Real Time Monitoring of an Efficient Water Reservoir System Based On WSAN (Wireless Sensor and Actuator Network)

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Abstract—**Water is one of the most essential resources to sustain life on earth, and over the last decade its population has increased at an accelerated rate and is estimated to be 6.8 billion. In this regard a system based on Wireless sensor and actuator network (WSAN) is proposed to store the water into reservoirs and to effectively monitor its distribution. In recent times, use of smart phone has become a second nature of people so we intend to utilize it and develop an android app for the system. Our proposed system is comprised of five nodes, one is master and the other is slaves. Each slave nodes is interfaced with level sensors for identifying the level and actuators like valves to distribute the water. This system is ideal for the irrigation system and water purification plants.**

Keywords—*WSAN, Water Level monitoring and controlling, Smart Phone.*

I. INTRODUCTION

For the past decade cell phones have become a necessary and essential part of our everyday life, we can easily communicate with people from practically anywhere, not only that we can gain useful information as well. Monitoring and control of various devices or system can be easily done with cell phones.

Previously many other systems are designed for the water environments through wireless sensor networks (WSN), but they are mostly used for the monitoring purpose and for this vary reason we proposed and developed this wireless sensor and actuator network to not only monitor but also control the water distribution by utilizing only cell phone.

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Over the years WSN is utilized in various monitoring and control application. It is a very essential way to acquire data from multiple nodes, data acquisition for monitoring and control is the base of our proposed system. Application regarding health care are also implemented using WSN as a means for communication between nodes and to deliver data over long distances. It is also utilized and implemented in various power distribution applications.

In our proposed system, we have designed an android to control the water levels and distribute according to the requirement, it also monitors the overall status of water level which is displayed on smart-phone. The smart phone receives the data using the installed application and the user can control the system if the level reaches to undesirable levels.

I. LITERATURE REVIEW

a. Review Stage

Numerous important articles are discussed based on IEEE 802.11b and 802.11e technology standards commonly used in control and automation applications [1]. IEEE 802.11e EDCA (Enhanced Distributed Channel Access) mode has the tendency to fulfill the task using real-time constrains in industrial applications for even fewer than 10 nodes and sampling time greater than 10ms [2-3].

The power consumed by sensor networks is high therefore several methods are examined previously to reduce the consumption of power using different methods of wireless sensor networks [4-5].

Nowadays, many commercial devices uses Zigbee and Wireless HART (http://www.Zigbee.org, accessed on 7 October 2010), http://www.hartcomm2.org/ [6]. Industries require a secure communications in their control applications. In this paper, the system we have suggested is working with star network because we in this proposed system we have the limited no of nodes that's we don't need more than seven time slots [7].Ranade, Priyanka, and S. B. Takale introduced an irrigation system based on WSN, implemented on FPGA as a core processor [8-9].

Zhou, Shihao, and Liang Zong utilized WSN for monitoring the temperature in different environmental condition used for Melon [10].

b. WSAN System

WSAN technologies made their mark since their introduction in many control based applications with better performance and accuracy. Our proposed system consists a group of sensors and actuators interfaced with each other by a wireless medium to perform their designated tasks. In such networks, sensors gather information of any physical quantity and actuators perform their respective action to cater the environment [11].

The network designed for the communication using wireless protocols, the system is based Star topology as show in Fig.1, the system is centralized based on master-slave technique, and all the devices are isolated from each other [12].
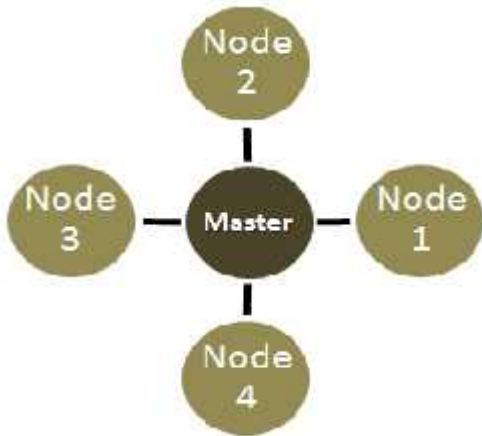

Figure.1: Star Network Topology

c. Centralization

The central hub is basically a bottleneck, if we are to increase its capacity, or even connect some additional devices with the system, it can easily increase the network size. In case of any fault, we don't have to worry about facing any complication regarding its detection in system, we can easily recognize the fault and smoothly remove that from system and more importantly our system will not be halted while removing the fault [13].

II. PROPOSED HARDWARE MODEL

Our proposed system is comprised of five distinct nodes which are deployed at four different locations as four slave nodes and one master node. All slave nodes have Arduino microcontroller as their base controller, ZigBee modules and MAX-232 IC to convert RS-232 serial port signal to suitable signals that should be compatible with TTL digital logic circuits and master node consist of ZigBee and Wi-Fi modules that are synchronized. The network created is based on the centralization technique; the ZigBee of master node coordinates with all slave nodes wirelessly and acquires data with the passage of time continuously. In addition each node as is designed for their appropriate reservoirs and their threshold levels are selected accordingly.

Figure.2: Proposed System Model

a. System Components Justification

i. ZigBeeModules

The method that we used for our proposed model as a means of communication with multiple nodes wireless is a ZigBee module (IEEE 802.15.4 standard), it services as a communication medium use to transmit and recieve data. This module is a standard Transceiver module that is adapted widely both in practical and domestic applications. The selection for this module has been made on the basis of its several charismatic factors like, it does not require licensing from an authority, effective in its compatibility to be used anywhere any time, durability to work even within a confined area as smaller geometric dimensions makes it convenient to be placed, no pairing of the devices is required, automatic node failure recovery, installed and equipped sophisticatedly even within a small area.

ii. Wi-Fi Modules

The purpose for using Wi-Fi module (IEEE 802.11 standard) is the unavailability of the ZigBee interface in smart-phones, for this reason it became essential to co-ordinate the ZigBee with Wi-Fi module to make communication possible between the designed system environment and smart-phone for controlling water level using mobile phone.

iii. A n d r o i d Application

In our proposed system, we develop an android application due to the user's inclination towards Android phones. According to Survey it is evaluated that, 51.8% of smart phone users use Android whereas 34.3% users use

iOS operating systems. Android studio development tools were used to create the Android application using Java and Android API because this environment is user-friendly and simple to configure.

III.   ANDROID APPLICATION

Designed application is titled as "WSAN based Water Reservoir System", the layout consists of four units for controlling with two sub-fields; one is for the displaying of previous water level status and the other is for the next water levels in reservoirs, but observing these two values we can identify weather the level of water is rising or dropping. At right hand side there are four Set-Buttons for relevant units to upgrade the current status of water reservoirs; an Exit-Button is also created to terminate the application.

Figure.3: Android Application

IV.   SYSTEM SOFTWARE MODEL

Fig.4 represents the system flow of the whole model. In our proposed system, we have analysed the water level by implementing the monitoring and control system using smart-phone application using WSAN network.
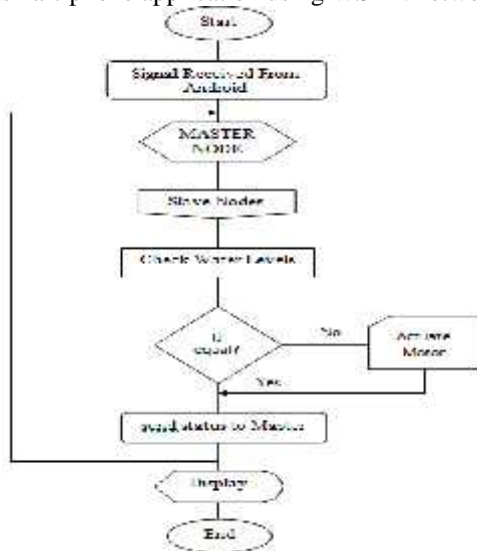

Figure.4: Flow Chart

After the system initialization a signal is generated that is received at coordinator ZigBee from a smart phone through Wi-Fi module that is synchronized with each other. The control signal is further broadcasted through coordinator to the network that includes four slave nodes; this signal is extracted from relevant slave node to perform

specific task according to the threshold levels. At the slave nodes, level of water reservoirs is analyzed either it is previously set at the required range or not; if it is set than the status of the reservoir will be transmitted to Master and from there it is further transmitted to the Smart phone for the users and in other case, if it is not equal to the required level, the valve of a pumping motors will be automatically actuated.

Another important task of our proposed system is to maintain the same water level in all reservoirs at any time, which will be beneficial in irrigation and City water distribution systems; this feature is achieved by comparing the status of all reservoirs and subsequently control signals will be sent towards the nodes, when any of the node's status of the reservoir does not match with others.

V.   RESULTS

The current proposed design is an embedded system which continuously monitors and controls the water levels of reservoirs and reports the status to seven segment display as well as android phone. Table.1. shows that the status lies as follows, range 0-25 indicates that reservoir is quarter filled (25%), 25-50 half filled (50%), 50-75 quarter to fill (75%) and in 75-99 range the reservoir is full (99%).

Table.1: Showing ranges of water levels

Ranges	Status of Levels
0 – 25	25%
25 – 50	50%
50 -75	75%
75 - 99	Full

The status of water reservoirs is also displayed on Seven-Segment, as shown in Figure.5.
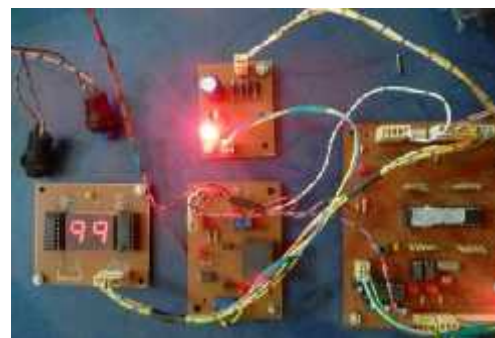

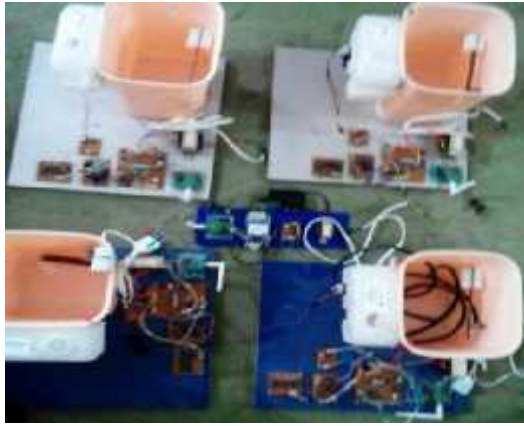Figure.5: Water level status on 7-Segment

Figure.6: Final view of prototype designed

VI.   CONCLUSION

In our everyday life the most expensive thing is Time, we want to do several major tasks within seconds or through just one touch of the smart phone, that's why we have created this smart reservoir system in which we control and monitor the water levels of the reservoirs through mobile phone. In this proposed model we present water reservoir system using WSAN (wireless sensor and actuator network), network is designed using ZigBee and Wi-Fi modules. An application is designed using Android studio which has installed on smart phone. ZigBee technology is one of the fastest technology in all over the world, works on free band frequencies. User transmit a control signal via smart phone using Wi-Fi module to the master node where the Coordinator ZigBee is deployed which further transfers the signal to the slave nodes to monitor the current level and control the valve if needed, it monitors the previous state and the present state to set the level then send the status to master node, if it's not then start pumping motor until reservoir reached up to the desired level then it will stop pumping and send status to master and master will further forward the current status of the reservoirs to android phone through the synchronization of ZigBee and Wi-Fi modules.
Our proposed system can be implemented in any environment and it is capable of handling intelligent decision making. It   is an effective and efficient way to enhance the reservoir systems. This model is very useful for the purpose of controlling water level in a very shortest time.

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