Design and Implementation of Water pump Automation system

Thesis/Project Group # 41

Rajib, Dey	*(10-17225-2)*
Sudipto, Roy	*(10-17252-2)*
Chowdhury Mohammed , Riajul Islam	*(10-16258-1)*
Aditi Anika Wardia	*(10-15542-1)*

Kamrul Hassan

Lecturer, Faculty of Engineering

American International University - Bangladesh

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Rajib Dey , Sudipto Roy , Mohammed Riajul Islam Chowdhury , Aditi Anika Wardia

***Abstract* — Water is one of our most valuable resources. The importance of water in our daily life can not be emphasized enough. Water scarcity is the serious issue in major cities. Wasting of this resource is not acceptable in any way. It is a common problem which is faced by every house owner, that when his tank is empty he has to switch on the motor and switch the motor off when it is full. Every day the water tank on our roof-top over flows and wastes 10-20 or more liters of water before we switch the water pump off. That is why an efficient way to pump the water from the water supply line to the roof-top tank of ours is needed. Due to the busy life it is common that the tank usually overflows without notice. One has to keep on observing his tank water level to switch off the motor once it is switched on. And sometimes this also can happen that the motor coil burns because of absence of water in the sump. So these are the everyday problem that motivated us in coming up with an affordable, automatic water level control system that doesn't need any attention once it is installed.**

In this paper we have discussed about design and implementation of water level control system which is microcontroller based, automatic, cost effective and a reliable system. It uses an Ultrasonic Distance Sensor along with a motor controller circuit which is installed at the tank. Ultrasonic Distance Sensor is basically a transceiver is used for detecting the water level in the water tank. It is completely automated with the help of a microcontroller. Also it doesn't touch the water and stays atleast a few inches over it , so there is no chance of any kind of germ contamination from the sensor to the water or any kind of damage to the device itself due to it being submerged in the water . While creating this project we took special care so that the sensor and the device never touches the water , that is why we programmed the device to turn the motor off when the water in the tank reaches 90% . We also took care that for no period of time the user should feel that there is scarcity of water in the tank , that is why we have programmed the microcontroller to turn the motor on when the water level decreases below 10%.So this means , after someone is done installing the device on their rooftop tank he/she can literally forget about this.It will work on it's own till the power to the device is there.

***Index Terms*— Water pump automation , sonar sensor , microcontroller , LCD , Relay , measuring height.**

I. INTRODUCTION

Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories and other applications with minimal or reduced human intervention.

The biggest benefit of automation is that it saves labor. However, it is also used to save energy and materials and to improve quality, accuracy and precision.

Water pump automation system is the technology of automatically collecting status data from the water tank metering devices and transferring that data to a water pump controlling system. Which will turn the motor on or off depending upon the water level in the tank. This technology mainly saves the hassle to physically check the water tank on our roof-top and turn the water-pump on/off , which in addition helps us avoid wastage of water.

This project is about the design and implementation of Water pump automation system. Water is an essential resource for all living things. The importance of an effective and efficient water pumping system cannot be over emphasized. This is very critical as non-efficient water pump system can lead to substantial loss of water and electricity also. Thus, it is essential to have an efficient and effective water pump automation system.

II. OBJECTIVES

The aim of this project was to Design and Implementation of Water pump automation system which is

- Produced using locally available components and resources: This is essential for making it feasible for manufacturing by local firms.
- Reliable and cost efficient in long term: The proposed design may require a larger initial investment but would save money in the long run if additional features are added.
- Immune to tampering: If the device is not immune to tampering then it's longevity will be greatly hampered.
- Marketable: Water pump automation system is not a project of academic interest only. It is something that we really need today. So, it is very practical and can be immediately deployed in the real world..

III. BASIC PRINCIPLE OF THE PROJECT AND DESIGN

In our project the inbuilt automated water height measuring system powered by ultrasonic distance sensor monitors the water height in the tank. The Microcontroller displays the water height (In Inches) in the LCD and while the water height changes in the tank it then displays the water height in percentage also. According to this percentage value of the height of the water, the Microcontroller drives the motor on/off through a relay.

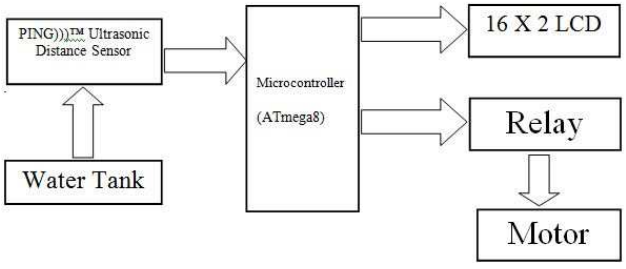

Figure: Block Diagram of Water Pump Automation System

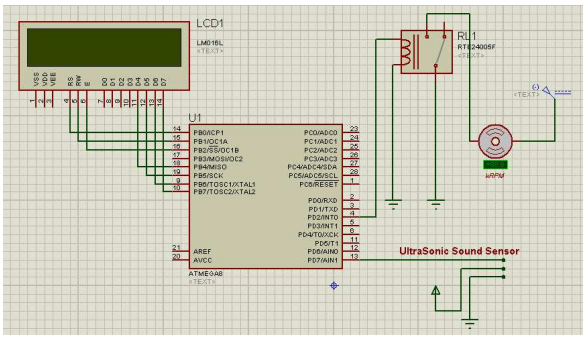

Figure : Circuit Diagram of Water Pump Automation System

Figure: Physical appearance of the Water pump automation system

IV. PROJECT IMPLEMENTATION

In this project we place the ultrasonic distance sensor right on top of the water tank. This ultrasonic distance sensor emits a 40 kHz (ultrasonic) burst. This burst travels through the air at about 1130 feet (13560 Inch) per second, hits an object and then bounces back to the sensor. The PING))) sensor provides an output pulse to the host that will terminate when the echo is detected, hence the width of this pulse corresponds to the distance to the target. The generally accepted value for the speed-of-sound is 1130 feet per second. This works out to 13,560 inches per second or 1 inch in 73.746 microseconds.[1]

A. Measuring the height

When the sensor starts transmitting then the sonar sensor sends a “high” to the microcontroller. While the ultrasonic wave is bounced back to the receiver part of the sonar sensor then the sensor makes this “high” signal into a “low” one. The microcontroller calculates the time between this one high and low pulse . But this whole time is for the ultrasonic wave to travel twice the distance of the water height in the tank. That is why we divide this time by two. We are calling this time as Elapsed time. If we divide this elapsed time by 73.74 then we will get the height in Inch. We have to remember that , all our calculations here is done in microseconds and inches.

B. Setting up the project for one particular water tank

When we are done with measuring the tank height (empty water tank) in inches then we will save this value onto an EEPROM by pressing the store button and after this the LCD will display the sentence “Data Stored”. So that if there is a load shedding or the power goes off due to some reason then we won’t have to measure the tank height again and again. So, basically we are fixing one set of this project for one water tank at a time. We can use one set of this project in many water tanks , but at first we have to do the measuring and saving the empty water tank height to the EEPROM first.

After this the LCD will display the tank height in the first column right after the text “Water Level”

C. Measuring the water height

To measure the water height all the procedures described in A is followed. After this the water height is displayed in the LCD in the second column, and after that the percentage value of the water height according to the tank height is displayed. To calculate the percentage value we used the following simple equation:

$$Percantage\ value = \frac{Water\ Height}{Tank\ Height} \times 100\%$$

D. Making the relay on/off

Through microcontroller we have programmed the microcontroller to switch the relay on when the water height goes down below 10% and switch the relay off when the water height is above 90% . We are switching the relay off at 90% and not when the tank is 100% full to save our sensor and the circuit which will be in the tank itself.

V. RESULT ANALYSIS

We tested the project in rooftop water tanks and it worked just fine. Here is a demonstration of the project on a plain floor, which will represent the water surface in the water

tank.

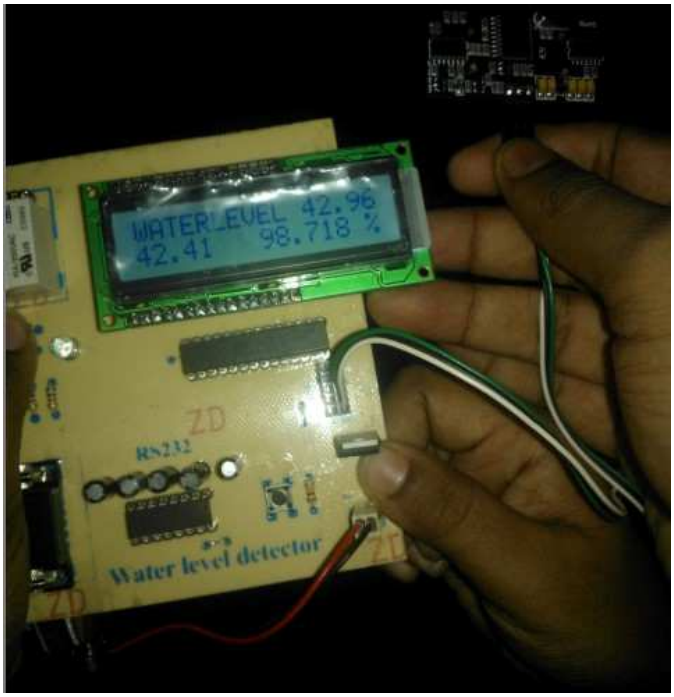

Figure: An almost empty Water tank

This represent an almost empty tank , which is 98.718% empty. The tank height is shown on the top right (in inches). The percentage value is shown in the bottom right corner.

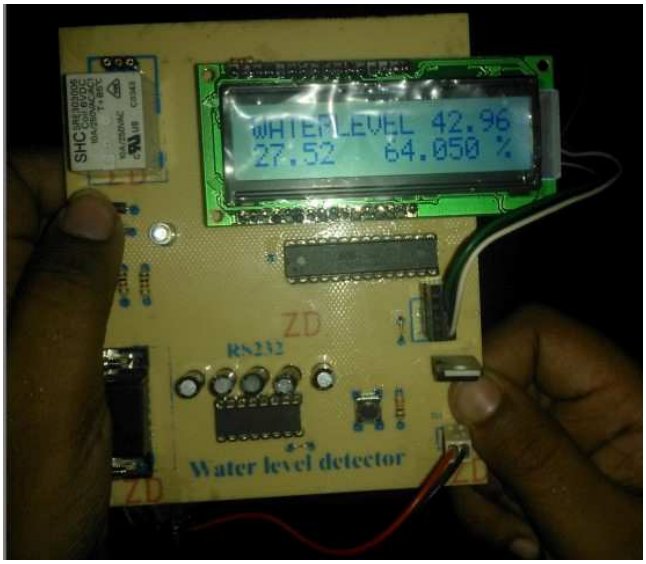

Figure: A semi-filled Water tank

After a few minutes the water will fill the water tank a bit. This represents a semi-filled water tank. Which is 64.050% empty.

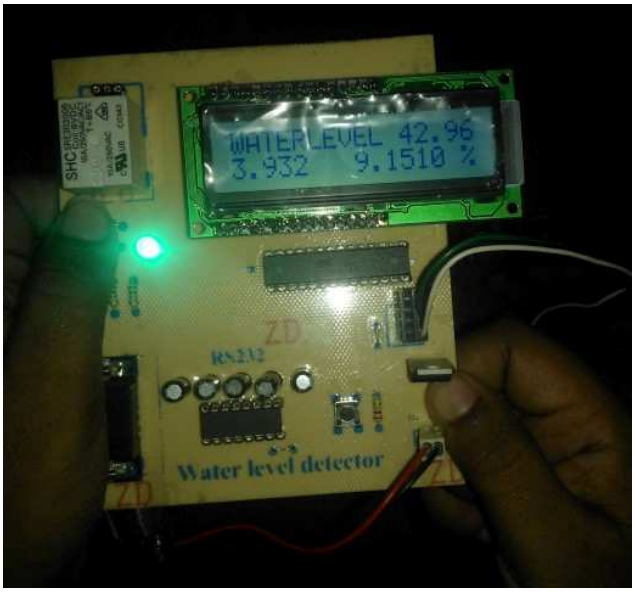

Figure: An almost filled Water tank

And at last , this represents an almost filled water tank with only 9.1510% left to fill. By the microprocessor we have coded the relay to turn the water pump off when it's 90%+ full. That is why we can see the Green LED light turning on, which indicates that the Motor is OFF.

	Tank Height (Inch)	Current height value (Inch)	Water Height (Tank Height – Current value) (Inch)	Percentage value (How much of the tank is empty)	Machine ON or OFF
1.	42.96	42.41	0.55	98.718%	**ON**
2.	42.96	27.52	15.44	64.050%	**ON**
3.	42.96	3.932	39.028	9.1510%	**OFF**

VI. Discussion and Future Work

A. Discussion

Since the inception of motor, we have invented new ways to use this device to meet various kinds of our needs. Pumping water from ground or other sources is one of them. As this technology is getting cheaper and cheaper day by day almost every single house will have one of this to pump water onto their rooftop tank. But most of the time we can see these rooftop water tanks is overflowing and water is being wasted. Water is one of the precious natural resource we find without paying anything. It is our duty to protect this resource for our

future generation .As so many people have predicted that next world war might just be a “Water War” between nations.

The typical water pump system in our household is very old and time consuming. This project of our is hassle free after the installation and can be operated without any human intervention except when the battery (power source) needs a changing.

B. Future Work

Now we are working to improve our technology. In future we want to add some extra features like –

1) Auto and Manual start:

Sometimes for some reasons we might need to stop the circuit and need to manually start the motor. That is why we want to include this features where the user will have the option to choose between Auto and Manual start.

2) Wireless Sensor:

To avoid connecting the sensor and microcontroller part with the relay with a long wire (which will be very long in high rise buildings) we want to include wireless sensor feature in our project. In this feature, the sensor and the microcontroller part in the rooftop water tank will be connected to the relay wirelessly . We can use GSM , ZigBee Network or RF Network . In these three modes RF network will be the cheapest but less reliable , where ZigBee network will be a bit costly and the best possible way to do it as this uses microwave network and creates an wireless ad hoc network around (10-100 Meters) it.[18]

3) For reserve tank or Multiple tanks:

For reserve tank we need 2 Ultrasonic sensor in the circuit. If in case we have a multiple tank setup then we will need multiple Ultrasonic sensors added to the circuit. One single Atmega8 microcontroller can accommodate upto 5 ultrasonic distance sensor.

4) For Multiple Motors:

For multiple motor setting we will need multiple single phase motor driver circuit. One single Atmega8 microcontroller can accommodate upto 5 SPDT (Single pole double Throw) Relay.

VII. Benefits and Limitations

A. Benefits

The benefits of this projects are –

- Saves water
- Saves time
- No need of any human intervention for a long time after the installation
- Saves Electricity by switching the motor off at the correct time
- Helps preventing a mess by stopping the overflow of water

B. Limitations:

This project of ours is a prototype. It can measure the water height in the water tank and display it in the LCD along with the percentage value perfectly but to connect an actual motor with the motor driver circuit we need to add the following things to the circuit :

- Low Voltage Protection Circuit
- Surge Protection Circuit

This project of ours shows a wide range of inaccuracy when we put the sensor into small water tanker/pots ranging below 20 Inches. Due to the extra echoes it gets from the very near walls of the tanker/pots. If the tank/pot is very narrow then also the senor gets confused by the extra echoes. So we can not put this sensor in those kinds of tanker or pots . But it works very well in typical 2000 Liters tank that most of the households have in their rooftop.

The ultrasonic sensor available in the market is not that efficient, if we want to increase our accuracy then we need to use more efficient sensor. Which will be a bit too costly but will give very accurate readings of the water height in the water tank.

VIII. Conclusion

Water is one of the most important basic needs for all living beings. But unfortunately a huge amount of water is being wasted by uncontrolled use. Some other automated water level monitoring system is also offered so far but most of the method has some shortness in practice. We tried to overcome these problems and implemented an efficient automated water level monitoring and controlling system. Our intension in this project was to establish a flexible, economical and easy configurable system which can solve our water losing problem. We have used a low cost ATmega8 microcontroller and Ultrasonic sensor in this system which is the key point to reduce cost.

We have successfully experiment the system and analyzed the results. The microcontroller-based water pump automation system provided a very satisfactory performance with a minimal percentage of error. Using this automation system, one can save manpower. This could have a substantial benefit from this project for efficient management of water.

We have used a low cost ATmega8 microcontroller and Ultrasonic sensor in this system along with different

component. PCB plays an integrated part to compact the whole system which make the. system more reliable and portable. All other automation on water pump system does not always reflect the proper water level detection and lagged when switching the water pump. But we successfully overcome all the obstrucle in our project water pump automation

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