Advanced Research in Electrical and Electronic Engineering
p-ISSN: 2349-5804; e-ISSN: 2349-5812 Volume 2, Issue 12 July-September (2015) pp. 49-54

http://www.krishisanskriti.org/Publication.html

Design, Development and Implementation of Microcontroller based System for all Liquid Level Measurement

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Abstract—*The designed, developed and tested prototype system for accurate measurement of liquid-level based on the principle of change in electric potential with variation in the liquid level, the sensor is fabricated using precision type potentiometer highly sensitive to the change in liquid level is described in this paper. The sensor is attached to a rotary shaft through the wiper. When the liquid level rises, the shaft rotates which makes variations in the potentiometer resistance. The output of the sensor is connected to the signal conditioner circuit using OPAMP (LM324 IC) basically used for small signal amplifications and calibration. Any change in liquid level changes corresponding value in the resistance of the potentiometer and hence the output of the signal conditioner circuit changes. The analog to Digital Converter IC (ADC0804) interfaced with Atmel AT89S52 microcontroller (µC) is used to digitize the analog signal for further processing and calibration by controller. The Liquid Crystal Display (JHD162A) interfaced to the controller display the calibrated value of the liquid level in inch, which is found to be very accurate and it nearly matches with the value as measured manually by scale. The designed prototype is very cost effective, less complex in design with liquid level measurement independent to the properties of liquid viz. viscosity as designed sensor mounted on container top of the liquid and wide range operability having many industrial applications for the liquid level measurement.*

1. INTRODUCTION

In the present days, embedded systems have less manual operations, flexible, reliable and accurate. Due to this demand every field prefers automated systems especially in the field of electronics and electrical engineering. Liquid level monitoring is also very important as it has found various applications in domestic as well as industrial purpose like monitoring and controlling water level in reservoir tank, monitoring and controlling oil flow in oil pumps, level monitoring of milk and alcohol in food and beverage industries. The main objective of this project is to design a system with easily available components and basic available resources which enables the user to monitor the continuous level measurement of various liquids in LCD .Microcontroller based systems have gained wide popularity due to its accuracy, portability and fast responding and hence it is suitable for sensor based applications. The designed system is based on a mechanism in which the potentiometer acts as a sensing element and microcontroller 8051 is used for displaying the liquid level. This water level controller is one of the cheapest & simplest devices which prevent wastage of both electricity and water [1].Such module or circuit can be installed in big buildings where manual monitoring of tanks is difficult and its indicator can be placed at some centralized location [2].This device is a recording device with microcontroller as the core controller to monitor the water level. It can automatically monitor changes of liquid levels, automatically track and record change value and time every time the water table and groundwater level changes [3]. This device can replace the existing manual measurement, mechanical float record curve simulation method high precision, changes of groundwater level for each 1inch, automatic data collection and storage for one time [4].The system has high efficiency ,frequency and accuracy of observation is higher. The potentiometric sensor produces analog output and ADC is needed for its conversion. ADCs are designed in some processors for measurement and monitoring system [5]. Today's modern systems are digital with enhanced features that are programmed finely for automation.[6].All conventional ADCs work in linear manner and produce a digital output code directly proportional to the length of the section of the analog input signal that is sampled to be digitized. However, quantization error is inherited in all types of ADCs [7].

Related Works

Various kinds of work are going in the field of level measurement. The linear digital output proportional to the parameter can be sensed by differential capacitive sensors irrespective of the fact that the sensor could possess either a linear or an inverse characteristic. Previous attempts in the field resulted in digital converters that are suitable for capacitance-type sensors. But the problem is to obtain a measurable output relative to the parameter being sensed by a capacitive sensor, a signal-conditioning circuit that converts the variations in the sensor capacitances C1and C2 to a proportional analog voltage or current is required . Radar based sensors have the advantages of non-contact measurement, the transmission time is unaffected by ambient temperature and pressure fluctuations (can be used in closed tanks, where the liquid is turbulent and in the presence of obstructions and steam condensate), but license needs to be obtained, the internal piping and multiple reflections can cause erroneous readings, transmitter setup can be tedious and changes in the process environment can be problematic. Laser level sensors are used in vessels with numerous obstructions, accuracy level is higher (better than 1 mm) but the limitations are it is expensive and it sensitive to dirt and smoke in the vessel. Ultrasonic sensors are easy to install, have no moving parts, can measure corrosive and volatile liquids, and the measurement is non-contact. But it needs high power, accuracy is low and cannot operate in vacuum or high pressure applications. It is expensive and temperature correction is needed. The Displacers/Floats are only available technique for a cryogenic application, they are adaptable to wide variations in fluid densities but are used only for relatively clean fluids, installation cost is high, depends on the specific gravity of the liquid; Temperature correction is needed. Magnetostrictive Sensor has high level of accuracy, it is reliable and repeatable, has low maintenance cost and wide operating temperature range, has low and stable offset and low sensitivity to mechanical stress but it can work only if the auxiliary column and chamber walls are constructed by nonmagnetic material and the magnets must not be operated beyond their Curie point. Capacitance level transmitters are suitable for use in extreme condition, and only a single tank penetration is required. But large errors are caused by coatings, but only limited to water-like media, temperature correction is needed. RF Capacitance has wide range of process conditions and has no moving parts has only a single tank penetration, is easy to use, and is easy to clean. Special considerations are needed to minimize errors caused by probe movement and complex circuitry is needed. Differential Pressure Silicon Sensors are inexpensive, has wide range measurements, can be isolated safely from the process, measurements can be digitally networked for remote computer access and need power and require two vessel penetrations, depends on the density and the temperature of the liquid. Bubbler-type sensor is simple to design, has low initial purchase cost but is not suitable for use in non-vented vessels, used gas may affect the contents of the tank.

2. DETAILS OF THE PRESENT WORK

2.1 Physical framework

Fig. 1, shows the constructional details and working of the designed system. A linear potentiometer of 1 kΩ acts as the main sensing element, which is screwed to a clamp and rotated through a shaft made of thin metallic rod of around 5mm in thickness which is attached to a float made up of light weight plastic material. When the liquid level changes, the potentiometer gets rotated which causes variation in its resistance, the potentiometer terminal is connected to an amplifier. For digital processing the output is digitized by an Analog to Digital converter –ADC 0804 which is interfaced to a microcontroller 8051which further processes the input from the ADC and display the liquid level in inch in an LCD attached to it.

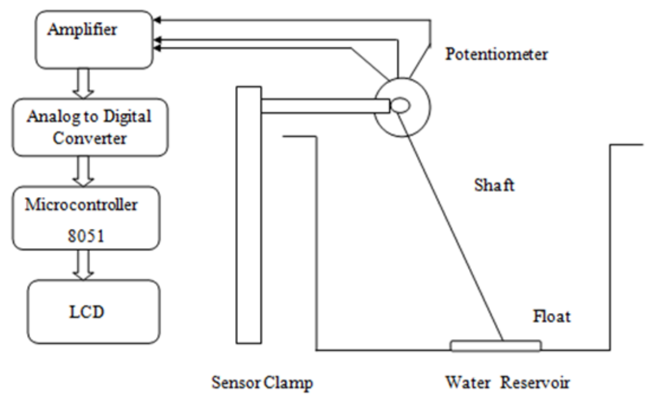

Fig. 1: Basic working principle of proposed system

2.2 Experimental Set-up & observations

The main objective of our proposed work is designing an electronic system to monitor liquid level of a miniature tank. A liquid level sensor using 8051 microcontroller that can be used to sense liquid level and monitor the liquid level in some display so as to prevent overflow and wastage of water and other liquids. Also designing an effective method of measuring the level of water or liquid from some other location. The microcontroller is programmed in such a way that it continuously displays the current liquid level. The source code is written in Assembly language and assembled using EDSIM51 cross-assembler. The generated Intel hex code is burnt into microcontroller AT89S52 using a suitable programmer named SUNROM. The software is well commented and easy to understand. The values and data are displayed on the LCD module.

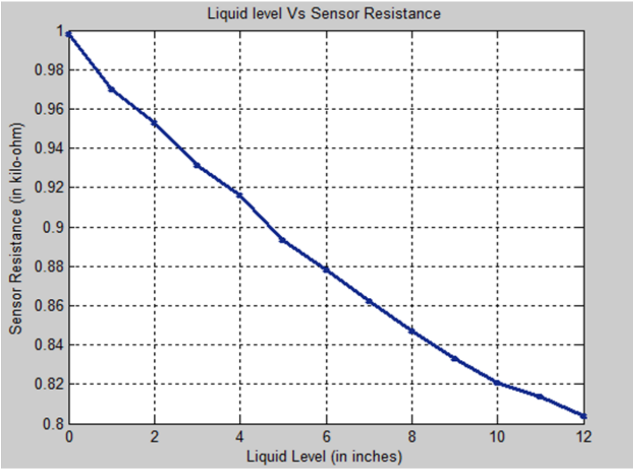

Fig. 2: Liquid Level Vs Sensor Resistance

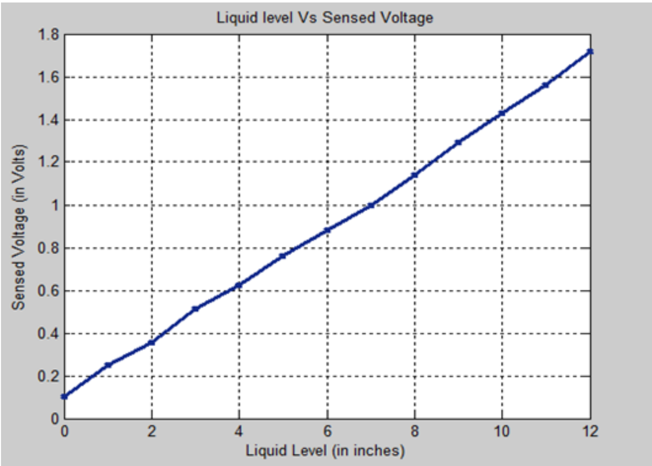

Fig. 3: Liquid Level Vs Sensed Voltage

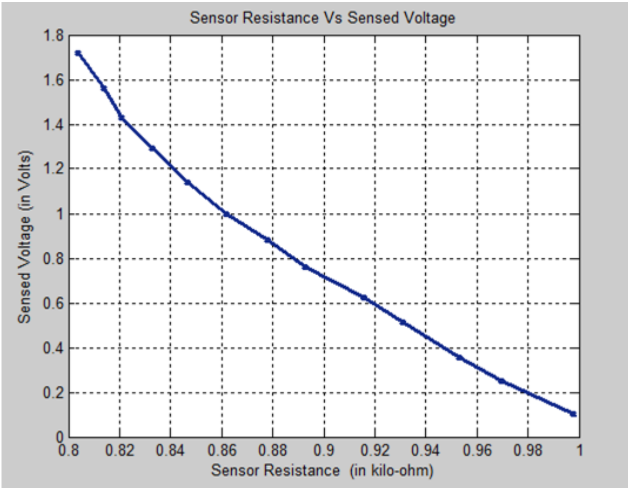

Fig. 4: Sensor Resistance Vs Sensed Voltage

The Sensed resistance and output voltage variation is linear with the variation in the liquid level. The resistance of the sensor decreases with increase in liquid level. At maximum height the resistance reaches its minimum value and maximum output is obtained using amplifier.

3. RESULT AND DISCUSSION

The proposed embedded system is designed and is working properly. With the rise in liquid level, the LCD displays the appropriate value in inches. Also when the liquid level goes down, the value displayed is correct.

One –fourth rotation of the potentiometer is used for the purpose of sensing thus the resistance variation with respect to the change in liquid level will be small. The corresponding output voltage is also small, so the gain of the amplifier must be properly selected to get desirable results. Precision in liquid level monitoring can be attained by using precision Potentiometer as sensor and Higher order Analog to Digital Converter. The float is not reactive with the kind of liquid, hence making the system independent of the density of liquid used. Only 3 ports of the microcontroller P1, P2 and P3 is used to serve the purpose and port P0 is kept unused as P0 requires external pull-up resistors.

4. FUTURE SCOPE

Further research can upgrade the system to a large extent. In future, it can be further modified by connecting alarm and thus we can get audio indication. The system performance can be improved by providing wireless operation and GSM control can be provided. A web based water level monitoring and controlling system can be designed, through which the system can be controlled from any place via internet even with different type of devices. The system performance can be enhanced by designing a sensing element specifically for the system.

5. CONCLUSION

Liquid level measurement systems can be done by various methods, one of such method is demonstrated in the above work. The system is designed with easily available components and the cost is very low. It is highly accurate and easy to calibrate. The accuracy of a system is very important in many sophisticated areas like industries and chemical plants, where the system must show accurate measurement. It can be used in widespread applications like in difficult to access overhead tanks, household tanks, oil refineries, in industries for sensing liquid level voltage and controlling, in many plants to ensure continuous power supply, in industries for automation process.

6. ACKNOWLEDGMENT

With the successful completion of the work authors want to acknowledge to the HoD of Department of Electronics and Communication Technology, Gauhati University.

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