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Embedded Based Level Measurement And Control Using Float Sensor

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ABSTRACT: The process parameters like Temperature, Pressure, Level, Humidity… etc., plays a vital role in process instrumentation. The accurate monitor and control of these parameters are very important in modern process control applications for the quality product output. This paper describes the development of a Microcontroller based Level Measurement and control system using a float sensor for measurement of level of liquid in a tank/container. The sensing unit uses a float connected to a potentiometer. When liquid level in a tank varies the float movement also varies the moving contact on the resistor coil which changes its resistance. The measured resistance is converted in to voltage by using signal conditioner which is proportional to the level of the liquid. For hardware implementation an ADC 0804 and LCD are interfaced with Microcontroller P89v51RD2. Further LCD is interfaced with 4 bit mode which reduces the hardware complexity. Software program developed using Micro version keil4 cross compiler. The developed hardware and software successfully implemented and tested with prototype system and the results are evaluated. The system is satisfactorily working with an accuracy of ± 0.1%.

KEYWORDS: Sensors, LCD Screen, Microcontrollers

1. INTRODUCTION

A level sensor detects the level of substances that flow including liquids, slurries, granular materials, and powders. All such substances flow to become essentially level in their containers because of its gravity .The level measurement can be in either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the detect levels that are excessively high or low. Float type sensors [1][2] can be designed so that a shield protects the float itself from turbulence and wave motion .Float sensors operate well in a wide variety of liquids, including corrosives. When used for organic solvents, how-ever, one will need to verify that these liquids are chemically compatible with the materials used to construct the sensors. Level measurement is vital in many process industries. Accurate control of level is essential nearly in all chemical processes. Depending upon the complexity situation, there are different methods for measuring the liquid level. They are Float type [3][4], Hydrostatic differential pressure gage type [5], Capacitance type [6], Ultrasonic type [7], Radiation technique etc. Level of liquid [9] in a tank/container should be maintained above the exit pipe if the tank empties the exit flow will become zero, a situation that would upset downstream process and could damage pumping equipment's that requires liquid. Level is measure [10] at the position of the interfaces between faces, where the faces are liquid/gas, solid/gas are immsensible liquid/liquid. Level is simply a measure of height this measurement is often converted to a volumetric or gravimetric quantity.

A. Principle of Operation

The principle of operation of float sensor is based on a float operated voltage potential divider method. A float operated voltage potential divider for liquid level measurement is shown in Figure 1.

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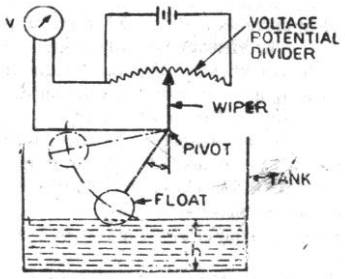

Figure 1: Float operated voltage potential divider for liquid level measurement

When liquid level rises in the tank, the float which is generally a hollow ball is raised. Its arm causes the wiper to move over the potential divider whose output terminals are connected to a voltmeter. As a float rises, the potential divider included in the output circuit gives an increased output voltage. Therefore the output voltage V is proportional to the liquid level h. the output terminals from the potential divider may also be taken to remote location for display and control.

In the present work a measurement system is developed to measure the level or height of a fluid or liquid which is contained in a tank/container .There are several instances required to monitor the fluid level of a tank for where a simple float type mechanism is sufficient. Level is measured by using float sensor which is a device used to detect the level of liquid contained in a tank. A developed hardware and software were successfully implemented on indigenously developed prototype system. The results are evaluated and we found that the developed system working satisfactorily with an accuracy of +/- 0.01%.

II. HARDWARE

The block diagram of a microcontroller based level measurement system is shown in figure 2, the schematic diagram of hardware is shows in figure 3 and in photograph 1. The system mainly consists of the following units. They are

2.1Float type sensor
2.2 Signal conditioning
2.3 ADC 0804
2.4 Microcontroller P89v51Rd2FN
2.5 DC motor
2.6 LCD display

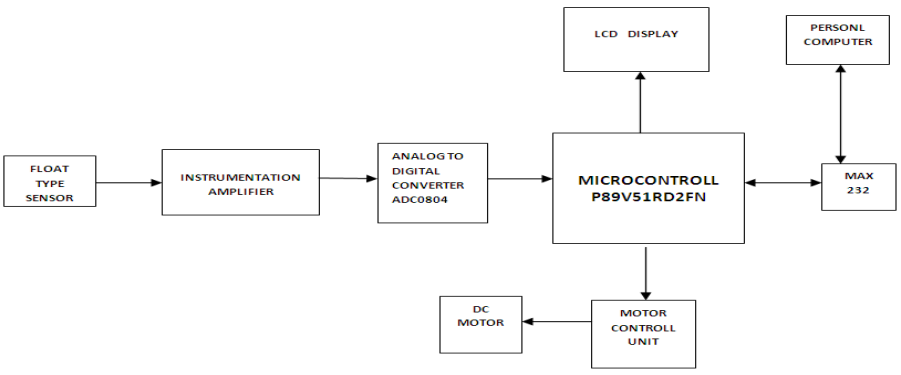

Figure 2: Block diagram and circuit diagram of Level measurement and control

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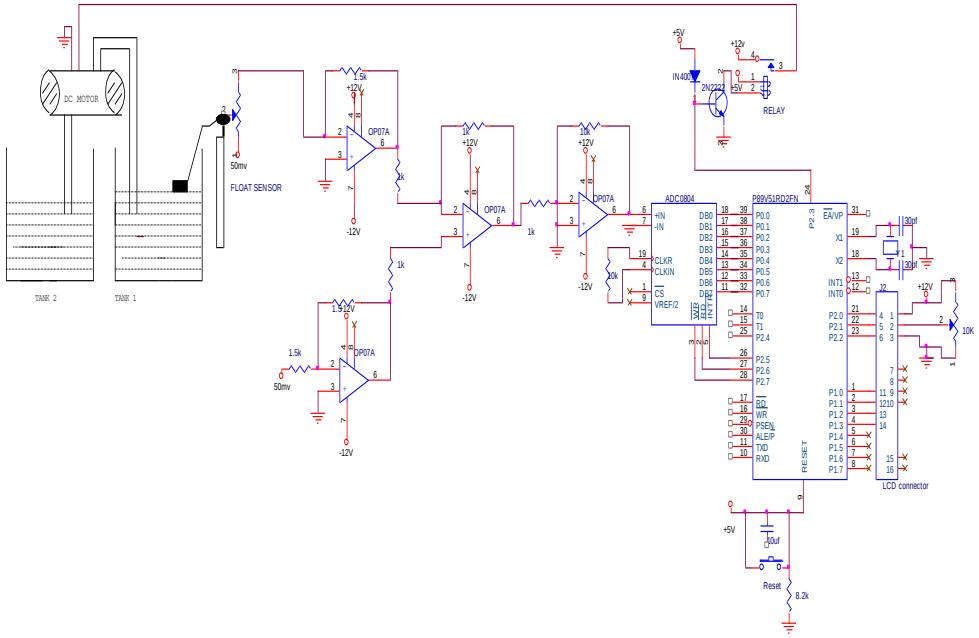

Figure 3: Schematic diagram of Level measurement with float sensor.

Photograph 1: Liquid Level measurement with float sensor.

2.1 FLOAT TYPE SENSOR

These are essential for the Level measurement applications where the resistance is converted to current or voltage signals which are proportional to the level of the liquid. It is accurate, simple installation, critical altering & easy to setup. Sensor operates when float rises from end position [8]. The resistance float type sensor is shown in figure 4.

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Figure 4: FLOAT TYPE SENSOR

Working Principle

The principle of operation [9] of float sensor is based on a float operated voltage potential divider method. A float operated voltage potential divider for liquid level measurement .When the liquid level raises in the tank, the float which is generally a hollow ball is raised and its arm causes the wiper to move over the potential divider whose output terminals are connected to a voltmeter. As the float rises, the potential divider included in the output circuit gives a varies output voltage. Therefore the output voltage V is proportional to the liquid level.

2.2 Signal conditioning unit

Any instrumentation measurement systems consist of various units starting from sensors to data representation units, among that signal conditioning plays an important role to modify the input useful to the required level for further processing An instrumentation amplifier designed as signal conditioning unit using op07 having capability of variable gain, low noise and it gives stable output. The output of float sensor is connected as input resistance of the instrumentation amplifier when the level of liquid varies then the resistance will be varied and the output voltage of the instrumentation amplifier also varies which is proportional to the level of the tank

2.3 ADC 0804

ADC is essential where an analog signal want to convert into digital world and in the present study ADC0804 [10] is used which has 8-bit resolution and 100us speed. It operates on +5V supply. The output of the instrumentation amplifier is fed to the ADC. The data is output from the D0-D7 when the interrupt is enabled. WR, RD, INTR are the control lines of ADC.

2.4 **MICROCONTROLLER** P89V51RD2FN

Microcontrollers are widely used in many commercial and industrial applications. In the present work we used P89V51RD2FN (Phillips made) microcontroller and it operates on +5V with 11.059 MHz and the final output of the level measurement after processing presented on LCD display(Lampex made)The digital data lines D0-D7 are connected to Port1 of the microcontroller. The operation of the level measurement system is very simple and is sensed by the float type level sensor. The level is then converted in to digital format by the A/D converter. WR,RD,INTR are the control lines of ADC are assigned to P2.5,P2.6,P2.7 and digital data lines are to be port P0.0 of microcontroller respectively. The microcontroller receives the data and displays the level measurement of the data D4-D7 are connected to P1.0-P1.3 pins, The RS,R/W,EN are assigned to P2.0, P2.1,P2.2 respectively. It receives the liquid level in digital form, processes the data and then displays on LCD.

1.5 DC MOTOR

A DC Motor which operates with +12V by 1Amp power supply for pumping the liquid. It consists of one inlet and one outlet for maintaining the level in a tank by pumping water. In this work the motor controlled by a microcontroller line of port P2.3 through a relay which is operates with +5V/+12V. The application software for the present work developed through communication interfacing with PC and MAX232 converter that converts RS232 voltage levels to TTL voltage levels and vice versa. One advantage of it is, its operating voltage is +5V same as microcontroller. It has two sets of line drivers for transferring and receiving data.

III. SOFTWARE

Keil Software is used for the development level application. It makes facilities for source code editing, program debugging and complete simulation in one powerful environment. The micro version development platform is easy to use and helping us quickly creates embedded programs that work. The micro version editor and debugger are

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integrated in a single application that provides a embedded project development environment. The algorithm and flow chat for level measure is given below.

Algorithm

1. Initialize the ports of the microcontroller.
2. Initialize the ADC and enable the interrupts.
3. Initialize the LCD display.
4. Clear the display.
5. Send the input data to ADC.
6. Start ADC conversion.
   Initial level measurement is 6 liters with corresponding voltage 1
   For every one liter the Level measurement = 6 + the present measure value.
7. If conversion is over Level can be measured in terms of voltage.
8. Control the motors for pumping and controlling of the level of the tank using the following condition.
   i) If level of the tank set point greater than the measured point then the motor will be in OFF position.
   ii) If the measured level of tank less than the set point then motor will be in ON position.
   iii) If the measured level of tank is equal to set point of the tank then motor either in ON or OFF position.

9. Repeat the steps from 6 to 8 for online Level measurement and control using float sensor.

S.NO	VOLTAGE (volts)	LEVEL MEASURED(liters)	LEVEL STANDARD(liters)
1	1	6.002	6.000
2	2	7.000	7.000
3	2.9	8.000	8.000
4	4	9.001	9.000
5	4.9	10.002	10.000

Table 1: Liquid level measurements using float sensors

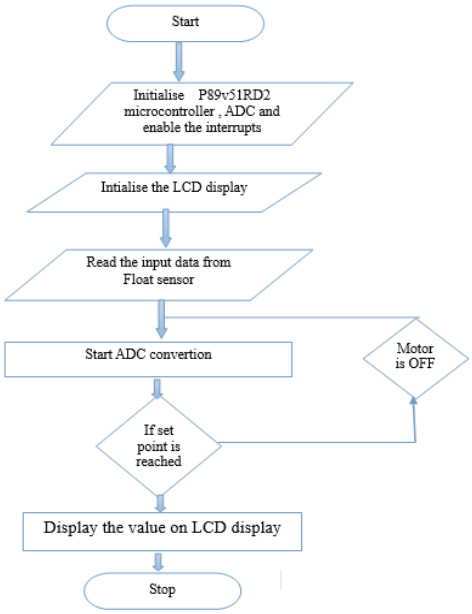

Figure 5. Flow chart for level measurement and control using float sensor

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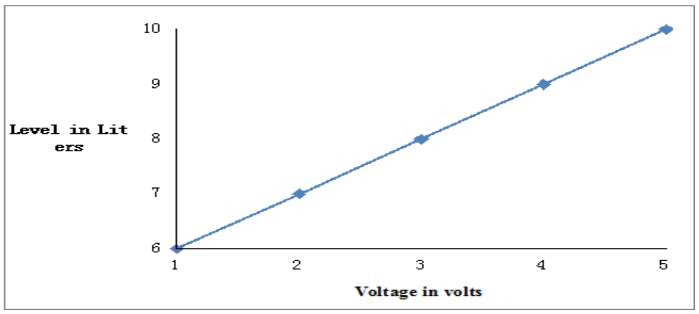
IV. RESULTS AND CONCLUSIONS

The prototype liquid level measurement system was successfully developed and implemented. The test measurement is compared with standard values. We observe that the results are in good agreement with the standard values as tabulated in table 1 and corresponding graph is shown in figure 6. But though the instrument cost is less and the accurate with ± 0.1% some disadvantages are associated in the level measurement using float type sensor when the tank/container consists of corrosion liquids. Hence, further it is suggested and good practice to use other advanced techniques such as differential pressure sensors and ultrasonic sensors. The results are shown in Table 1 and the corresponding calibrated curve of Level measurement is shown in Graph 1.



Graph 1: Plot showing level measurement using float sensor.

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BIOGRAPHY

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