Design and Implementation of Multi Tank Monitoring Based On Low-Power ZIGBEE and AVR for Automatic Water System Control

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Abstract— **Water shortage and preservation is the serious- major issue throughout the globe. Now a days, the monitoring and regulation of water supply is a very common problem which is faced by every house, office, companies, colleges etc. Manual controlling requires someone to perform all time monitoring and regulation. When the tank is empty one has to switch ON the motor and to switch OFF the motor when it is filled. Problem becomes complex when single motor is used to fill up multiple tanks and even more complex when the tanks are spread over a large area. Also, according to the level of water available in the tank and the sizes of tanks, the amount of time required for filling up of tanks is variable. In such case there may be huge wastage of water while filling all the tanks to their capacity or some of the tanks may not filled to their capacity. To monitor all this things via human is too complicated and even not possible when the tanks are located at larger distances. This everyday problem that have observed at our workplace has motivated us to come up with an affordable, wireless automatic water level control system that doesn't need any attention once it is installed.**

The aim of this paper is to design and implementation of multi-tank monitoring system which is based on low-power ZigBee wireless communication technology for automated water level control and monitoring.

Index Terms— **AVR Microcontroller, Electromechanical valves, Level Sensors, ZigBee. Multi-tank Controller**

I. INTRODUCTION

The water resource management in many domains of the world like water industries, swimming pool, dam, river, coastal, fisheries, irrigation and canal control, oceanography and so on 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 most 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 reported. It would be possible to track the actual implementation of such initiatives with integration of various controlling activities. The various technologies are utilized to design the automated water control system by using embedded technologies like microcontrollers with RF module (radio frequency module), GSM (Global System for Mobile communication) and certain minor circuit for single tank-single motor control by IC555. This paper is to design and implementation of multi-tank monitoring system which is based on low-power ZigBee wireless communication technology for automated water level control system and monitoring. The system reduced many problems, if there is single motor to ON-OFF and multiple tanks to fill. Each tank having its own filling time, according to level of tank i.e. partially filled, half filled, fully filled or may even empty. To monitor all this things via human is too complicated and even not possible when the tanks are located over larger area. Therefore, water controlling system implementation makes potential significance in home and industries applications.

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

II. LITERATURES SURVEY

There are some literatures surveys that are based on water level control and automation systems. Till now, several attempts have been made to provide an effective monitoring system to observe the level of water. A number of papers reported with different technologies to develop this kind of monitoring system. Also, there are some papers that overview and compare the current techniques in this area like, water level controller using 555 timer proposed in [2], automatic water level controller system in [3]. Greswell et al. [4] developed a simple, inexpensive, portable and wired water level monitoring system for multiple applications. Moreno et al. in [11] presented the design specification of an active water level monitoring system using 8051 microcontroller and Digital Input/Output (DIO1) board. Yan et al. developed an intelligent coalmine water level measuring and monitoring system using the Wireless Sensor Networks (WSNs), and microcontroller PIC [13]. The paper introduces the notion of water level monitoring and management within the context of electrical conductivity of the water and wireless communication between tank and motor. More specifically, it explains about the microcontroller based water level sensing and controlling in a wireless ZIGBEE environment. Water Level management approach would help in reducing the power consumption and as well as water overflow. Web and cellular based monitoring service protocol that would determine and sense water level is reported in [1]. The paper presents smart water level indicator and discuss about the system to monitor the changes of water level time to time and send an alert to the system for controlling using wireless ZIGBEE. This paper comprises of three parts, in which the first part is to detect water level using transistor BC547 as switch (level sensor). The microcontroller system is responsible for processing network protocol. The second part processes the data that has been collected based on the deepness of water level. The third part is the system, which

modulates the signal that has been collected and transmited the modulated signal via a ZIGBEE antenna. the signal receives by ZIGBEE receiver then accordingly main valve or motor control automatically.

III. IMPLEMENTATION

The block diagram of automatic water control by using zigbee system is as shown in fig. 1 and 2. It has two microcontrollers, one at the tank and another at the motor pump. They perform the task of controlling level detection and sequencing the communication via wireless device ZIGBEE. The communication between the transmitter at the tank and the receiver module is wireless whereas the valve at the tank are connected through wire to the transmitter module at the respective tank. Block diagram of transmitter placed at the tank is as shown in fig. 1. 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". This LOW and HIGH combination is detected by the level sensor (transistor switch). Two sensors are placed at each tank for these two levels. The sensor outputs are given to the ADC port of controller.

As soon as controller detects that tank is empty, it turns ON the valve at the respective water tank and sends a request to the receiver module to turn ON the motor. If tank is filled then corresponding valve is OFF and controller sends the status of respective tank to the receiving module which stores the status and displayed the information on LCD. At this condition main motor is not OFF as their may be tanks which are not filled. Suppose all tanks are filled then, so a request is sent to receiving module from the tank controller through zigbee module to turn OFF the motor pump and display the status of every tank as filled is displayed.

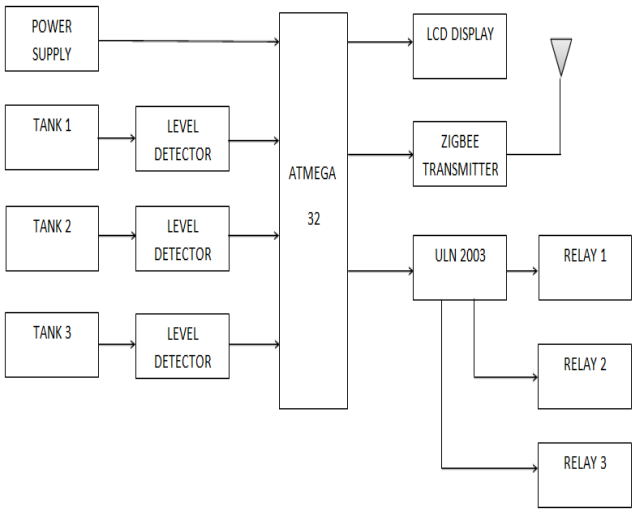

Figure 1: Block diagram of transmitter

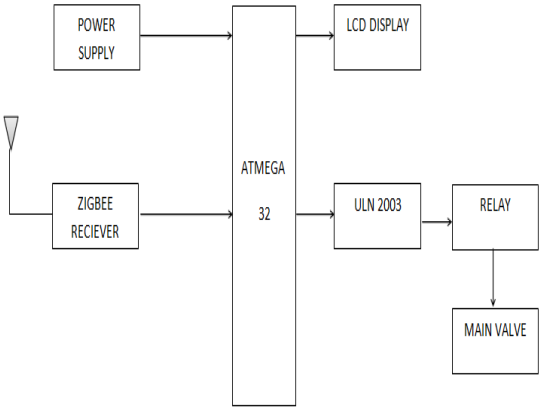

Figure 2: Block diagram of receiver

Zigbee is used for the development of the system because it offers flexibility in design. As range of zigbee is 30m then lot of area is covered with the help of multihop property of zigbee. Addition of new tank in zigbee network is simple task as multi node communication is main advantage of zigbee.

IV. CIRCUIT DIAGRAM

The circuit diagram is comprises of two main parts a) Transmitter circuit b) Receiver circuit. Transmitter circuit is as shown in fig. 3 and receiver circuit is as shown in fig. 4. Mainly two microcontrollers are used, one at tank and other at pump (motor or receiver circuit). They perform task of level check and operate valve and pump. Level circuit use BC547 transistor. In tank there are two levels high(full) and low(empty) for checking level. This level circuit output goes to ADC port of microcontroller. Microcontroller checks the signal value. If low (empty) output is given by level sensor then valve is ON using relay. This relay operated on driver ic ULN2003 connected to output port of microcontroller.

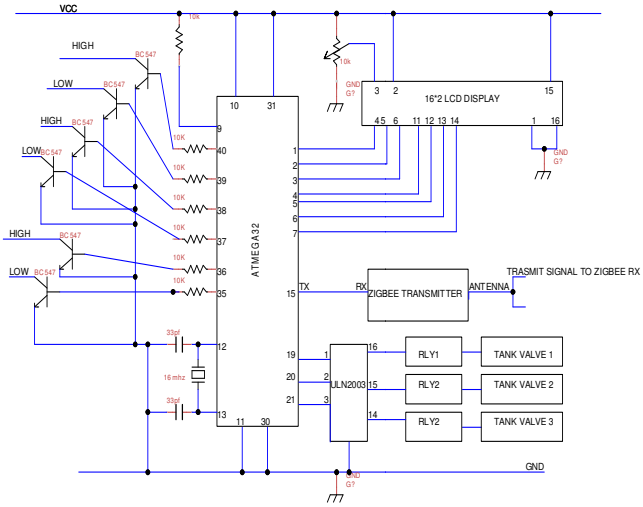

Figure 3: Circuit Diagram of transmitterNear Water Tank

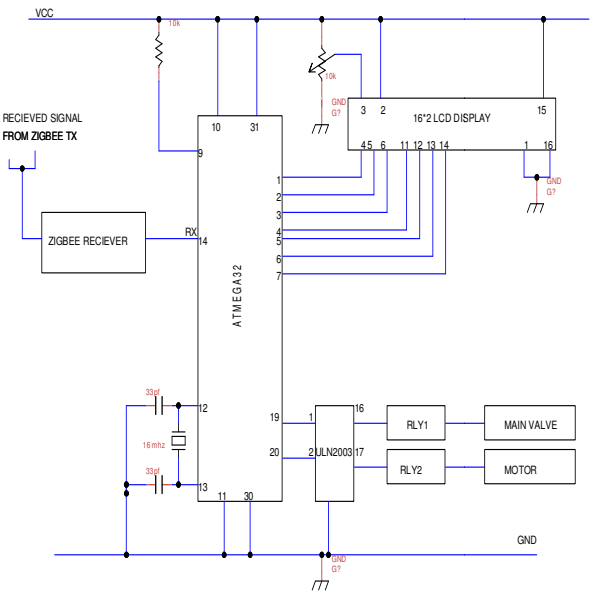

Figure 4: Circuit Diagram of receiver Near Main valve or motor

VI. RESULTS

System is implemented and different results that are obtained on display unit are as shown in the fig 5.

Figure 5(a) shows the status of LCD which displays the basic name of system. The system can be implemented at various areas college, office, industries etc.to make Zero wastage of water.

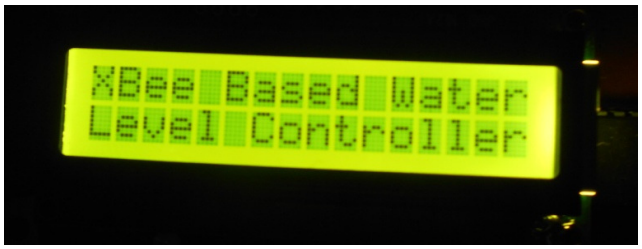

Figure 5(a): XBEE Based Water Level Controller

Figure 5(b) displays the output when all tanks are initially empty and the motor is needed to turn ON. Signal is send via XBEE module to Turn ON the motor.

Figure 5(b): Output When All Tanks Are Initially Empty

When all tanks are empty and required to ON the motor this is automatically done by the XBEE signal reception. The message that is displayed during this process is as shown in fig 5(c).

Figure 5(c): Main Valve Unit turns ON when tanks are Initially Empty

Whenever any of the tanks is empty then the XBEE transmitter will not send any signal to receiver so as to make motor OFF. Unless and until all tanks get filled no signal is transmitted to make motor OFF. The above mentioned condition is as shown in fig 5(d) where F means full while E means not full.

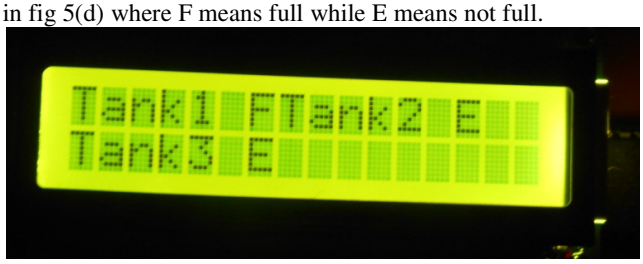

Figure 5(d): When Any of the tanks Are Empty

Figure 5(e) shows the output when all tanks are filled. If all tanks are checked that filled or not than an than only acknowledge the receiver.

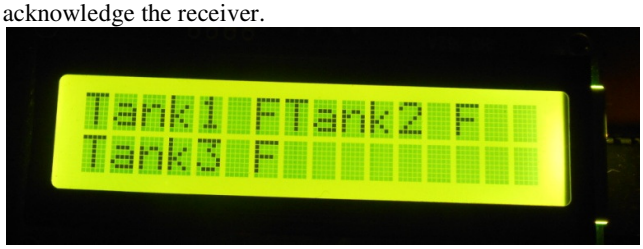

Figure 5(e): When all tanks are filled

Figure 5(f) displays the output if all tanks get filled then the XBEE transmitter will send an acknowledgement to receiver to make motor OFF

Figure 5(f): When all tanks are filled turn of the motor or main valve

VII. CONCLUSION

This paper explained the design of automatic water level control system using wireless module zigbee. With the

utilization of wireless module, system becomes flexible and addition of new tanks can be easily incorporated. Design of system is very simple and is cost effective as compare to the other systems that are discussed in the literature review. With the automatic monitoring of remotely distributed tanks, required man power as well as power consumption can be saved.

The biggest advantage of the system is it can saved wastage of water because as water in specific tank is filled then valve of that tank is closed thus avoiding the waste of water.

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. The wired sensors can be replaced by wireless and the coverage area can be increased. The wireless method of sensing can also be applied for water leakage detection.

REFERENCES

[1] Muktha Shankari , Jyothi K, Manu E , Naveen I P, Harsha HerleStudent, Dept. of Instrumentation Technology, RVCE, Bangalore, India paper on " Wireless Automatic Water Level Control using Radio Frequency Communication " in International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering *Vol. 2, Issue 4, April 2013,* ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875

[2] Ranjan Tarafdar, Madhulina Sur, B-Tech, 3rd year student, Guru Nanak Institute of Technology Dibyendu Sur, Life Member FOSET, Member IEEE, Assistant Professor, Guru Nanak Institute of Technology," WATER LEVEL CONTROLLER USING 555 TIMER IC "07-ENR-RANJAN TARAFDAR.

[3] S. M. Khaled Reza., Shah Ahsanuzzaman Md. Tariq., and S.M. Mohsin Reza., "Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue", Proceedings of the World Congress on Engineering and Computer Science, Vol 1,pp.1-7, 2010.

[4] Melaty Amirruddin., Nurhakimah M. Mukhtar., Hana A. Halim., and Nur S. Noorpi., "Microcontroller Based Water Level IndicatorUsing GSM Modem: Design and Application", 1st International Conference on Future Trends in Computing and Communication Technologies, pp.79-83, 2012.

[5] Yan Xijun., Lu Limei., and Xu Lizhong., "The Application of Wireless Sensor Network In the Irrigation Area Automatic System", International Conference on Networks Security, Wireless Communications and Trusted Computing, Vol.1, pp.21-24, 2009.

[6] Christian Reinisch., Wolfgang Kastner., Georg Neugschwandtner., and Wolfgang Granzer., "Wireless Technologies in Home and Building Automation", 5th IEEE international conference on Industrial Informatics, Vol. 1, pp.93-98, 2007

[7] Y unpeng Liu., and Chen yang., "Based on GSM Network of Intelligent Telemetry Water System", International Conference on Electronics and Optoelectronics, Vol.2, pp.220-222, 2011.

[8] L. L. Pfitscher., D. P. Bernardon., L. M. Kopp., M. V. T. Heckler., and J. Behrens, "Automatic Control of Irrigation Systems Aiming at High Energy Efficiency in Rice Crops", Proceedings of the 8th International Caribbean Conference on Devices Circuits and Systems (ICCDCS), pp.1-4, 2012.

[9] Dr. Seema Verma., "Wireless Sensor Network application for water quality monitoring in India", National Conference on Computing and Communication Systems (NCCCS)., pp.1-5, 2012.

[10] Mihajlovic, Z., Radmilovic, Z., Milosavljevic, V., Rajs, V., and Zivanov, M., "Implementation of Remote Environmental Monitoring System Using RF Modules with Secure Communication between Devices", Conference on Embedded Computing MECO., pp.54-57,2012.

[11] Yin Hailong., Xu Zuxin., Wang Juan., and Ren Yi., "Wireless Real-time Observation System for Water Level of Urban Drainage", Third International Conference on Measuring Technology and Mechatronics Automation., Vol.3, pp.1158-1161, 2013.

[12] B O"Flynn., Rafael Martínez- Català., S. Harte., and C. O"Mathuna, "Smart Coast - A Wireless Sensor Network for Water Quality Monitoring," 32nd IEEE Conference on Local Computer Networks., pp.815-816, 2007.

[13] Xizi Li., and Changyi Jiao., "Water Conservancy Monitoring System Based On Wireless Sensor Network", 2nd International Conference on Mechanical Automation and Control Engineering., pp.1858-1860, 2011.