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Wireless Automatic Water Level Control using Radio Frequency Communication.

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ABSTRACT: Water scarcity is the serious issue in major cities. 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. 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, wireless 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 wireless, automatic, cost effective and reliable. It uses two Radio Frequency transceivers along with a controller each installed at the tank and sump. Radio Frequency transceivers are used for wireless communication. It is completely automated with the help of a micro controller. The system doesn't need any attention of the user unless the sump is empty. Installation cost is reduced since the system is wireless. It is reliable because it has no problems arising after installation such as breakage of wire [4].

Keywords: **Radio Frequency (RF), Acknowledgement (ACK), Global System for Mobile Communications (GSM), Graphical User Interface (GUI), Ultra High Frequency (UHF), General Packet Radio Service (GPRS).**

I. INTRODUCTION

Sustainability of available water resource in many region of the world is now a dominant issue. This problem is quietly related to poor water allocation, inefficient use, and lack of adequate and integrated water management. Water is commonly used for agriculture, industry, and domestic consumption. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. In the last few decades several monitoring systems integrated with water level detection have been accepted. Measuring water level is an essential task for government and residence perspective. It would be possible to track the actual implementation of such initiatives with integration of various controlling activities. Therefore, water controlling system implementation makes potential significance in home applications.

In this paper we discuss about automatic water level sensing and controlling with wireless communication between controllers placed at the tank and the sump. So the system basically operated with two controllers and RF transceiver modules. The Part II and III of the paper briefly discusses about the design and working of the system.

There are some literatures that survey water level control and automation systems. Also, there are some papers that overview and compare the current techniques in this area. The paper introduces the notion of water level monitoring and management within the context of electrical conductivity of the water. More specifically, it explains about the microcontroller based water level sensing and controlling in a wired environment. Water Level management approach would help in reducing the home power consumption and as well as water overflow. Finally, they have proposed a web and cellular based monitoring service protocol that would determine and sense water level globally [1].

In the next paper the micro controller based wireless, GSM based water level indicator is explained. Paper says that advances in communication technology, made new trends to emerge in monitoring system. The most popular standard forobile phones in the world are Global System for Mobile Communication (GSM). The smart water level indicator is presented by the paper. It discusses about the monitoring system to monitor the changes of water level from time to time and directly send an alert to user via GSM cellular network immediately. This paper comprises of three parts, which is the main part comprising the development of the system that is capable to detect water level using microcontroller. The microcontroller is the 'brain' of the system which is responsible of processing network protocol, which comprises of transmitting packets and receiving packets. The second part is the development of the system that can process the data that has been collected based on the deepness of water level. The last part is the system, which modulates the signal that has been collected and it will transmit the modulated signal via an antenna. Then, the signal

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will be received by the receiver to be displayed on the Graphical User Interface (GUI). Overall, the system design comprises of hardware design and software development [2].

The next paper is wireless sensor network in irrigation area automatic system. The system is based on the UHF transceiver for wireless data communication. It consist three nodes. Sensor node, the sink node and the information center. The sensor node is responsible for gathering the water-level, the gate position and the rainfall information. The sink node is responsible for receiving the data transmitted from each sensor node, and real-time uploading to the information center through GPRS network. The information center is responsible for receiving the data, and providing to the terminal user to visit. The traditional irrigation area automatic system mostly uses the wire to connect the water-level, rainfall and gate position sensors and the data acquisition to transmit the hydrographic information. But in the wireless system there is no complex wiring, wire damage, and the cost in installment and maintenance is less. So it enhances the system's reliability and extension [3].

II. BLOCK DIAGRAM DESRIPTION

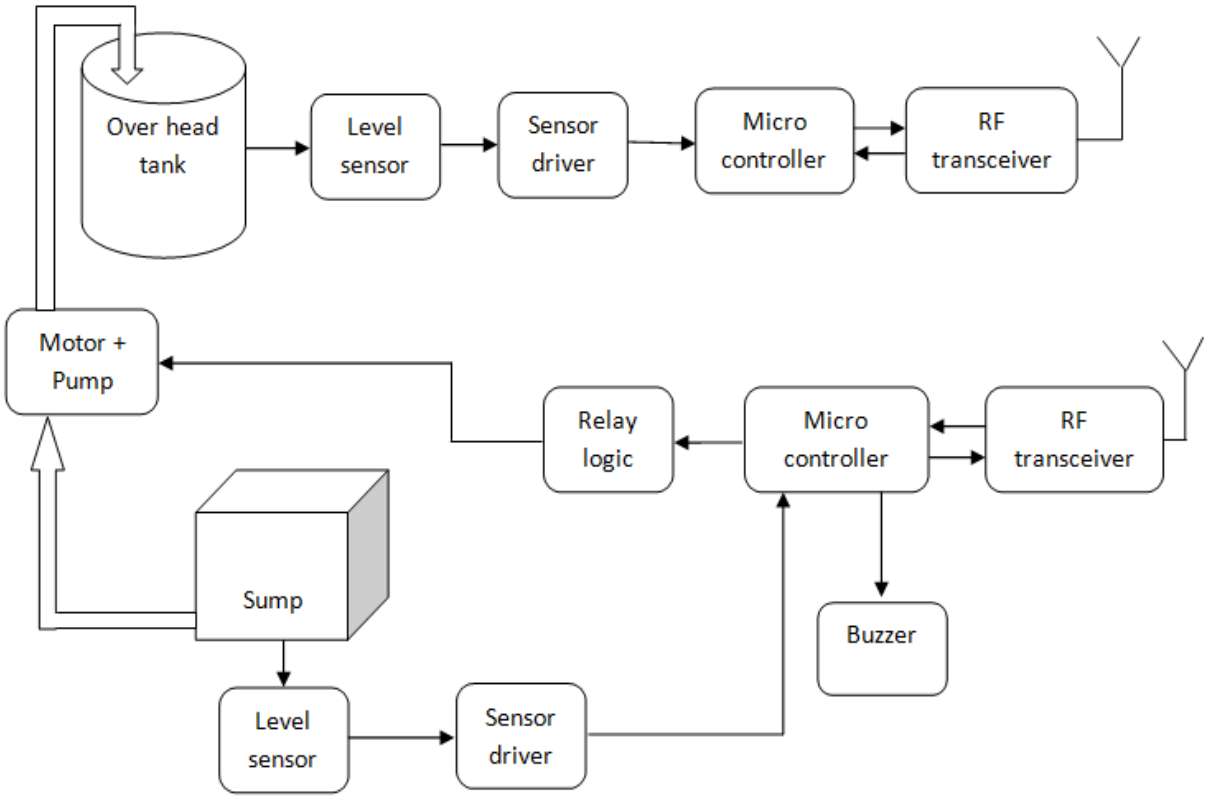

Fig1. Block diagram of wireless water level control system

In this section we discuss about the design of our proposed system "wireless automatic water level control system". The block diagram describes about two main sections of the system, transmitting section and Receiving section. Transmitting section has a level sensor, a sensor driver circuit, a microcontroller, RF transceiver module and an antenna.

The receiving section consists of a level sensor, sensor driver, buzzer, relay logic, microcontroller, motor, pump, RF transceiver and an antenna.

A. Level Sensor

The level is sensed with a conducting metal strip. It works on the principle of electrical conducting property of water. When a signal is sensed by the level detector, it is fed to the microcontroller through a driver for further action. In the receiving end level sensor is installed in the sump to sense the presence of water in the sump.

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B. Microcontroller

The controller is the heart of entire design. The controller used here is simple ATMEGA89S52 which has a set of serial transmission and receiver pins, I/O ports and timers, which are the basic requirements system proposed. The controller accepts the acquired data from the sensors. Depending on the condition of water level in the tank it generates an encoded control signal. The controller output signals are transmitted over a RF transceiver serially.

In the receiving end, the controller again receives signals with the help of a RF transceiver module, decodes it and takes decision depending on the presence or absence of water in the sump. That is either it turns the motor ON or OFF. If the level of water in the sump is very less for the motor to drive, then it turns a Buzzer to warn the owner. So the automation and controlling is handled by the micro controller.

C. R.F Transceiver

Basically a transceiver is a module which has a transmitter and a receiver. Here we use a R.F transceiver which transmits and receives R.F signal. The frequency range of the signal is 433MHz. The module modulates the data using a carrier signal of frequency 433MHz and transmits through an antenna. On the other hand it demodulates the received signal. The modulation which takes place here is amplitude shift keying. The module requires an external antenna connected to it to transmit the signal. The length of the antenna is $1/4^{th}$ of the wavelength of the signal. And wavelength (ƛ) is calculated from

$C = f ƛ$

Where C is the speed of light, f is the frequency of module and ƛ is the wavelength of the signal. For the 433MHz module it is around 17cm.These transceivers are placed at the sump and the tank for the purpose of error free communication. So for every request signal from the controller placed at the tank, an acknowledgement signal is transmitted from the controller at the sump. Suppose an error or loss of data occurs during transmission, then the system is programmed to re-transmit the data.

III. PROCEDURE

The hardware design is as shown in the block diagram. It has two microcontrollers placed one at the tank and another at the sump. They perform the task of controlling, error detection and sequencing the communication.

At the tank, two levels of water are taken into account i.e. when the tank is almost empty as “LOW” and full as “HIGH”. Two sensors are placed at these two levels. The sensor outputs are amplified and given to the tank controller as interrupts so that the highest priority is for “LOW” level. So the conditions for tank controller to send request are:

- When a level “LOW” is detected.
- When a level “HIGH” is detected.

As soon as an interrupt occurs, the tank controller has to communicate with the one at the sump. So a request is sent from the tank controller through R.F module. For every request that it sends, the controller at the sump has to acknowledge for communication effectiveness. Suppose an acknowledgement is lost or an error occurs then the request is retransmitted. The communication bits are configured in such a way that first 4 bits of transmission always indicates the device identity and next bit is error detecting bit and last 3 bits are data bit. The device identification bit avoids the interference of signals of two neighbouring systems.

At the sump, controller along with a transceiver module is placed. The sensor is placed for detecting the presence or absence of water level. Sensor signal is given as the external interrupt to the controller. When the controller at the sump receives a message of “LOW” water level at the sump, it acknowledges to the tank controller and switches the motor. And suppose the water level at the sump is at “NO WATER”, the controller switches a buzzer to alert the owner and sends a request to the tank controller to wait until water is filled back into the sump. Controller keeps on producing a buzzer alert for every half an hour. Once the sump is filled it alerts the controller at the tank and the tank controller sends the request again to switch the motor. And when a “FULL” water level at the tank is received by the sump controller, it switches off. So the conditions for sump controller to send requests are:

- When “NO WATER LEVEL” in the sump is detected.
- When water is filled back.

A small prototype based on the above conditions is written in C programming language. That is later dumped into the micro controller and the whole hardware design is implemented. And the serial communication is handled by the serial buffer register of the microcontroller with the help of external RF module connected to the TX and RX pin. The flow of the program can be well understood with the help of flow chart given below.

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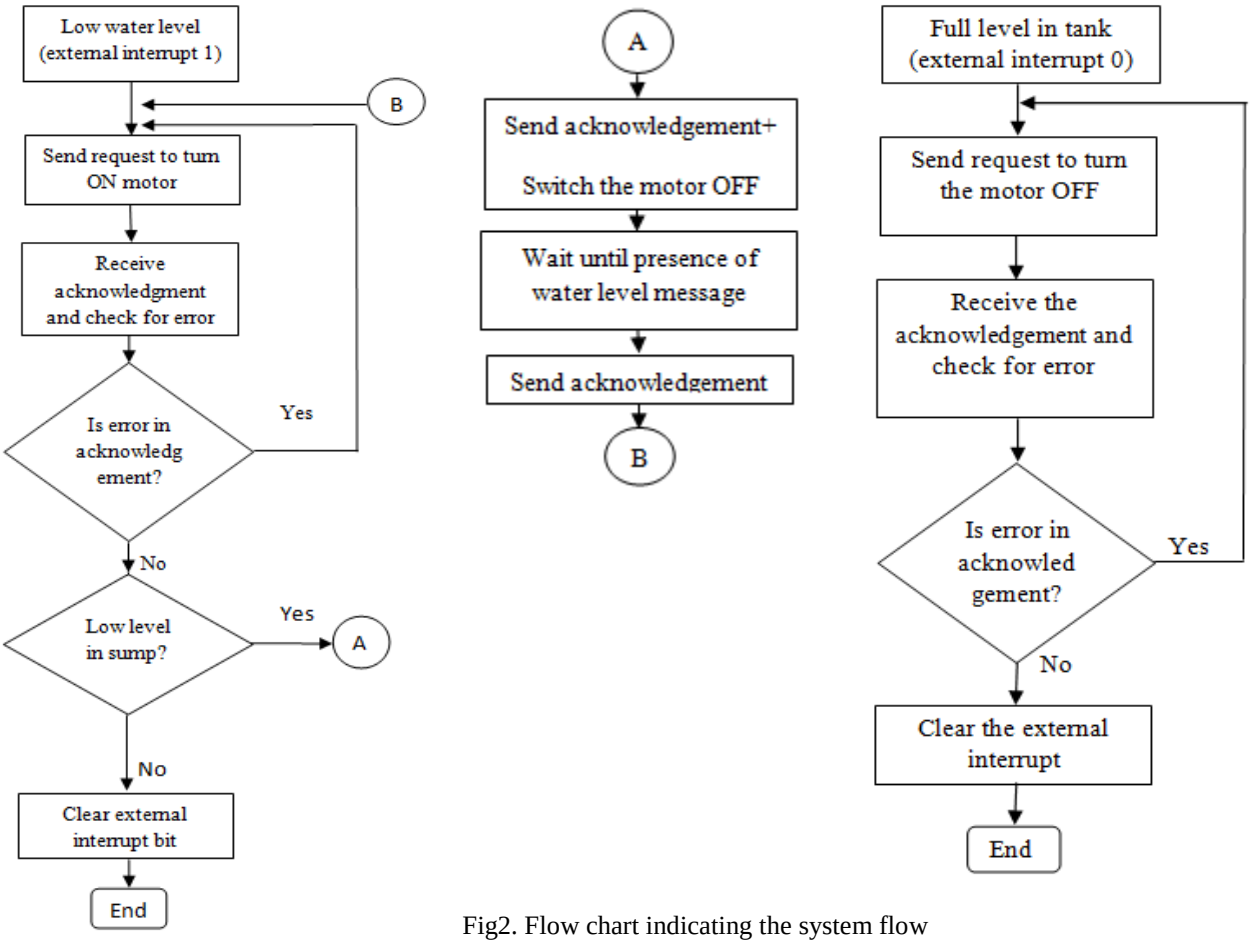

Fig2. Flow chart indicating the system flow

IV. EXPECTED RESULTS

TABLE I

Sump/ water level	Micro controller action at tank	Micro controller action at sump
When tank water level is LOW	• Generates an encoded signal • Transmits through RF transceiver	• Receives signal • Checks decoded signal • Sends ACK • Checks sump water level • Switches motor ON if level is not LOW
When tank water level is HIGH	• Generates an encoded signal • Transmits through RF transceiver	• Receives signal • Sends ACK • Checks decoded signal • Switches motor OFF
When sump water level is LOW	• Sends acknowledgement for NO WATER level at sump • Sends acknowledgement for PRESENCE of WATER LEVEL • Re-requests for 'motor switch ON'	• Switches motor OFF • Sends NO WATER message • Alerts with a buzzer for every 30 minutes • Alerts the tank controller when water is filled

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V.COCLUSION

In this paper we have explained about the design of a cost effective easy method to control the water level of the tank wirelessly and automatically. As per our design it is best implementable for houses and offices. The range coverable is only up to domestic and office areas. It is observed that domestic and offices are one of the major areas of water polling. So implementing the low cost easy maintainable wireless system is one among the solutions. It has no problem such as breakage of wire arising after installation.

But the same idea can be extended to large coverage area and can be implemented in industries. And also for irrigation purpose [6]. The wired sensors can be replaced by wireless and the coverage area can be increased [11]. The wireless method of sensing can also be applied for water leakage detection.

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