LIQUID CHAMBER MONITORING SYSTEM

Arun Tank[1], Vaishali Raval[2]Kamlesh Joshi[1], MehulMistri[1]

[1]PDDC Students, LDCE, Ahmedabad
[2] Design Engineer, Ahmedabad

Abstract

The objective of this project is to measure different parameters of liquid, and to display the status of those parameters on LCD display. Here we are going to measure four parameters (1) Lighting of the liquid chamber. (2) Temperature of the liquid chamber. (3) Level of the liquid. (4) pH value of the liquid.For the industrial purpose we can use this concept for continuous monitoring of these four parameters of any liquid. This concept is useful where storage of liquid under monitoring of these four parameters is mandatory. And this project provides initial concept and idea to provide the industries to facilitate to monitor the parameters of the liquid.

1. Introduction

Liquid Chamber Monitoring System provides following features of measuring the parameters:

(1) Light or Darkness of the Liquid Chamber.

(2) Temperature of the Liquid Chamber.

(3) Level of the Liquid in the Chamber.

(4) pH value of the Liquid.

Among this four parameters two of them level and pH value are related to liquid, and remaining two of them temperature and lighting are related to atmosphere of chamber.In this project we are trying to provide the reliable and efficient electronics design to measure these four parameters. If we discuss the project block wise then there is mainly eight blocks of the project as listed below. The complete system has developed using 89C52 microcontroller.

Figure 1 shows block diagram of LCMS which has following building blocks:

1) 89C52 Microcontroller electronics
2) ADC electronics
3) LCD display electronics
4) Power Supply electronics
5) Light monitoring electronics

6) Temperature monitoring electronics

7) Level monitoring electronics

8) pH monitoring electronics

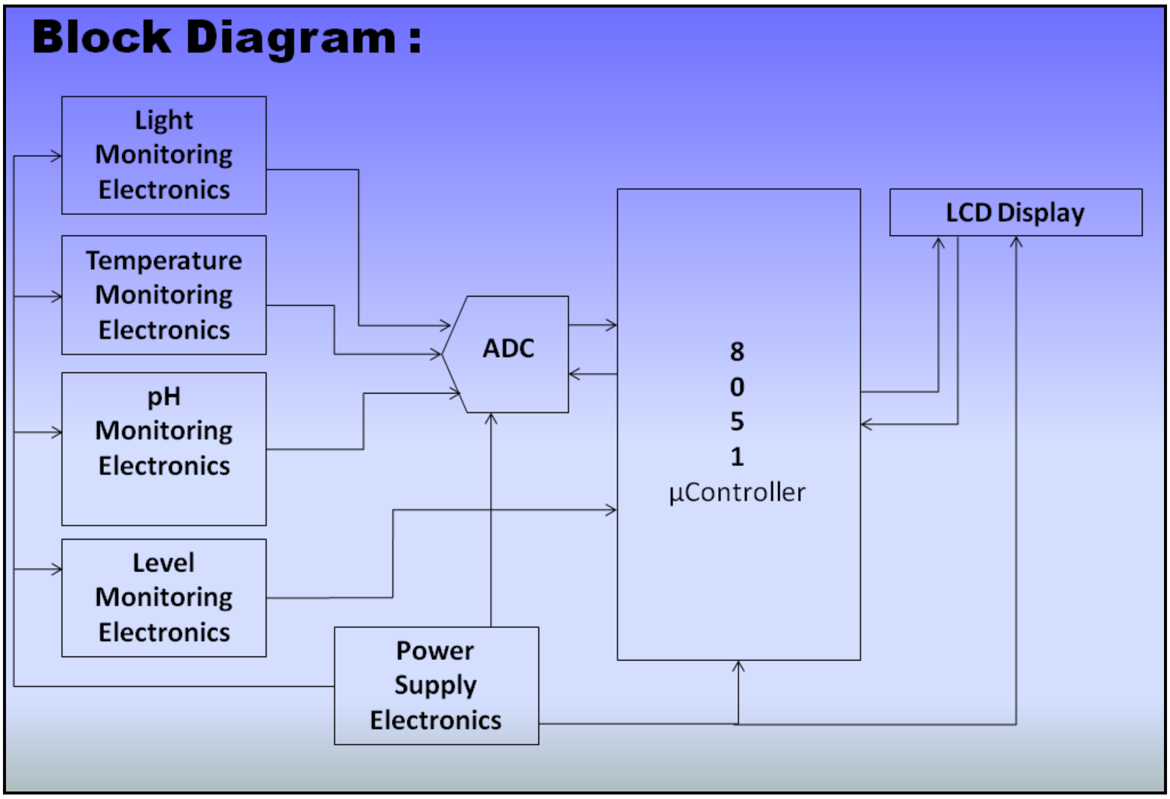

Fig. 1: Block Diagram of Liquid Chamber Monitoring System

1.1 *89C52 Microcontroller electronics*

It is a low-power, high performance CMOS 8-bit microcontroller with 8KB of flash Programmable and Erasable Read Only Memory (EPROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the MCS-51™ instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful Microcontroller, which provides a highly flexible and cost effective solution for many embedded control applications.

1.2 *ADC electronics*

This electronics provides the facility of transforming the real world data which is in the analog form from analog to digital. In this project we are using three channels of the total eight channels. We can select any of the one channel by setting the bits on the address lines ADDA, ADDB, ADDC. Here we will select the channel and take that digitize data to microcontroller for further process in the program. The main functionality of this section is to scan the analog data continuously from the selected channel and to digitize it for providing it to microcontroller

1.3 *LCD display electronics*

This electronics provides the facility of displaying the data which is scanned by ADC electronics. The main functionality of this electronics is to take data from the microcontroller and to display the data on the LCD. It is the controllable electronics by microcontroller electronics. It will display the parameter which is to be selected to measure and display.

1.4 *Power Supply electronics*

This electronics provides power supply to all the electronics sections. Here we are generating +5V supply for providing voltages to microcontroller and ADC electronics. And -9V supply is for the pH monitoring electronics for the supply of 741 Op-Amp IC. For this we are using 7805 to generate the +5V and a dry cell battery for -9V.

1.5 *Light monitoring electronics*

This electronics provides analog signal generation with respect to the lighting of the liquid chamber. It is the LDR based electronics which gives variation in the resistance of the LDR with respect to lighting. This analog voltage is the input of the ADC analog input channel. When analog channel of the measuring the lighting of the chamber is selected, then LCD will display the data of the lighting of the chamber.

1.6 *Temperature monitoring electronics*

This electronics provides analog signal generation with respect to the temperature of the liquid chamber. It is the LM35 based electronics which gives the analog voltage with respect to temperature of the liquid chamber. This analog voltage is the input of the ADC analog input channel. When analog channel of the measuring the temperature of the chamber is selected, then LCD will display the data of the temperature of the chamber.

1.7 *Level monitoring electronics*

This electronics provides the data that the chamber is empty or full of liquid. This circuit is simple wired and transistor based logic circuit to indicate the level of the liquid in the chamber. LCD will display the data of the liquid level in the chamber that the tank is filled or empty. Here we can monitor the levels of liquid at various points like… Empty, 50%, 90% and ready to Overflow.

1.8 *pH monitoring electronics*

This electronics provides analog signal generation with respect to the pH of the liquid. This voltage is given to 741 Op-amp based circuits to make the voltages in positive voltage range. This will give the information in the analog voltage form to ADC analog input channel. This analog voltage is the input of the ADC analog input channel. When analog channel of the measuring the pH of the chamber is selected, then LCD will display the data of the pH of the liquid.

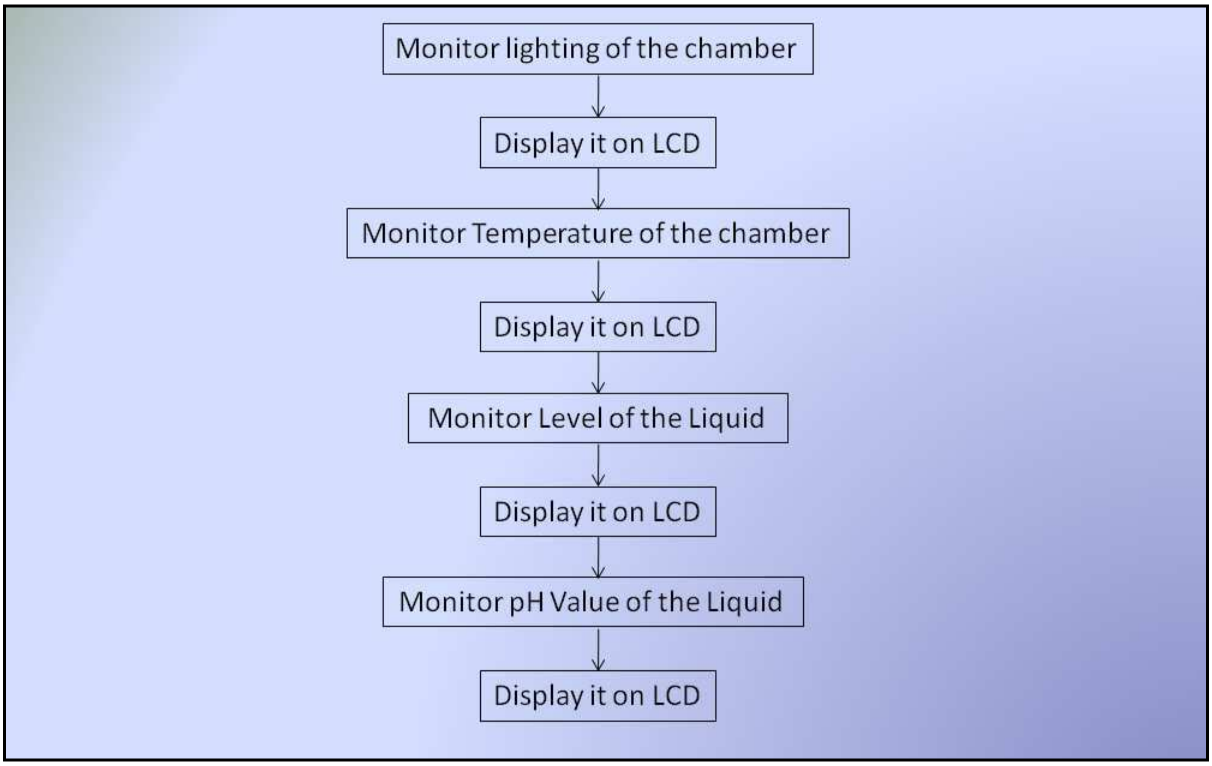

Fig.2: Data flow diagram

2. Theory of pH Measurement:

A very important measurement in many liquid chemical processes (industrial, pharmaceutical, manufacturing, food production, etc.) is that of pH: the measurement of hydrogen ion concentration in a liquid solution. A solution with a low pH value is called an "acid," while one with a high pH is called a "caustic." The common pH scale extends from 0 (strong acid) to 14 (strong caustic), with 7 in the middle representing pure water (neutral):

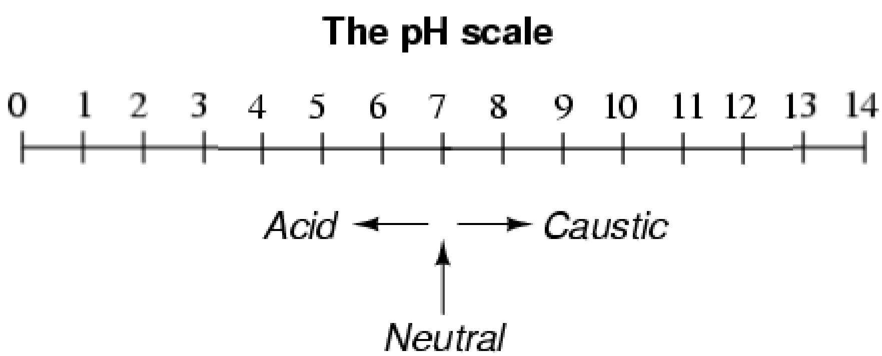

Fig. 3: pH Scale

The design and operational theory of pH electrodes is a very complex subject, explored only briefly here. What is important to understand is that these two electrodes generate a voltage directly proportional to the pH of the solution. At a pH of 7 (neutral), the electrodes will produce 0 volts between them. At a low pH (acid) a voltage will be developed of one polarity, and at a high pH (caustic) a voltage will be developed of the opposite polarity.

An unfortunate design constraint of pH electrodes is that one of them (called the *measurement* electrode) must be constructed of special glass to create the ion-selective barrier needed to screen out hydrogen ions from all the other ions floating around in the solution. This glass is chemically doped with lithium ions, which is what makes it react electrochemically to hydrogen ions. Of course, glass is not exactly what you would call a "conductor;" rather, it is an extremely good insulator. This presents a major problem if our intent is to measure voltage between the two electrodes. The circuit path from one electrode contact, through the glass barrier, through the solution, to the other electrode, and back through the other electrode's contact, is one of *extremely* high resistance.

The other electrode (called the *reference* electrode) is made from a chemical solution of neutral (7) pH buffer solution (usually potassium chloride) allowed to exchange ions with the process solution through a porous separator, forming a relatively low resistance connection to the test liquid. At first, one might be inclined to ask: why not just dip a metal wire into the solution to get an electrical connection to the liquid? The reason this will not work is because metals tend to be highly reactive in ionic solutions and can produce a significant voltage across the interface of metal-to-liquid contact. The use of a wet chemical interface with the measured solution is necessary to avoid creating such a voltage, which of course would be falsely interpreted by any measuring device as being indicative of pH.

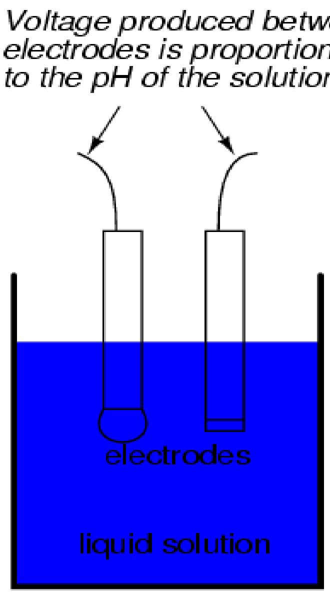

Fig. 4: pH Measurement

3. Electronic circuitry for pH measurement

3.1 *Sensor Circuit Board:*

Figure shows developed electronics circuitry for sensing pH, light, temperature and level of the liquid.

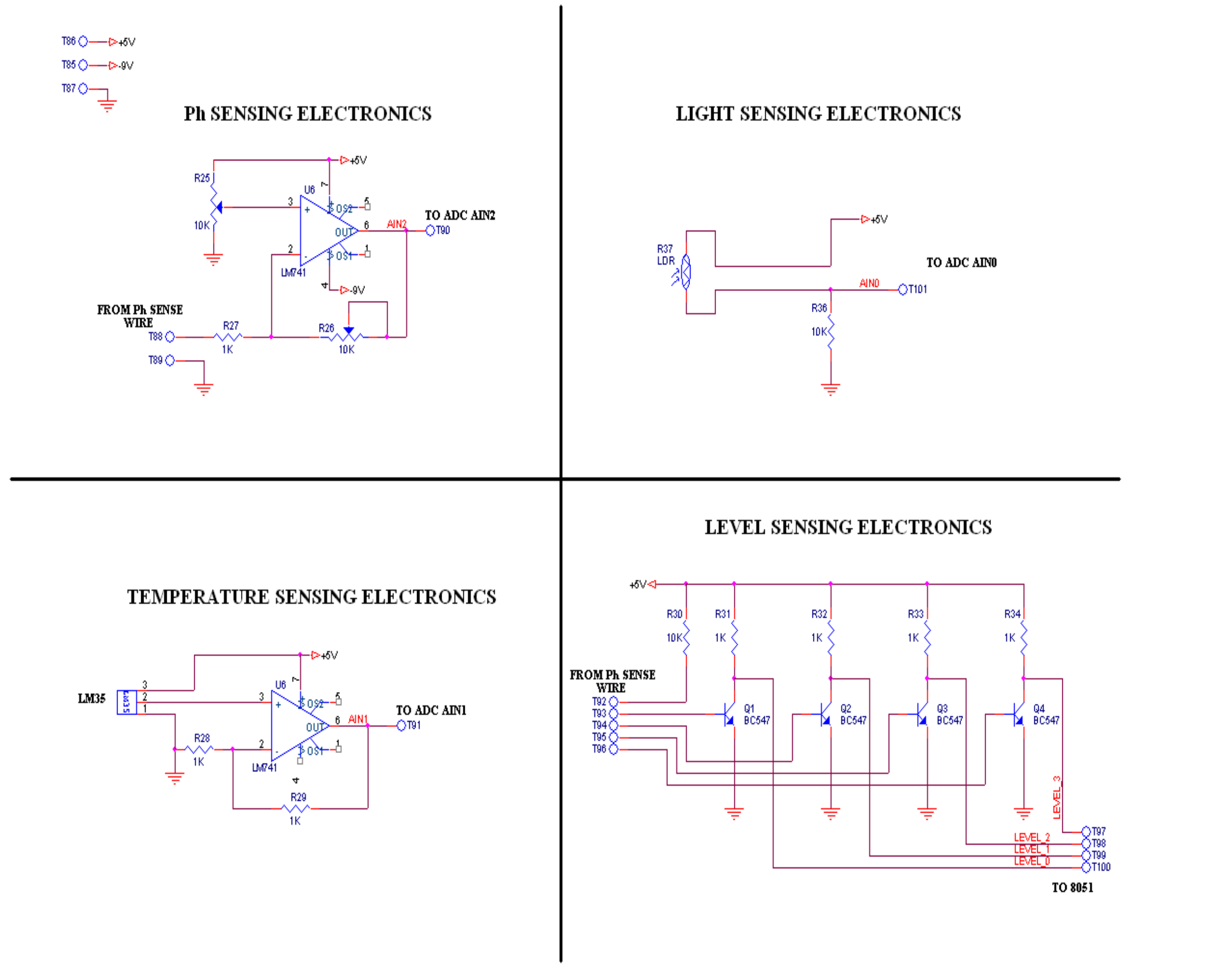

Fig.5: Sensor circuit schematic

In this circuit we use a pH probe to measure the pH level of liquid. This pH probe give some output Voltages as per the pH level of the liquid. Now, here pH probe gives an output between -0.5 to +0.5 voltage as per pH of liquid. As this voltage range is not suitable for the ADC we must convert it into the appropriate range which is suitable for the ADC. For this we can give this voltage to the OpAmp. Here OpAmp Converts this Voltage to the 0 to 5 Volts, which is suitable for ADC. Now, As we give the O/P of OpAmp to ADC, the ADC converts this Voltage to Hex Code and Finally this O/P of ADC given to the Microcontroller.

3.2 *Calculations:*

pH = - (E(96485)/(19.14(T)+5227.13))+7, where E=Voltage given by pH probe. pH Calculated by OP-AMP circuit is given by following Equation.

$V_o = V_{ref} (1+ (R_f/R_1))-((V_{in})R_f/R_1)$

Where Vin = Voltage given by pH probe.

pH Comparison Table :

Table 1: pH Comparison

Sr. No.	Liquid Material	Actual pH Value.	Measured pH Value.
1	Acid	1	2
2	Baking Soda	9	10

So here we can observe that in our project the measurement given by pH circuit is deflected by ± 1.

3.3 Light Circuit Description:

In this circuit we use a LDR to measure the Light Intensity of liquid Chamber. This LDR give some output Resistance as per the Intensity of the Liquid Chamber. Now, here LDR gives an output Resistance between 63Kohm to 93Kohm Resistance as per Light Intensity of Liquid Chamber.

Here for the suitable output, this Resistance is attached in series with the other 10K Resistor and make a Voltage divider circuit. Now, the O/P of this voltage divider circuit is carried out and given to the ADC. The ADC converts this Voltage to Hex Code and Finally this O/P of ADC given to the Microcontroller.

3.4 Light Measurement:

Final Lux of Light is calculated in this circuit is as per below given Equation is as follows:

Lux = Antilog (((log10(R))-

(1.78))/(0.62)) Where R = O/P

Resistance given by LDR

3.5 Temperature Circuit Description:

In this circuit we use an LM-35 IC to measure the Temperature of liquid Chamber. The LM-35 gives output 10mV/^{O}C as an output Voltages as per the Temperature of the liquid Chamber.

For the suitable input to ADC Here we amplify this voltages with the gain of 2 by the OpAmp. Now, as we give the O/P of OpAmp to ADC, the ADC converts this Voltage to Hex Code and finally this O/P of ADC given to Microcontroller.

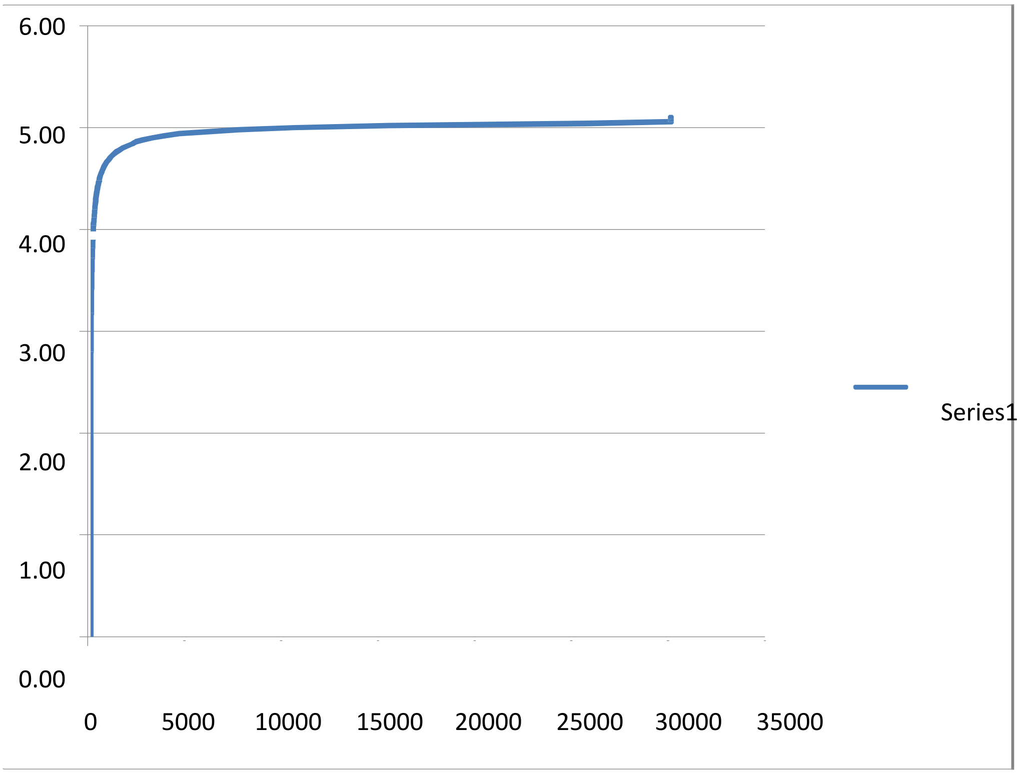

Fig. 6: Light response

Table 2: Calculation of LDR and Illuminance

LDR O/P OR ADC I/P	ADC O/P BINARY	ADC O/P DECIMAL	ADC O/P HEX	ILLUMINANACE (LUX)
5.08	254	11111110	FE	30000
5.00	250	11111010	FA	10507
4.50	225	11100001	E1	471
4.00	200	11001000	C8	146
3.00	150	10010110	96	32
2.00	100	01100100	64	9
1.00	50	00110010	32	2

3.6 Temperature Measurement:

Vo =Vin (1+(Rf/R1)) 3.7

3.7 Temperature Comparison Table:

Table 3: Temperature Comparison

Sr. No.	Time	Actual Temp. Value.	Measured Temp. Value.
1	Day Time	37	38
2	Evening Time	29	30

So here we can observe that in our project the measurement given by Temperature circuit is deflected by ± 1.

3.8 Level Circuit Description:

In this circuit we use 5 different wires to check the level of the liquid inside the Chamber. Among them 1 is act as a normal wire and the other 4 wires are acts as a sense wires, which are placed on different levels of the Chambers like… Empty, 50% Level, 90% Level & Ready to Overflow.

These wires are connected with the different transistors. These transistors are works as a switch. As level of the liquid of the Chamber is increased the wires are sensed its level and gives the O/P to Transistor. Transistor acts as a switch and gives the appropriate O/P to Microcontroller.

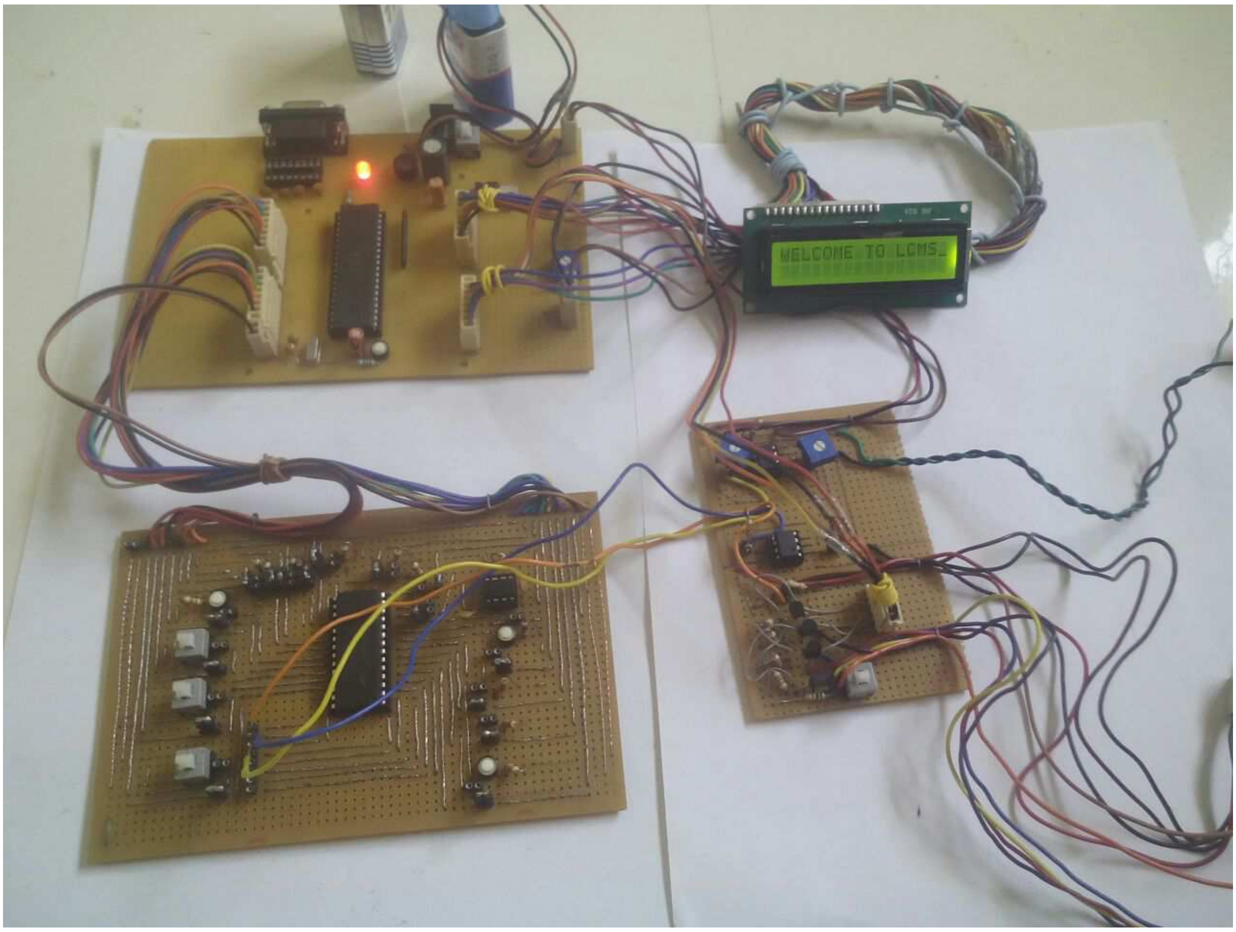

Fig.7: Test Setup

Fig.7 shows test setup of LCMS. LCD display shows 'WELCOME TO LCMS' Electronic interface circuits are also shown in it.

4. Conclusion

Developed microcontroller based LCMS is working efficiently. It can measure pH value of water, acid, etc. types of liquids.

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