© July 2015 | IJIRT | Volume 2 Issue 2 | ISSN: 2349-6002

Campus Overhead Tanks Controlling System Using GSM and ZIGBEE based WSN

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***Abstract*— Water is an inseparable part of human life and management of water has become a crucial issue across the world considering scarcity of water felt by human beings. This paper presents a GSM and Zigbee based efficient embedded water management system for smart distribution of water. This system controls distribution of water in a campus considering priorities and requirements of respective overhead tanks. It provides ease feasibility to control distribution of water from a remote location using SMS commands through GSM. Traditional system has limitations like manual overrides, occurrence of extreme conditions such as no water, wired and complex systems etc. These limitations can be overcome by this effective embedded system using GSM and Zigbee based WSN. In this system data communication between overhead tanks and base station is carried out using wireless zigbee protocol.**

***Index Terms*— Zigbee, GSM, SMS, WSN.**

I. INTRODUCTION

Today's human generation experiences a serious water scarcity. One of the reasons for this is inefficient water distribution systems and negligence involved in management of available water. This has given rise to new water conservation concepts to get better water management especially in urban areas. The conventional water distribution and management system has certain disadvantages like extreme conditions such as no water or overflow of water causing wastage of water. Traditional involves higher amount of human interventions which may lead to errors in water management. To avoid such situations a smart embedded system with GSM and zigbee based wireless sensor network is proposed in this paper.

The proposed system measures water level of overhead tanks with the use of level sensors and passes this information to the base station for monitoring and control. This transfer of information is carried out by zigbee technology. As zigbee is wireless protocol it provides ease feasibility over conventional wired networks. The GSM concept is used to deliver status of overhead tanks as well as base tank to user so that user can monitor and control smart water distribution from a remote location. ARM7 LPC2138 microcontroller is used in Master Unit associated with base tank and PIC16F877 microcontroller is used in Slave Units associated with overhead tanks.

II. LITERATURE SURVEY

A. WSN concepts used in the proposed system

Following are the concepts used in the proposed system for wireless communication.

- Addressing and routing in ZigBee

For zigbee based communication, to collect data from overhead tanks is the critical part of the system. Block diagram of the system displays the zigbee concept used in the system. Hence it is necessary to understand routing algorithm of zigbee concept.

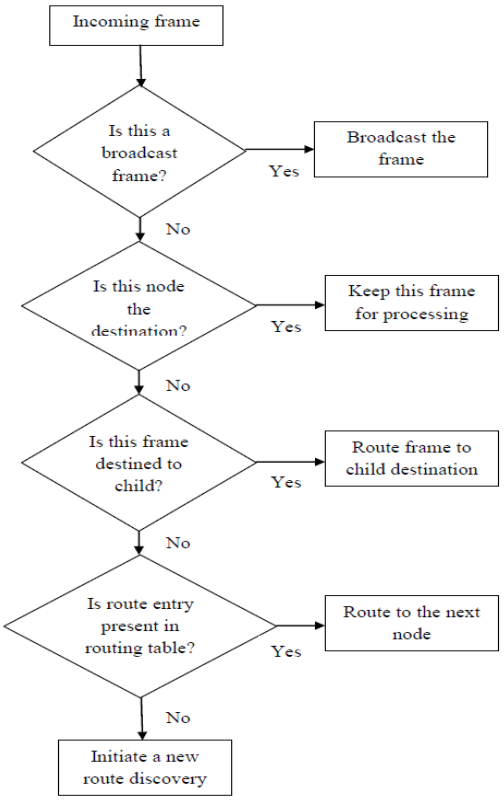

Fig.1 Routing Algorithm

A zigbee coordinator and a zigbee router store a number of routing table entries which can be used to route an incoming data frame to desired destination. It can also be used for route repair task. On reception of data frame following activities take place at zigbee node termed as zigbee routing algorithm as shown in Fig.1.

Steps for zigbee routing algorithm

1. On reception of data frame, if it is a broadcast frame then broadcast that frame.
2. Else, if current zigbee node is destination for data frame then keep this frame for further processing.
3. Else, if frame is destined for child of current node then route the frame to child destination.
4. Else, if the current zigbee node has route entry present in routing table then route the data frame to the next node on the destined route.
5. Else, initiate a new route discovery if there is no destination entry in the routing table of current zigbee node.

- The GSM Technology

GSM is acronym for Global System for Mobile communications and is one of most widely used cell phone technology.GSM makes use of SIM (subscriber's Identity Module) card for identification of users account which allows GSM users to quickly move themselves from one GSM phone to another by moving the SIM card. Frequency bands used for GSM networks are 850 MHz, 900MHz, 1800MHz, and 1900MHz [9]. The main advantages offered by GSM are:

i. Standardization
ii. Capacity
iii. Quality
iv. Security

B. Literature Review

B. Panidra reddy and P. Eswaran developed a system for monitoring overhead tanks. They preferred zigbee based WSN for the same. Prototype remote node was developed by them.

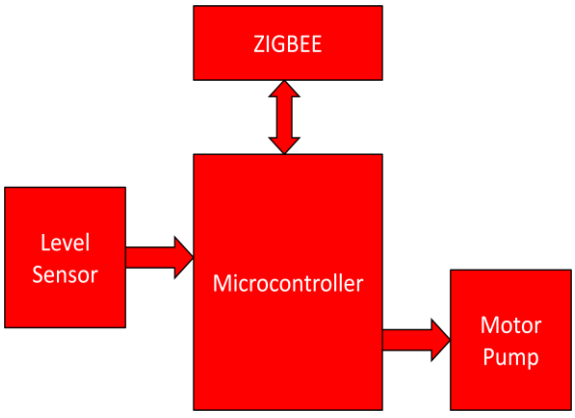

Fig. 2 Remote Node

Every overhead tank unit has one remote node with four components as shown in Fig. 2. It consists of a microcontroller, level sensor, zigbee unit and motor pump. Level sensor is used to measure level of water in an overhead tank. Motor pump is used for pumping water into the tank. A microcontroller is used to control remote node. Zigbee unit is used for communication purpose. [1]

As compared to the system presented in above work, our proposed system has some advantages. One of them is use of GSM which helps the user to know the status of the system at any point of time and then control the system from a remote location. Another advantage is that switching of motors is done by microcontroller of Master Unit and not by microcontroller of Slave Unit, which reduces complexity of the system.

Dong IK Shin, Soo Jin Huh and Pil June Pak describe use of Zigbee radio technology for biological sensor networking for μ-Healthcare. Their investigations of different wireless technologies and comparison between them technologies concludes that Zigbee technology is more advantageous for WSN among standard protocols. [4]

Wang weiya, Lu Zhanfeng, Gao Li and Hu Gui designed and implemented patient ECG monitoring system based on WBAN by Zigbee protocol. ECG is primary reference of diagnosis of heart diseases. So real time monitoring of ECG is important to prevent and for treatment of heart diseases. There are some systems available based on GPRS and Bluetooth. But these systems have disadvantages of high power dissipation, higher cost, high electromagnetic radiations and bad system expansibility. But with the use of WSN based on Zigbee above mentioned disadvantages can be overcome. [6]

According to Wang Weihong and Cao Shuntian, for Greenhouse monitoring, use of smart embedded system is essential. [3] For effective crop growth, different methods can be used to control environmental parameters such as light, CO2 concentration, temperature and humidity as per requirement. This is greenhouse monitoring which is essential for agricultural automation. In conventional systems for greenhouse monitoring, data transmission is through cables which brings many problems. It is difficult to place the cables; they can be easily eroded and also difficult for maintenance. It is not economical and can cause accidents.

To avoid such accidents, a remote intelligent monitoring system (RIMS) based on Zigbee Wireless Sensor Network is developed. Here data is transmitted using a wireless network. Only one ADC is used which results in greater accuracy. Such a WSN system has advantages like lesser complexity, reduced human cost and ease of maintenance. The Zigbee concept works on spread spectrum technology. Here frequency hopping is automatically achieved for data transmission which greatly improves reliability. This system based on WSN holds good

stability and accuracy and probability of data transmission can be up to 95%. [3]

III. SYSTEM ARCHITECTURE

Fig. 3 gives us a block diagram of overall system. It consists of base tank of high capacity situated at ground for storage of water coming from distribution system. Base tank is associated with Master Unit.

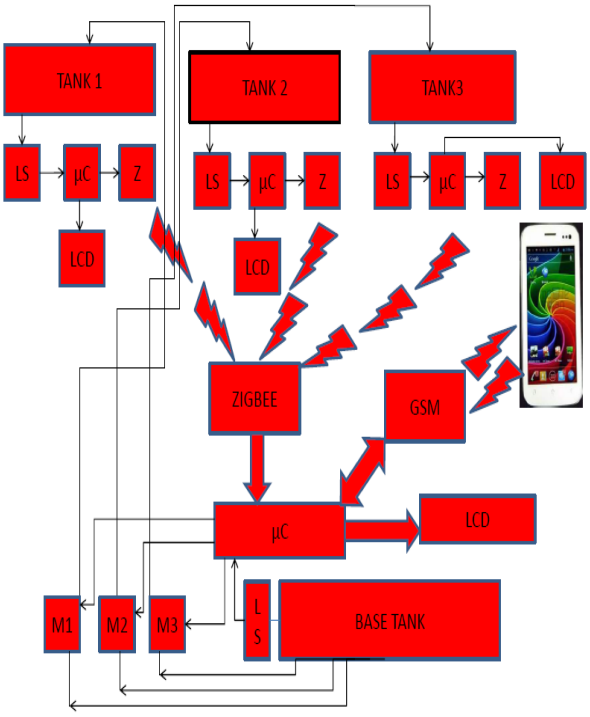

Fig. 3 Block Diagram of proposed system

Master Unit consists of microcontroller, level sensor, Zigbee unit, GSM unit, LCD display and motors M1, M2 and M3. Level Sensor detects the level of water in base tank. Zigbee unit receives information transmitted by zigbee unit of Slave Units. At the base tank, LCD display shows status of the system. GSM unit communicates status information to the user at remote location using SMS alerts so that user can control the system by sending SMS commands to Master Unit. By analyzing the SMS commands received through GSM unit (sent by user) and considering status of base tank given by level detector as well as status of overhead tanks received through zigbee units, microcontroller of Master Unit controls the switching operation of motors M1, M2 and M3.

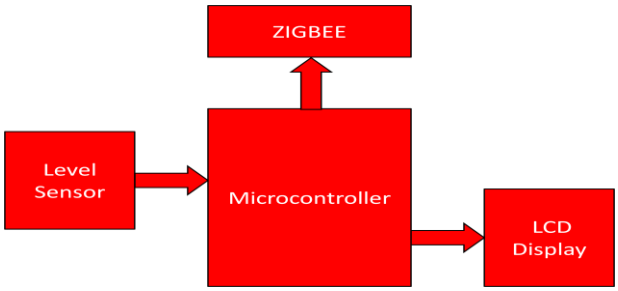

Fig.4 Diagram of Slave Unit

Every overhead water tank has one Slave Unit with the components as shown in Fig 4. It consists of a microcontroller, level sensor, Zigbee unit and LCD. Level Sensor detects level of water in overhead tank. Zigbee unit configured for communication purpose transmits status of overhead tank to Master Unit. LCD display shows level of overhead tank. A microcontroller is used to control the Slave Unit.

IV. RESULTS AND DISCUSSION

Implementation of Slave Unit circuitry is simulated using Proteus IDE. Communication through zigbee is replaced by direct connection of wires in simulation. As shown in Fig. 5, potentiometer indicates functional output of level sensor L1. LCD is used to display water level to user.

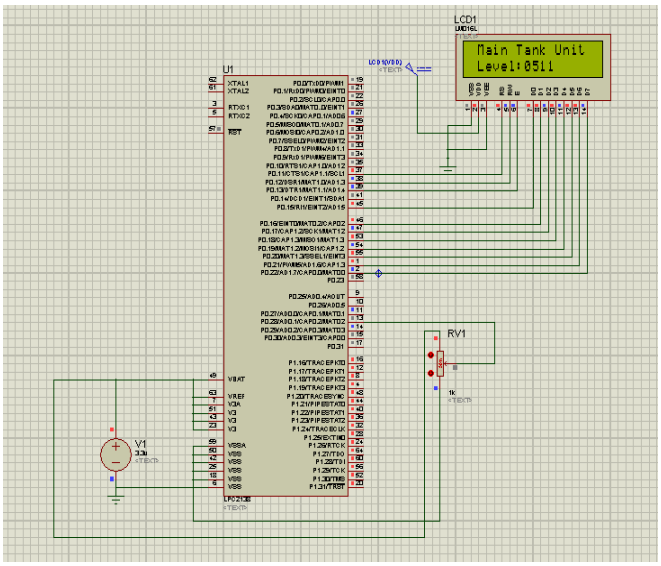

Fig.5 Simulation of Slave Unit

The system consists of two modes of operation:

a. Auto Mode(A)
b. Manual Mode(M)

a. Auto Mode(A)

Auto Mode (i.e. automatic operation of the system) can be selected by the user by sending SMS 'A' to microcontroller of Master Unit through GSM. It is not a mode set by default. In Auto mode, the control of the system is with the microcontroller of Master Unit. During this mode, operation of the microcontroller is in closed loop. Initially it checks the

status of the base tank, until it reaches a specified threshold level. Once water level of base tank goes beyond threshold level, the program enters a loop to distribute water to overhead tanks according to the priorities and water level equations set in the program. Priorities can be changed in Auto Mode by sending SMS to microcontroller of the Master Unit through GSM. In Auto mode, system sends SMS containing status of tanks and motors to user for every switching operation of motor.

b. Manual Mode(M)

It is a mode set by default, it means at start of system or after 'Reset', system starts in Manual Mode and sends this information to user by sending SMS via GSM. User can change mode from Auto to Manual, by sending SMS 'M' to the microcontroller of Master Unit. In Manual mode, the control of the system is mainly with the user of the system. To run the system in Manual mode, initially user checks status of all water tanks by sending enquiry SMS 'R' to the microcontroller of Master Unit, using GSM. After analyzing status of the tanks, user sends different control commands through SMS for switching of the motors, considering priorities of distribution of water. In Manual Mode system turns OFF all the motors at extreme condition of no sufficient amount of water in base tank to avoid dry run of motor in base tank and communicates this information to user through SMS. If level of water in an overhead tank reaches its maximum value then system turns OFF respective motor to avoid wastage of water and communicates this information to user through SMS. In Manual mode system informs user about status of all the tanks and motors periodically by sending SMS to make it more convenient for user to take further decisions.

V. CONCLUSION

A smart embedded system for monitoring and controlling water distribution to overhead tanks in a campus is proposed in this paper. This system uses zigbee and GSM based WSN to inform tank level information and help in controlling the same to a person at a remote location. Simulation of electronics used here is done in Proteus. This system helps us to prevent unnecessary manual overrides, reduce manual work, avoid emergency conditions and optimize the cost. This smart embedded system for water distribution in a campus helps to turn it into a smart campus.

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