# Embedded Design of a Water Distribution Algorithm of Overhead Tanks using GSM and ZIGBEE

Mr. Prasad P. Patil
Dept. of Electronics and Telecommunication Engineering,
SKN College of Engineering,
Pune-41, India

Dr. S. K. Shah
Dept. of Electronics and Telecommunication Engineering,
SKN College of Engineering
Pune-41, India

***Abstract*— This paper proposes an efficient and effective embedded system for smart water distribution to overhead tanks in a campus. The proposed system is useful for monitoring and control of overhead tanks in a campus by taking into account the priorities for distribution of water in overhead tanks as per water requirements of respective overhead tanks. This paper provides Embedded Design of an Algorithm for Water Distribution of Overhead Tanks using GSM and ZIGBEE for Manual as well as Auto Mode of operation of the system. The conventional system for overhead tanks monitoring has limitations like manual overrides, wired and hence complex water management, possibility of extreme conditions, etc. All these limitations can be overcome by effective and efficient embedded system with GSM and zigbee based wireless sensor networks. Remote water tank monitoring is possible by zigbee based wireless sensor network. Smart use of GSM enables user to control this system from a remote location.**

***Keywords*— Zigbee, GSM, Embedded Design of an Algorithm, Remote Water tank monitoring***

## I. Introduction

In today's world, water conservation has become a very important element. Different water conservation concepts are emerging every day. Considering the current scenario in a campus with large human population, the management of water is really important. The campus which uses proposed embedded system turns into a 'smart' campus by overcoming limitations of conventional systems with the help of wireless sensor network consisting of zigbee technologies and GSM.
Use of GSM and zigbee technology in the system provides ease feasibility on implementation over wired network. The proposed system is useful to monitor and control the overhead tanks i.e. filling the water tanks or stopping the pumping motors, taking into consideration the priorities of distribution of water into the overhead tanks. Slave Units near the overhead tanks monitor water levels and communicate them to Master Unit. Master Unit situated at base tank controls the distribution of water based on monitored water levels and priorities of distribution of overhead tanks, either in Auto Mode or in Manual Mode.

## II. Literature Survey

### *A. 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.

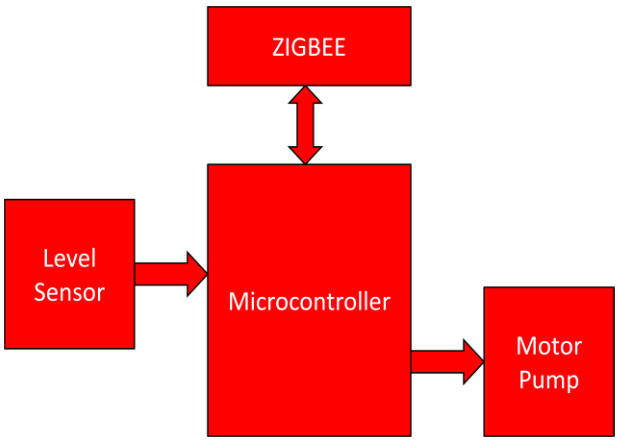


Fig. 1 Remote Node

Every overhead tank unit has one remote node with four components as shown in Fig. 1. 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, the 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.

*B. Review of conventional system and its comparison with proposed system*

This section describes limitations of the conventional system for overhead tanks monitoring and control. It is noticed that cost for electricity consumption is lesser during night time than the day time. Proposed system can operate during night time unlike conventional system leading to large savings in electricity bills.

The overhead tanks for particular building may have different water requirement priorities at different times. Conventional system is unable to meet this requirement and hence leads to inefficient water distribution. In contrast, as proposed system takes into account different priorities at different times and hence delivers smart water distribution.

The status of water level in overhead tanks to be communicated to base station is mostly done using wired network in conventional system. Unlike this, proposed system uses zigbee based wireless sensor network to communicate the same information.

In conventional system, user may not have total control over switching of motor for water distribution and this may lead to switching of motors at undesired times resulting in mismanagement of water. This drawback can be avoided with the use of GSM technology in the proposed system.

Proposed system is less complex and may cover more area with the use of zigbee technology which leads to efficient time, cost and area management unlike conventional systems.

Extreme conditions such as no water can be avoided using this smart and efficient embedded system.

## III. System Architecture

Fig. 2 shows block diagram of system. This system structure is composed of a Master Unit associated with base tank and three Slave Units associated with three overhead tanks.

Water received from various sources will be distributed to designated overhead tanks from base tank. The Master Unit situated near the base tank decides the quantity of water to be pumped to particular tank, considering priorities of overhead tanks for distribution of water. The Master Unit consists of level sensor, zigbee unit, GSM unit, LCD display and motors M1, M2 and M3. Level sensor is used to detect the level of water in the base tank. Zigbee unit receives status of overhead tanks transmitted by zigbee units of Slave Units and feeds to microcontroller of Master Unit.GSM unit helps the user to control the operation of system from remote location. Communication between user and Master Unit is carried out by GSM unit. It sends status of system to user. It receives SMS commands from user and feeds to microcontroller of Master Unit. Microcontroller of Master Unit controls switching operation of motors by analyzing SMS commands received through GSM unit (sent by user) and considering status of base tank detected by level sensor as well as status of overhead tanks received from Slave Units. Motors M1, M2 and M3 are used for pumping water into overhead tanks T1, T2 and T3respectively from base tank. LCD display shows status of the system i.e. level of water in all the tanks as well as mode of operation of system along with the priorities of overhead tanks.

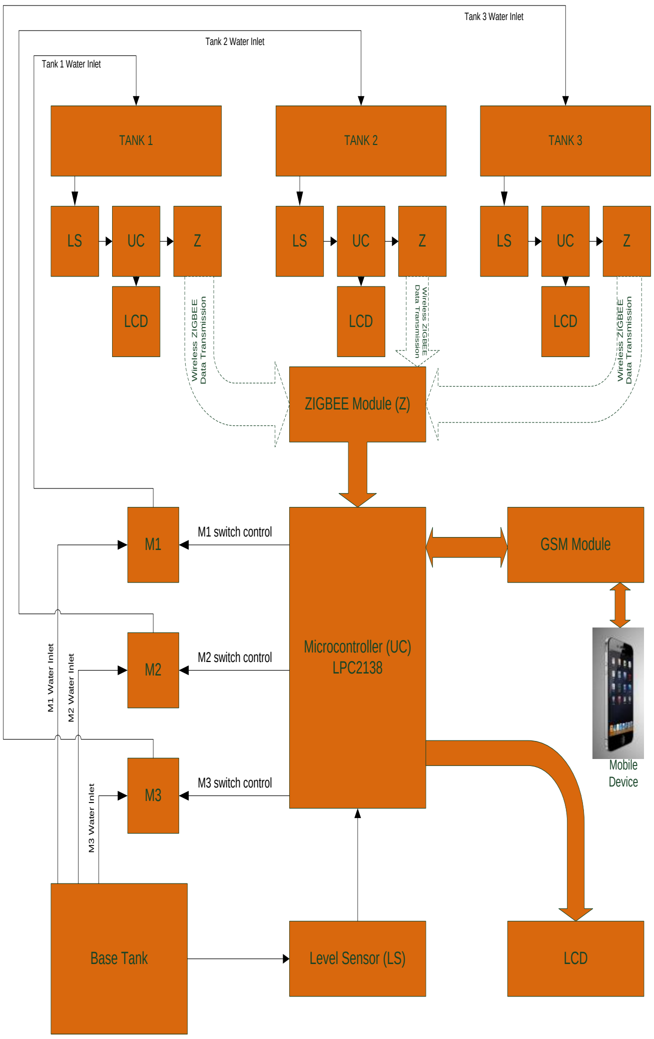


Fig.2 Block Diagram of System

Every overhead water tank is associated with one Slave Unit with the components such as microcontroller, level senor, zigbee unit and LCD display as shown in Fig. 3. Level senor is used to measure the level of water in overhead tank, a ZigBee unit transmits status of overhead tank to Master Unit and LCD display shows status of that particular overhead tank. A microcontroller is used to control the Slave Unit.

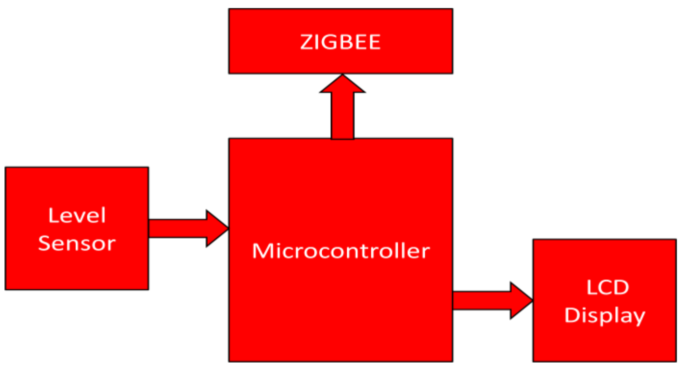


Fig.3. Slave Unit

## IV. Results and Discussion

The project consists of two modes of operation:

A. Manual Mode (M)

B. Auto Mode (A)

### *A. 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.

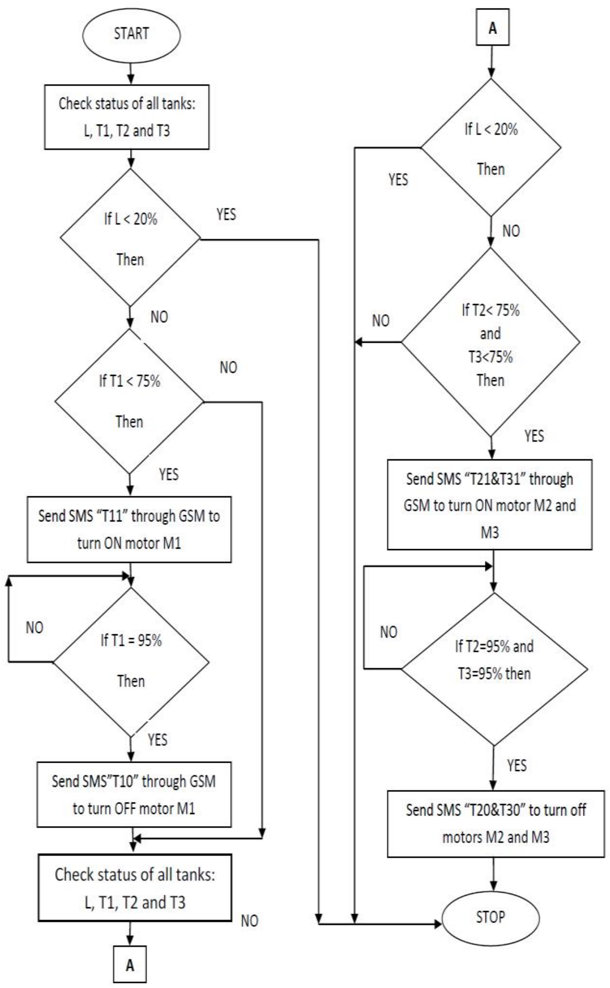


Fig.4. Flow chart for an example of result in Manual Mode

After analyzing status of the tanks, user sends different control commands through SMS to switch the motors, considering priorities of distribution of water. User receives SMS alerts showing status of tanks and motors periodically from microcontroller of Master Unit, through GSM. 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.

Out of n number of permutations and combinations of handling of this system in Manual Mode, here one example is considered. The flowchart given in Fig.4 explains this particular example.

- XYZ:
  X represents motor for tank number 1 M1, X € {1, 0}
  Y represents motor for tank number 2 M2, Y € {1, 0}
  Z represents motor for tank number 3 M3, Z € {1, 0}
  1: Motor ON
  0: Motor OFF
- R: Request for the status of all tanks
- T1, T2, and T3: Number of overhead tanks as well as levels of water in them respectively.

### *B. 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.

In Auto Mode if priority set by user is 'P123'then it means that tank T1 will get higher amount of water available in the base tank than tanks T2 andT3. Tank T2 will get higher amount of water than tank T3 but lower amount of water than T1. Tank T3 will get lower amount of water available in the base tank than tanks T1 and T2. When there is need of distribution of water from base tank to overhead tanks in an Auto Mode different priorities can be set by sending SMS 'Pabc' through GSM. As in this case, three overhead tanks T1, T2 and T3 are used; six different combinations of priorities can be set.

According to priority, amount of distribution of water can be explained as below:

In the priority Pabc,

'a 'stands for the overhead tank in which 50% of available water of the base tank will be filled.

'b' stands for the overhead tank in which 35% of available water of the base tank will be filled.

'c' stands for the overhead tank in which 15% of available water of the base tank will be filled.

It means if level of water in a base tank is 40 units then for priority 'P123', 20, 14 and 6 units is to be filled in tanks T1, T2 and T3 respectively. Here, X, Y and Z are levels of water in overhead tanks T1, T2 and T3 respectively, after filling water in them according to priority for a particular iteration. If initial levels of water in tanks T1, T2 and T3 before start of iteration are 25, 36 and 42 units respectively then values of X, Y and Z in this case are 45, 50 and 48 units respectively. Here 70 units is considered as maximum level of tanks T1, T2 and T3.The flowchart given in Fig.5 explains the operation of system in Auto Mode.

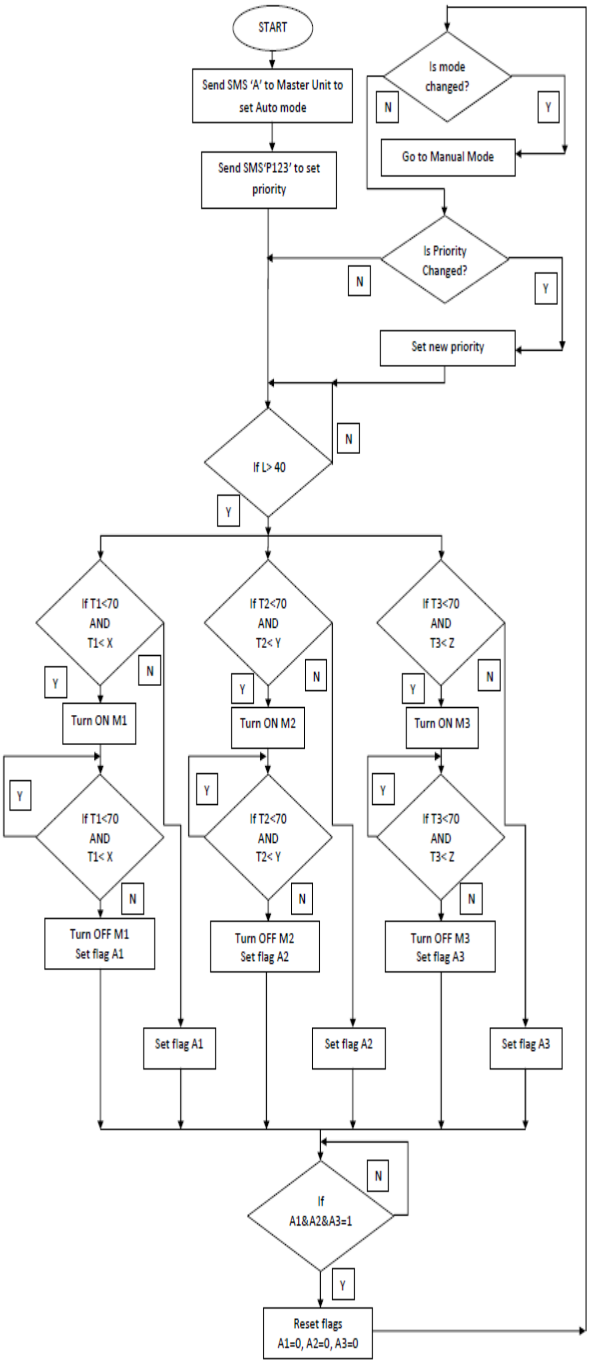


Fig.5. Flow chart for Auto Mode

## V. Snapshot of Working System

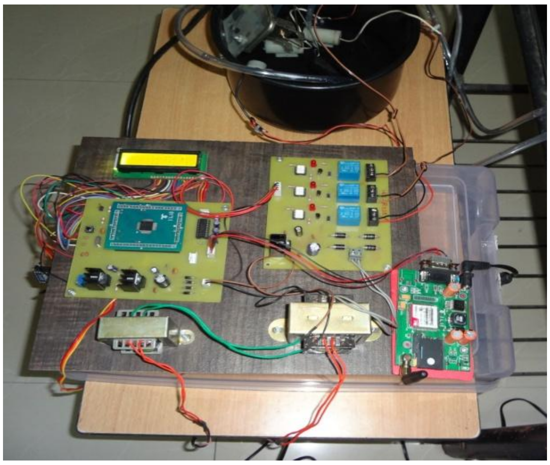

Fig. 6 Snapshot of the Master Unit at base tank

Fig. 6 shows a snapshot of base tank Master Unit. The base tank controller, LPC2138, is interfaced to different circuits like GSM, Zigbee, LCD display and Relays. GSM is used for communication between controlling authority i.e. user and Master Unit. Zigbee is used to collect tank status from overhead tanks' zigbee modules. LCD display shows status i.e. information like level of water in tanks and operating mode of system. Relays control switching of motor based on control signals received from Master Unit.

## VI. Conclusion and Future Scope

A smart embedded system for monitoring and controlling water distribution to overhead tanks in a campus is proposed in this paper. This paper provides Embedded Design of a Water Distribution Algorithm of Overhead Tanks using GSM and ZIGBEE for Manual as well as Auto mode of operation of the system. This system uses zigbee and GSM technology to inform tank level information and help in controlling the same to user at a remote location. This system helps 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 plays an important role in turning a campus into a smart campus.

In further advancement of these project following features can be added for better analysis of water tanks.

1. To monitor and control quality of water.
2. To detect and control leakages of water.
3. Use of solar panel to power overhead tank controller unit.
4. Use of digital sensors to monitor water levels.

## REFERENCES


[1] Reddy B.P., Eswaran P., "*Metro overhead tanks monitoring system using zigbee based WSN*" Information and Communications Technologies (ICT), 2013 IEEE, pp367-371.

[2] S. M. Khaled Reza, Shah Ahsanuzzaman Md. Tariq, 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 2010 Vol I, WCECS 2010, San Francisco, USA, October 20-22, 2010.

[3] Wang Weihong and Cao Shuntian, "*Application Research on Remote Intelligent Monitoring System of Greenhouse Based on ZIGBEE WSN*," Image and Signal Processing, 2009. CISP '09. 2nd International Congress on, Oct 2009 IEEE, pp1-5.

[4] Dong Ik Shin, Soo Jin Huh and Pil June Pak, "*Patient Monitoring System using Sensor Network Based on the ZigBee Radio*," 6th International Special Topic Conference on ITAB, Tokyo, 2008 IEEE, pp313-315

[5] Faisal Hussian, Shakeel Durrani, Junaid Farooqi, Hassan Mahmood, Ghalib Junjua, Imran Jattala, Nassar Ikram, "*RFID & WSN Based Integrated Maternity Ward Monitoring System*," Multi Topic Conference (INMIC), 16th International, 2013 IEEE, pp43-48

[6] Wang weiya, Lu Zhanfeng, Gao Li, Hu Gui, "*Research on Wearable EeG Monitoring System Based on ZigBee*," Cross Strait Quad-Regional Radio Science and Wireless Technology Conference, 2011 IEEE, pp929-932

[7] Yogita Patil, Ramandeep Singh, "*Smart Water Tank Management System for Residential Colonies Using Atmega128A Microcontroller*," International Journal of Scientific & Engineering Research, Volume 5, Issue 6, June-2014, pp355-357

[8] Haesung Tak, Daegeon Kwon, and Hwan-Gue Cho, "*Water Tank Monitoring and Visualization System Using Smart-Phones*," International Journal of Machine Learning and Computing, Vol. 3, No. 1, February 2013, pp142-146

[9] Zigbee specification version r13, December 01 2006.

[10] http://www.scribd.com/doc/56072334/zb

[11] http://freewimaxinfo.com/Zeebee-networks.html

[12] http://what%20is%20GSM%20Overview.%20GSM%20Technology.html