11. This specification describe by the physical and logical behavior of the SIM. The first SIM was developed in 1991 by Munich smart card maker, who sold the first 300 to the Finnish wireless network operator Radiolinja. SIM is an integrated circuit that is intended to securely store the international mobile subscriber identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephony devices. Now it is possible to store contact information on SIM cards. SIM cards are always used on GSM phones, for CDMS phones and LTE capable handset. It can also be used in satellite phones, computers or cameras.

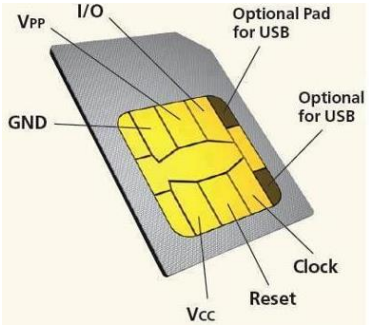


Figure: SIM card.

Today, SIM cards are ubiquitous, allowing over 7 billion devices to control to cellular networks around the world. There are three operating voltage for SIM cards: 5v, 3v and 1.8v. Modern SIM cards allow Application to load when the SIM is in use by the Subscriber. Modern SIM cards. Each SIM cards is Internationally identified by its integrated circuit card identifier (ICCID).

CHAPTER 4: SYSTEM DESIGN

4.1 Circuit Diagram of the Systems

4.1.1 Circuit Diagram of Transistor Based Liquid Level Indicator System

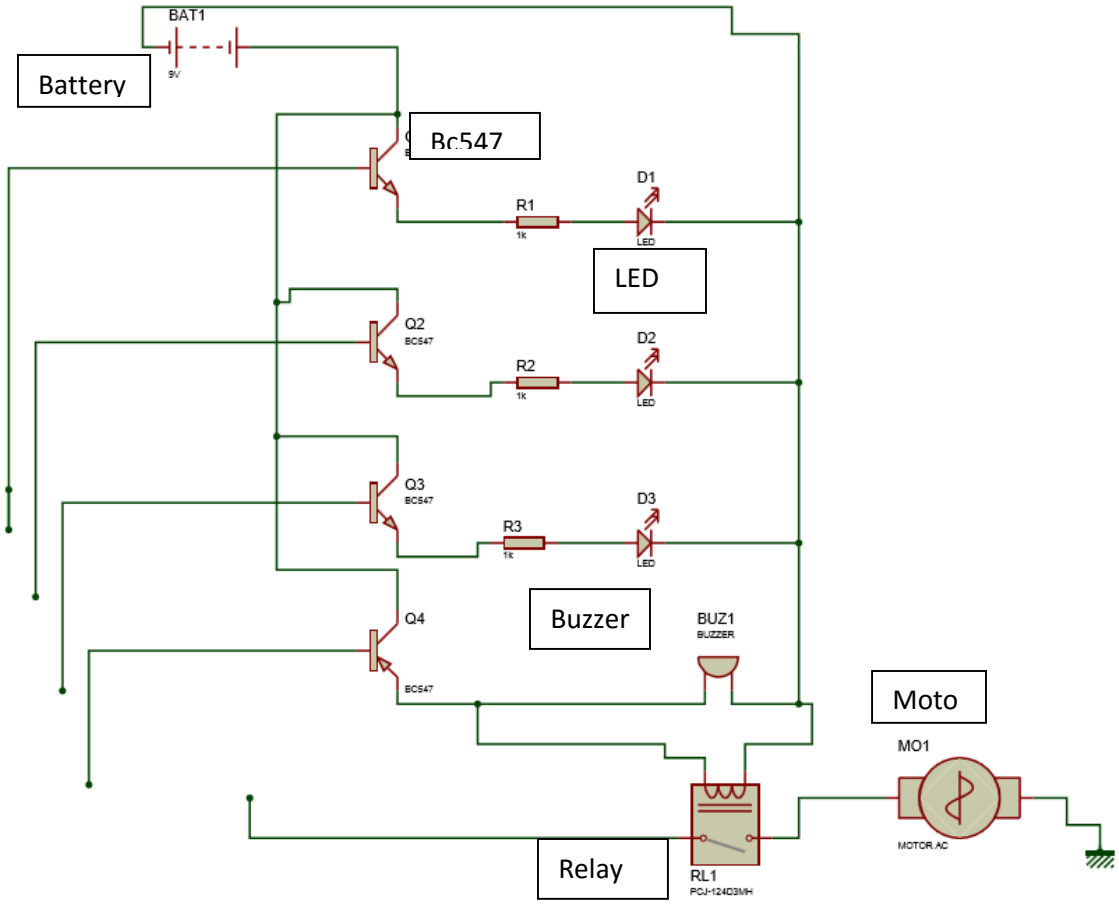


Figure (18): Circuit diagram of transistor based liquid level indicator system

Working principle:

The circuit consists of four sensing wire probes which is dipped in water to sense the level of water. The probe A which is connected to transistor Q1 is common to other three pr B, C and D probes that is the bottom most part of liquid tank. It also act as a reference level. The probes B, C,

and D of transistor Q2, Q3 and Q4 are set as maximum, middle and minimum level respectively. When the level of liquid in tank touches the probe A and B both, a small current flow from A to B Through water and to the base of transistor Q2. As a result the transistor Q2 conduct current through resistor to LED (D2) and LED (D2) glows which represent the maximum liquid in the tank. Respectively when the level of liquid in the tank touches to probe C, transistor Q3 get current from probe A, LED (D3) get this current through resister and glows to indicate the middle level of the liquid.

Same phenomenon happened to Transistor Q4 and LED (D4) glow to indicate the minimum level of the tank. When liquid level reaches to minimum level the buzzer start making beep sound and relay which is an electromagnetic switch that turned ON the AC motor. Respectively relay turned OFF the AC motor when liquid level reaches to its maximum level to prevent the waste of valuable liquid.

4.1.2 Circuit Diagram of Microcontroller Based Liquid Level Indicator System

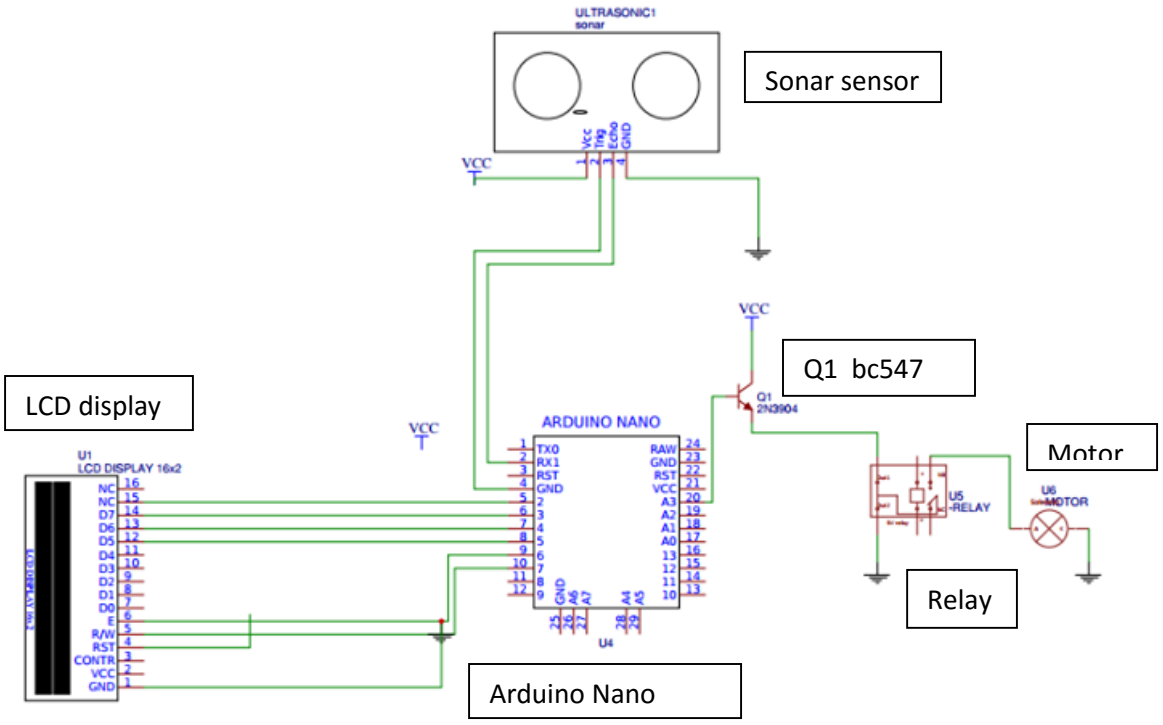


Figure (19): Circuit diagram of Microcontroller based liquid level indicator system

Working principle:

In this microcontroller based liquid level indicator system the sonar sensor is used to sensing and detect the liquid level up to 2cm to 400cm. Sensor sends out ultrasonic sound at 344m/s to the liquid element of the tank and reservoir to detect the level. Then it sends the signal to the microcontroller. Microcontroller processed it then sends the processed signal to the relay. The relay is an electromagnetic switch. After getting the signal the relay switches ON and OFF the AC motor. When the liquid elements tank remain empty then relay switches ON the motor and when the liquid element tank remain full then the relay switches OFF the motor. The LCD displayed output. And the system will run with the continuous process.

CHAPTER 5: IMPLEMENTATION OF THE SYSTEM

5.1 Hardware Implementation

All the necessary equipment's for this project have been bought. Within six months leaving eight semester we will implement this project.

5.2 System Testing

This system has been not implemented yet so we have not tested the system.

CHAPTER 6 DISCUSSION: AND CONCLUSION

6.1 Discussion

This project discusses the issues related to the design of liquid level indicator system by using transistor and Arduino Nano microcontroller. It will help to automatically control the level of liquid element in houses, industries and commercial complexes. It also helps in the efficient utilization of available water sources.

6.2 Future Work

In future we want to upgrade this system with GSM module. By including GSM module to the system we can turn ON and OFF the motor through SMS and also get information through SMS on mobile phone. We will try our best to make it simple, easy to use, easy to install and make available for all.

6.3 Conclusion

Liquid level indicator system is used in the huge containers in most big companies and industries. Many people in all countries have their overhead tanks and reservoir uses this system to control and to prevent wastage of liquid element. This system is very beneficial in rural, urban areas as well as industries.

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