Development of Water Level Monitoring System with Capacitive Sensor

X.Anitha Mary, Lina Rose, K.Rajasekaran

Abstract: ***Tanks are used to store water in households. Tamil Nadu faces a 40% water deficit currently. In which water tank overflow occupies 11% in this deficit. When we turn on the motor we are not aware of the water level present in the tank, we only realize after the tank over flows. Due to these incidences water is being wasted in large quantities every day in India. When there is an overflow of water from the tank algae is formed on the roof tops and also around the tanks, which when unnoticed degrades the tank material along with the building. Water leaks into the house through the damaged roof tops. The objective of the paper is to develop an efficient method to measure water level in a Sintex tank.***

Index Terms**:** ***capacitive sensor, Astable Multivibrator, XBEE, water level.***

I. INTRODUCTION

A water level controller is a device that manages water levels on a variety of systems such as water tanks, pumps and swimming pools. The basic function of a water level controller is to regulate water flow and optimize system performance, following are some conventionally used methods for fluid level measurement for a water tank – Floats, Hydrostatic Devices, Magnetic Level Gauges, Magnetostrictive Level Transmitter , Ultrasonic Level Transmitter, Laser Level Transmitter, Radar Level Transmitter. When domestic environment is concerned, cost is one of the important factor influencing the selection of methods. So it is necessary to come up with a design which is more cost effective and easy to install for a environment. Once the level is sensed, the electrical quantity has to be processed by a micro-controller and are transmitted and received by Wi-Fi modules to display it. Due to the digital support provided through this process the user decides, when to switch ON the motor based on the level sensor readings. This also helps in the conservation of electricity.

II. PRIOR RESEARCH

The liquid level measurements can be done in numerous methods such as inductive, capacitive, optical etc. The efficiency of each depends on the type of measurement system and the area in which monitoring is carried out. Measurement of liquid level has been Measurement of liquid level of a vessel has been developed widely. The measurement can even be made from the liquid parameters as permittivity, permeability, conductivity etc. The design and development of capacitive sensor also paved the way for such measurements cheap and robust. Often, capacitive sensors are referred as non contact sensors, and are categorized as reactive sensor whose output depends on the input frequency. Such sensors require special signal conditioning circuits in interfacing and converting the sensor parameters practically. Tremendous research works are being carried out on sensors for water level measurements across the globe. The area becomes more significant when the outcome of such research benefits the urban and rural remote areas who cannot afford the commercial sensors which are expensive. The previous work done by the authors [1],[5] was on level measurement in large wells and bore wells. The experiment was done using other parameter, pressure. Similarly there are many analyses done to conclude to a best sensor for such measurement. The research on development of capacitive sensor has been done by some researchers. The design and development of sensors by Jaims Bhatra [2] and Khaled Reza [3] guided the sensor development and microcontroller interfaces for measurement. Paczesny, et. al, conducted experiment in the capacitive sensor for liquid level measurement made with inkjet printing technology [11]. Furthermore, Wei, et. al, conducted a research in implementation and characterization of a femto-Farad capacitive sensor for pico-liter liquid monitoring [13] . The interfacing has also limitless alternatives for any senor or any measurement. The recent advances in IOT and embedded processors made the interfacing like a Childs play. Smart sensor for remote monitoring system using XBEE was proposed by Francisco m. lópez [6] and Seong Pem Lim [7].

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III. PROPOSED METHODOLOGY

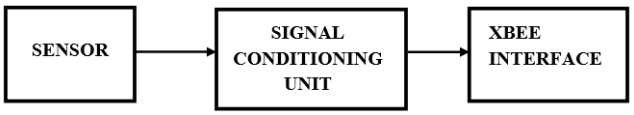

Figure 1 Proposed Block Diagram

The objective of the paper is to develop an efficient method to measure water level using capacitance. The sensor used is a Capacitance type whose capacitance output is converted into frequency using a 555Timer which is then processed and put up on a server accessible through the Wi-Fi Local Area Network. Figure 1 shows the block diagram of water level monitoring system at transmitter end. The placement of sensor in the tank is shown in figure 2.

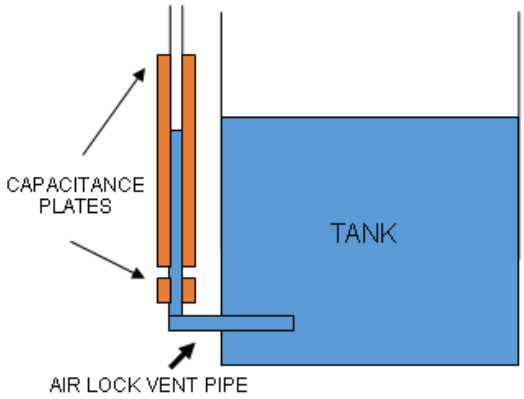

Figure 2 Capacitive sensor arrangement

The sensor works on the principle of capacitance. Two conducting plates are placed over the air lock vent pipe forming a parallel plate capacitor. When the fluid level in the tank varies the level in the pipe also varies. When the air is replaced by fluid, the dielectric medium changes and this in turn influences the capacitance of the parallel plate capacitor. The variation of the capacitance is given by[9]

$C = \varepsilon A / D$

Where,

C=Capacitance in Farads

Ɛ = Permitivity of dielectric (absolute,not relative)

A= Area of plate overlap in square meter

d= Distance between plates in meters

IV. SIGNAL CONDITIONING UNIT

The purpose of the signal conditioning circuit here is to convert the capacitance into frequency.

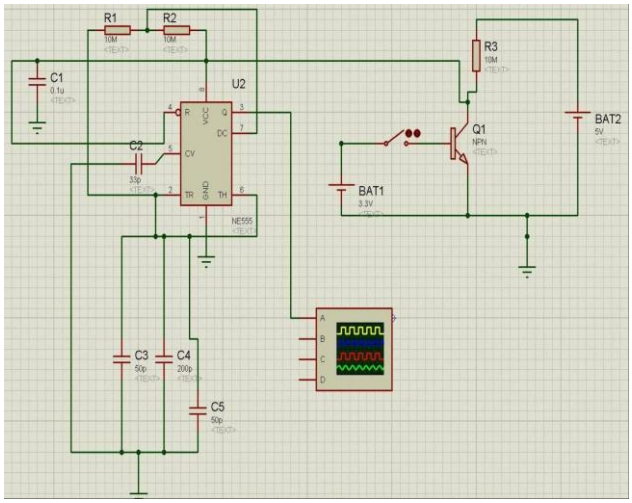

Figure 2: Pspice Simulation of the signal conditioning circuit

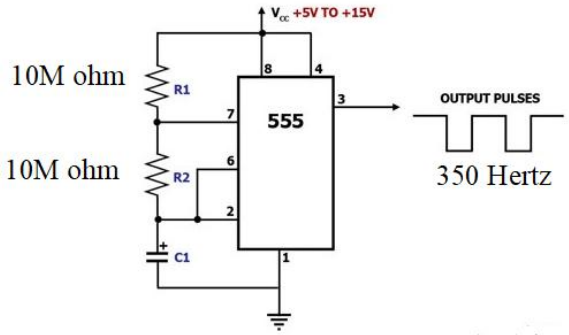

Figure 3: signal conditioning circuit for capacitance to frequency converter

Frequency is given by, $F = \frac{1.44}{(R_1 + 2R_2)C}$

The circuit used here is a 555 Timer in Astable multi-vibrator mode with the capacitive sensor connected as the timing capacitor of the multi-vibrator, there-fore creating an inverse relation between the capacitance and the generated frequency.

V. XBEE TRANSMISSION

XBee module accepts those data serially and is transmitted to its receiver section through a wireless based technology [2]. XBee comes under the family of RF modules wireless technology that found to be easy and cost-effective. The advantages of selecting a XBee communication module is that it allows multiple protocols and RF features. Xbee is one among radio communication protocols that enhance wireless data transfer. Xbee allows transmission on a long distance through its different the mesh and routing capabilities by passing the data between intermediate nodes if needed to transmit to more distant ones. The Xbee protocol defines three types of nodes: Coordinators, Routers and End Devices.

The only requirement for Xbee to work is of one Coordinator per network. Even if all nodes can send and receive data, the specific functions they do differ. Among the three node types - coordinators are the most capable ones. Each network consists of coordinators which establish the network originally. A coordinator also stores information about the network, such as security keys. This cannot go idle or sleep mode but because it is the coordinator that should store the packets for end device nodes[4].

S No.	Level(cm)	Capacitance pF
1	1	22
2	2	24
3	3	25
4	4	26
5	5	28
6	6	29
7	7	30
8	8	30
9	9	31
10	10	32

Data from other devices are relayed by the routers which act as the intermediate nodes. Similar to coordinators routers also cannot be battery powered or sleep mode when working with coordinators. Routers can connect to other devices and with the coordinators, should also store the packets for end devices [3,5]. The extension of networks cannot be done by coordinators even if they are present in the node. This task is done by the router.

End devices may be sensors or output devices which are mostly battery powered devices. In this case, HyperTerminal in PC which is a battery powered device act as storage of information from the sensor connected via Xbee. The end devices cannot retrieve data directly from other devices, but are permitted to talk/communicate with parent devices only as coordinators and routers [6]. This will reduce the cost because of its reduction in functionality[7,8].

VI. RESULTS AND DISCUSSIONS

Figure 4: Experimental setup with capacitive sensor arrangement

Figure 4 shows the proposed setup to find the water level using capacitive arrangement. By varying the water level, the capacitance value are measured and converted into frequency using astable multivibrator. The value of R1 and R2 are chosen to be 10 MΩ. the capacitance obtained from the tank Table 1: water level Vs Capacitance are connected to the experimental setup thereby frequency is obtained. The frequency is obtained using oscilloscope and thereby calibration is done with capactive value and water level as shown in Table 1. The following observations were found after the result.

1) Precise parallel placing is required.

2) More effort required in gluing the plates.

3) After the water is drained, the water on the walls of the pipe affects the capacitance between the plates.

4)The plates are fragile and are vulnerable to damages.

VII. CONCLUSION

The objective of this work is to provide an efficient method to reduce the wastage of water and to monitor the level of a tank wirelessly. This concept provides the flexibility to adapt and extend as needs change. The working model was implemented using controller and transmitted wirelessly through ZigBee protocol. The level of various tanks can be measured at the same time with ease using this technique. This method can be implemented in places where more tanks are to be measured simultaneously. The same concept can be implemented in sintex tank as future work.

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