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Design, Construction and Implementation of a Household Water Tank Monitoring System: A Wireless and GUI Based Approach

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Abstract—*Water is a very essential element for the survival of Human race as well as all living creatures of the world. Now a days, Specially in major cities of the world are facing the scarcity of water. Wastage of water during transmission has been considered as a major culprit for this situation. In This paper we try to introduce a effective barrier to this wastage by designing & implementing a automatic water level monitoring system which not only ensure reducing financial expenses & home power consumptions but also ensures the effective use of natural drinking water. In our research we tried to design a cost effective & fully automatic/manual control system for household water tank. The sensors used are based on the principle of electric conductivity of water. We investigate our research by implementing a microcontroller processing unit to detect the level of the water & automate the water by switching on/off the required set of pumps and also used a wireless environment to communicate with a remote computer where the status are displayed & controlled accordingly on a visual basic GUI platform.*

Keywords*: Atmel microcontroller, conductivity, water pump, visual basic, GUI platform.*

1. INTRODUCTION

Sustainably managing our water infrastructure is one of the biggest challenges facing the water sector and is essential to protecting human health. Growing pressure on water resources from population and economic growth, climate change, pollution, and other challenges has major impacts on our social, economic, and environmental well-being. Due to over-pumping, many of our natural aquifers are affected causing the ground water level down. 2/3 of the world's wetlands have been lost to development. Moreover the issue is going more worsen day by day due to inefficient use of water and lack of proper water management of our daily life. It is in our hands to ensure whether our children and their children inherit the same world. Therefore efficient use and minimum wastage of water should be our prime objective.

Most of the households of small towns even many of our cities do not have proper water monitoring system for their water preservers. The common method they use is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank. Due to lack of adequate warning or sensing the water level reaching the highest level, these method are inefficient sometimes causing a huge wastage of water. Here In this paper a very cheap and adequate method of monitoring is introduced. It provides a wireless and programmatic based approach of sensing and automation of water levels.

The works of this paper is mainly divided by the following ways. Chapter two mainly concentrated on the basic ideas and building blocks of the design. Working principle and methodology is described in chapter three. Chapter four and chapter five included the proposed design framework and conclusion respectively.

2. BASIC IDEAS & BUILDING BLOCKS

The overall designed system consists of two main modules: first is system unit which consists of level indicator, level sensor unit, processor unit, Water Pump Controlling unit & a wireless modem and second is a visual basic GUI interface for information display and remote controlling of the first unit. The overall block presentation is as shown in the Fig. [1].

A. Level indicator

Eight different colour LEDs are used for showing eight different discrete level of water. It will indicate the levels following a feedback from the sensor unit.

B. Level indicator unit

The sensors used here are basically conductive sensors and considered very simple corrosion free water level indicator for home and industries. The unit consists of a switching transistor 2N2222 and a small resistor. The transistor is switched on to drive the corresponding LED, when its base is supplied with current through the water through a electric conducting material.

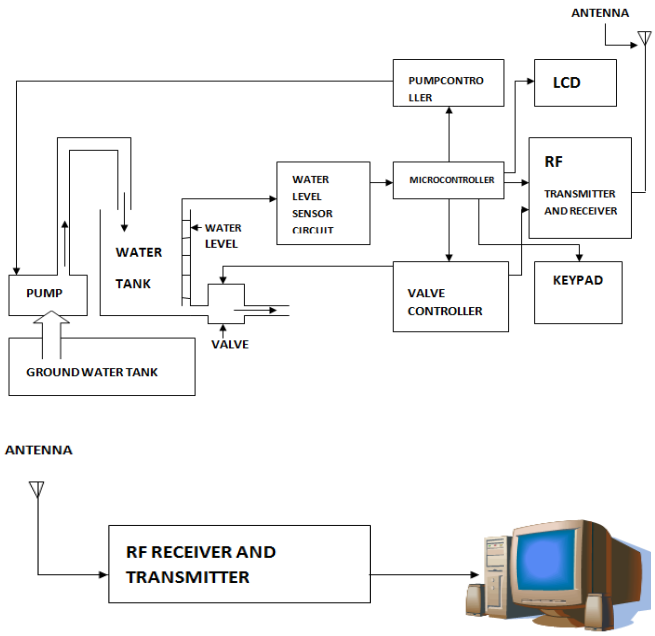

Fig. 1: system unit & GUI display unit.

C. *The Processor unit*

A very basic ATMEL family microcontroller is used here as a processing unit as it fulfilled the requirement of low cost implementation of the system. AT89C51microcontroller is consists of timers, analog to digital converter and USART module inside its own chip. Therefore no other external components are needed for its application and it's a natural choice of the designers.

D. *Pump control unit*

Water pumps controlling unit is connected to the output ports of the microcontroller. It basically consists of relay driver circuit is used here to control the externally connected water pump and the flow control valve. When the transceiver in the remote unit receives a signal regarding the operation of the pump or the valve, the controller operates the relay circuit to switch the pump or the valve on or off to control the water level.

E. *Wireless modem*

The RF modem is used here to wirelessly transmit the reading of the water level to the remote computer within an approximate range of (30-50) meters. The RF modem or the transceiver is capable of both transmitting and receiving. . Here in our project we use FSK modulation which gives us a frequency bandwidth of 2.4 GHz. The model of the RF modem we are using is CC2500.

3. WORKING PRINCIPLE & METHODOLOGY

The designed architecture cab be divided by two parts.

A. *System Architecture*

Invention of Microcontrollers has changed the modern era of electronics. From many years they are used in control and automation engineering. Here also we used a atmel microcontroller to reduce the system complexity and smooth automation process. The first stage of the design is concentrated on sensing the water levels of both ground water reserver and main upper water tank. Microcontroller analyses and processes the feedback provided by these sensors and accordingly on/off the water pumps to maintain the required level of water in the tank. The whole design flowchart is shown in the Fig. [2] below.

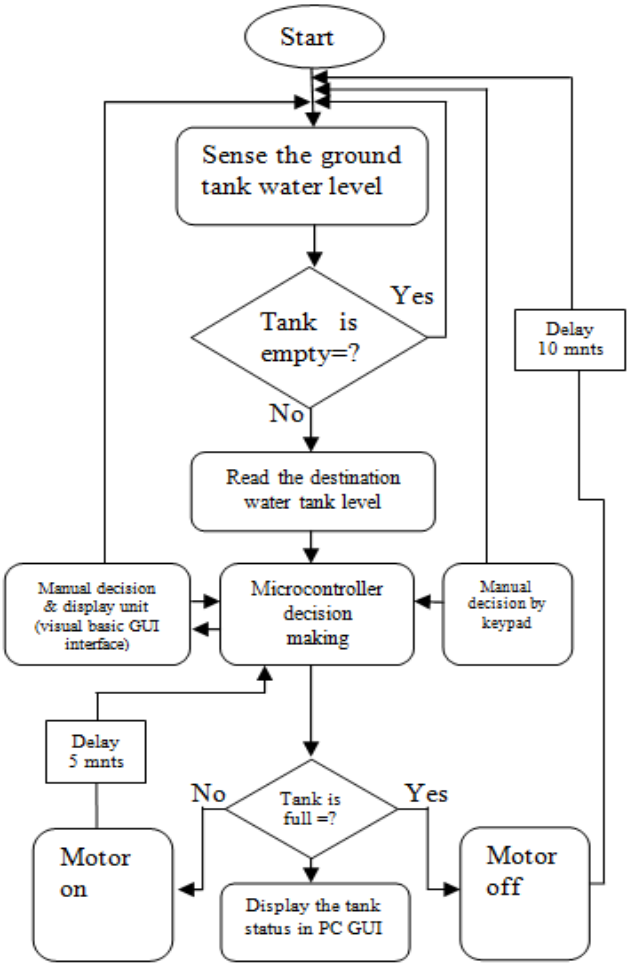

Fig. 2: Flowchart of the design

B. *System Description*

Here we used two different level sensors. First sensor is placed in the bottom of the ground water reserver tank to gather the information of stored water. Second set of eight sensors are placed at different positions of heights of the upper water tank. All the sensors are conductive sensors made locally with eight copper plates tied up in a line in different positions on a plastic

PVC stick. The first copper plate is with 5v ac supply is placed at the bottom of the tank. Next plates are arranged step by step above bottom plate. When water is raising the base of each transistor gets electrical connection to 5V AC through water and the corresponding plates; which in turn makes the transistors to conduct to glow the level indicating LEDs.

The control operation water pump is controlled by the processor and a pump driving circuit. Water pump is connected with an output pin of microcontroller via a relay driving circuit which is connected with a transistor [3]. Another relay is used to controlling the valve. Emitter of the relay driving circuit is connected to ground and collector is connected to the relay unit.

With no voltage or input current applied to the transistor's base lead connected in pin no 16 of the microcontroller, the transistor's emitter-to-collector channel is open, hence blocking current flow through the relay's coil and the pump motor is in OFF -position. However, if sufficient voltage and input current are applied to the base lead, the transistor's emitter-to-collector channel will open, allowing current to flow through the relay's coil causing motor pump in ON-position.

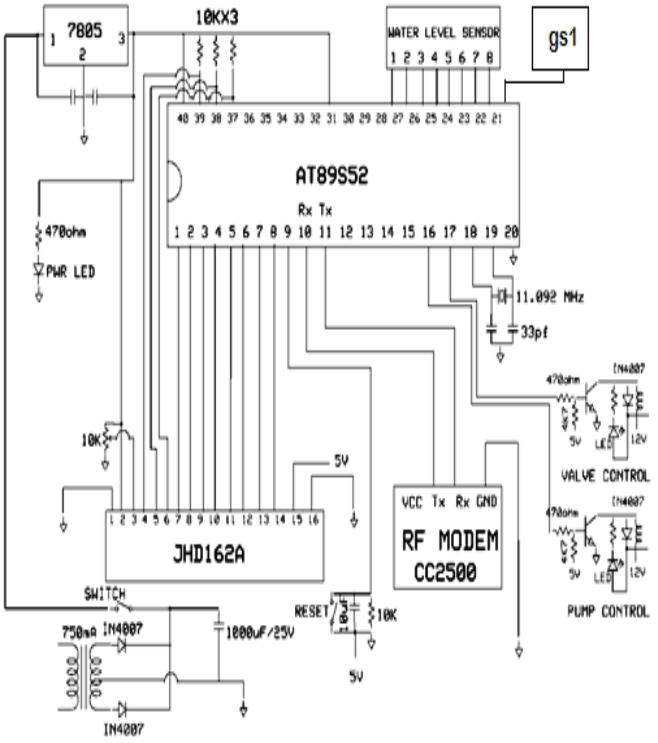

Fig. 3: complete circuit diagram

To implement the system we should connect the necessary circuit components of AT89S52 microcontroller. Alternating current is converted to a 5V regulated dc to feed the processor unit. Pin 21-28 are used getting the data from the sensors to the microcontroller. A 16x2 on board LCD is also used to observe the tank status locally as shown in the Fig. [4].

Fig. 4: On board water level display

LCD displays tank empty status When non of the conductive copper plate sensors of the upper water tank touches the water level and level 0,1,2,3,4,5,6,7 are attained based on water level accordingly.

Now we introduce some intelligence in the analyzing & processing part of the design. When ground water level sensor **gs1** connecting pin no 21 senses a ground (0V) signal the processor continuously keep wait & check method to fill the ground reserver. When it senses a +V signal it means the reserver have sufficient water and checks the upper tank water status through water level sensors connected from pin 22-28 as shown [3] . Again here also sensing mechanism is remain the same and processor activates motor pump only when it detects a zero in the bottom sensor of the upper tank. If we found highest level sensor pin no 22 detects a +5V , processor considers as the tank is full and motor remains a OFF state. Therefore depending upon the acquired sensor data processor automatically controls the pump and displays the water level status on LCD. The operation can also be stopped /On/resumed manually at any point of time with the help of some predefined keys of the keypad connected.

Now, the installed wireless RF module helps to communicate with the remote PC. The RF modem is used here to establish wireless transmission of the reading of the water level to the remote computer within an approximate range of (30-50) meters. This RF modem or the transceiver is capable of both transmitting and receiving mode of operation.

Lastly, a printed circuit board (PCB) of the entire board circuit is prepared. This made the assembly more compact and efficient. We took the help of Express PCB to design the layout of the entire circuit (refer Fig. [5]).

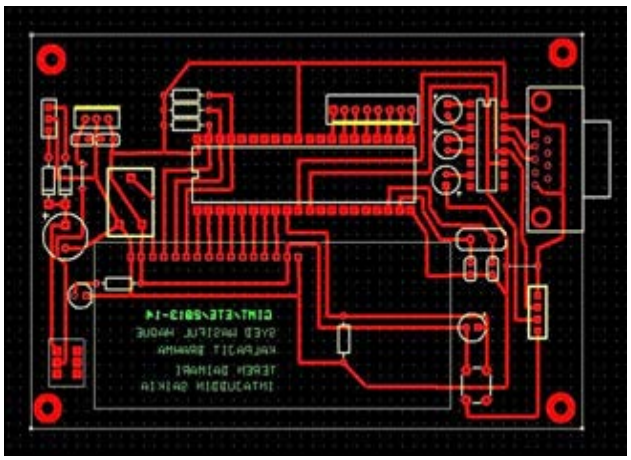

Fig. 5: PCB implementation of entire circuit.

C. Software implementation

The main firmware, we used to control the entire process is developed in MikroC pro-environment, a advanced C compiler for 8051 family. The whole program is written in embedded C language. We also developed a visual basic GUI environment, adding more comfort & flexibility to the design. Visual Basic is the first programming language to design program for WINDOWS environment hence it is the most mature programming language for WINDOWS environment. At the same time it has many components in library to develop professional application for business and other fields. It is act as a interface of communication between remote PC and the processor. Here we can observe the real time tank water level & motor ON/OFF status in a graphical way . Below are some of the screenshots of the graphical user interface, showing different levels of the liquid[5].

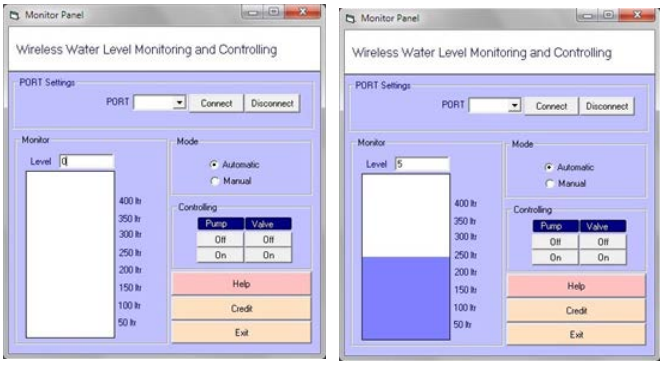

Fig. 5: Developed GUI interface

GUI starts working as soon as connecting it to the processor through wireless serial port. We can also control the processor manually by selecting the manual option. So, The level of water can finally be monitored on the computer screen and simultaneously control the level & water motor both manually or automatically.

4. CONCLUSION

The water is a very important element for human life. But unfortunately a huge amount of water is being wasted every day. Lack of proper water management system is considered as one of the prime cause of this wastage. It becomes very irritating nowadays to monitor the level of water in the tank and thereby refill periodically as most of us has become very busy in our day to day life. So we tried to overcome this deadlock and designed a efficient water management system. In our design we mainly focused on some key aspects like flexibility, cost effectiveness and easy accessibility etc. As we used RF wireless communication; system range is limited up to only 30 meters. For this reason the remote display unit always need to set within a closed range less than 30 meters. Therefore we can say this system is designed to suit a complete household requirement rather than commercial use.

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