Solar based advanced water quality monitoring system using wireless sensor network

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Abstract- Underwater wireless sensor network is the simple and basic way to monitor the quality of water using wireless sensor network (WSN) technology powered by solar panel. To monitor the quality of water over different sites as a real time application, a base station and distributed sensor nodes are suggested. A WSN technology like zigbee is used to connect the nodes and base station. To design and implement this model powered by solar cell and WSN technology is a challenging work. Through WSN various data collected by various sensors at the node side such as pH, Turbidity and oxygen level are sent to base station. At the base station collected data is displayed as visual and is analyzed using different simulation tools. The advantage in this system is low power consumption, no carbon emission, more flexible to deploy at remote site and so on.

Keywords: WSN, Redox sensor, pH sensor, Turbidity, NTU.

I.INTRODUCTION

In 21st century there were lots of inventions, development, globalization and so on, but in that time there were pollutions, global warming and so on are also be formed, because of this there is no safe drinking water for world's population. Where dirty or contaminated water is used for drinking purpose without any proper treatment in many developing countries. The reason for this is the lack of water quality monitoring system and which creates serious issues.

To take preventive actions for quality maintenance we got an idea that a system should be implemented to monitor the quality of water in easy way, so it can easily analyze some of the critical and important factors of water. Various environmental parameters such as temperature, pH, oxygen density, turbidity and so on from water can be collected by these systems using different sensors. The development of

WSN technology provides us approach to real time data acquisition, transmission and processing.In general the user can get real time water quality data from faraway, but in this system there are several nodes and a base stations where each node contains a group of sensors and the nodes are distributed in different water bodies. By those sensors in water the collected date is sent to base station via WSN channel. Basically a PC with Graphic User Interface (GUI) for user is used as a base station. To analyze the water quality data and when water quality detected is below preset level, Alarm is automatically raised. Using various simulation tools the recoded data can be analyzed for future correspondence and actions.

II.SYSTEM ARCHITECTURE

Water is essential resource of life for each living organism on the earth. In examining quality of water, oxygen level plays important role in water. Health issues of human, plant and living organisms on the earth depends on water quality. Rain, riversand lakes are the main sources of water. Rain water running over the lands contains many useful as well as harmful contents, may be soluble or insoluble. Salt and particles in soil decides the acidity of water. An insoluble particle mixed in the water degrades usefulness of water for particular application, where traditional measure of water quality is transparency.

To measure the oxygen level, acidity, and turbidity of drinking water as well as water that may be used for agriculture and industrial process is the main aim. Water quality measurement parameters by remote access and by using wireless communication facilitates quality control, record keeping and analysis using simulation software at base station. The parameters that are analyzed and control to improve water qualities are oxygen level, pH and turbidity. The objectives of idea implementation are as follows.

- Measurement of pH, Oxygen level and Turbidityof water using sensors at remote place.
- To avail local power supply to sensor nodes using solar energy.
- To collect data from various sensor nodes and send it to base station by wireless channel.
- To control data communication between source and sink nodes. (Synchronization using time division)
- To simulate and analyze quality parameters for quality control. (Graphical and numerical record using VB & MATLAB)
- To publish the corresponding record over web for public information and further assessment of water resource.

The detailed block diagram of water quality monitoring system is shown in Figure 1.

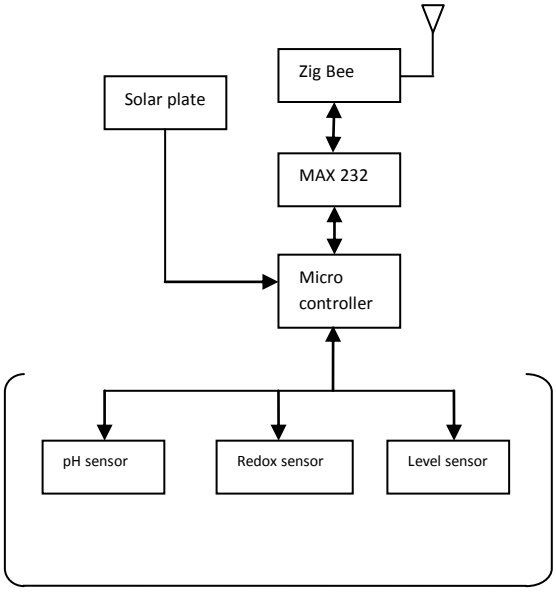


FIG a. Block diagram of transmitter

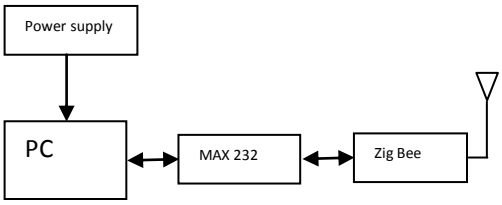


FIG b. Block diagram of receiver

III.HARDWARE DESIGN

We are going to discuss the detailed design of pH sensor interfacing, oxygen sensor interfacing, turbidity sensor interfacing and solar power module in this part.

A.pH sensor interfacing

The high accuracy pH probe IH20 is used as a pH sensor which has output voltage from -412mV to 412 mV. The theoretical output of the IH20 pH probe is approximately 59.16 mV/pH at 25°C, i.e. for acid output voltage is positive, for neutral it is null and for base it becomes negative with 59mV per unit pH starting from null. This output voltage is affected by environmental temperature thus it is required to compensate the temperature factor. The necessary arrangement is done to compensate the temperature effect as shown in Figure 2. Output of IH20 sensor is converted in to 0~2.5V range which is further given to 89S52 processor for processing.

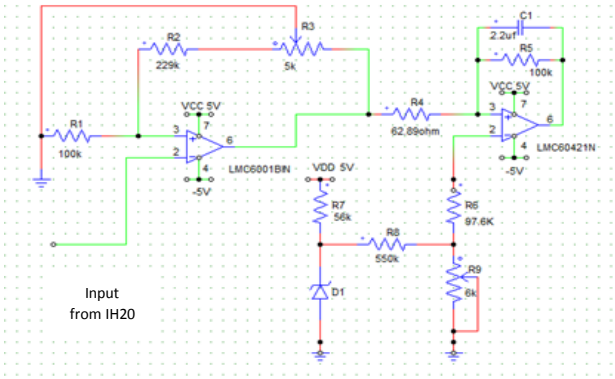


Fig.2 Circuit diagram of IH20 sensor interfacing.

B.Oxygen sensor interfacing

Since ARM controller requires 0-3V voltage to decide logic level (0 or 1), it is required to use amplifier and conditioning circuit to increase the voltage and current level of output from Redox sensor. Redox probe generates a voltage proportional to the amount of free oxygen in the water in the range of 0V to 95V. This sensor is used to measure the density of oxygen in water. The main difficulty of measuring voltage across these probes is that the output impedance of the probe is very high, so a high input impendence component is chosen to match it. The Redox interface circuit is shown on figure 3.

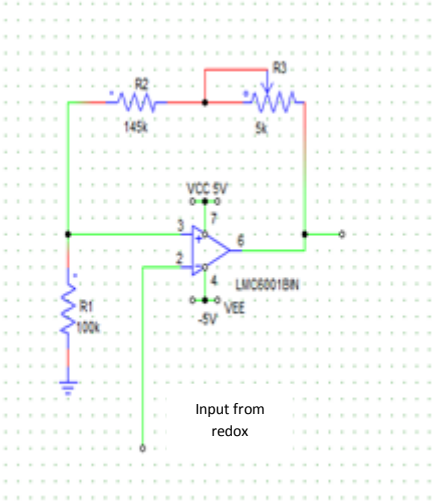


Fig.3 Circuit diagram of Redox sensor interfacing**.**

C.Turbidity level sensor interfacing

Turbidity sensor is to measure the clarity of water, the output voltage range represents turbidity value ranging from 0 to 4000NTU (Nephelometric turbidity unit) Output of circuit is 0~5V which is transferred to 0~3v compatible to ARM controller. The Turbidity level sensor interface circuit is shown on figure 4.

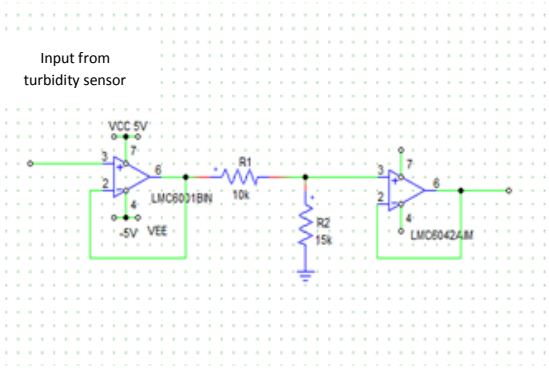
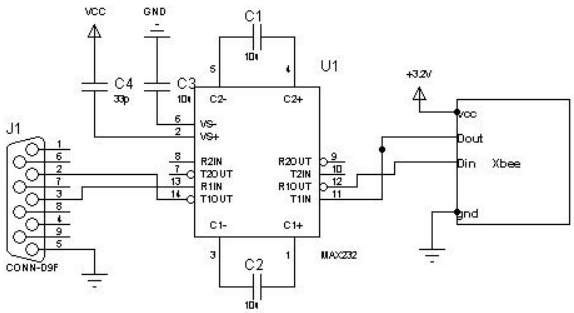


Fig.4 Circuit diagram of Turbidity level sensor interfacing.

D.Zigbee module interfacing

A wireless technology like Zigbee works on standard IEEE 802.15.4 protocol & operates on unlicensed bands worldwide at the frequencies 2.400-2.484GHz, 902-928MHz and 868.0-868.6MHz. Low cost, low power (3.3V), and up to 65000 nodes with an AES encryption standard for communication are the main advantages of Zigbee. Figure 5 shows interfacing of Zigbee with controller board.



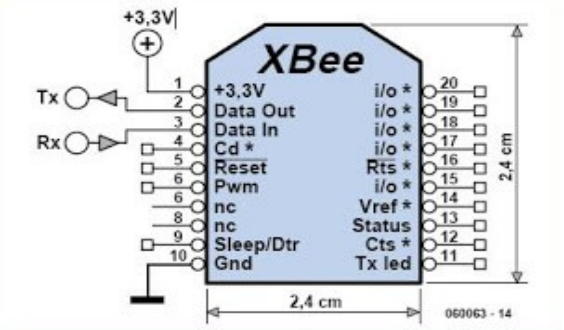


Fig 5 interfacing of zigbee with MC

E.Solar panel interfacing

In a practical water quality monitoring system, where sensor nodes are distributed in remote sites, power supply has become an extremely important issue, sometimes even the bottleneck of the system. Using wires to connect nodes to power lines nearby is not practical, because the nodes usually distribute in remote places, and the total expense in connecting all these nodes is unbearable. Another method is to use battery only. The advantages are obvious, but batteries have limited lifespan and cannot stand for a long time. Replacing depleted batteries regularly is inconvenient. To avoid unnecessary work and make the system more flexible to deploy, solar panel is to use in this system to supply power for the sensor node, together with the battery to recharge when solar power is not enough, such as night.

The output voltage and power of the solar panel used is 13.5V, 1.5W. Since the sunlight changes day and night, a battery with 12V output is needed to store and maintain the output voltage of the solar power module. When the sunlight is strong and solar panel outputs higher than 12V, the regulator turns on, thus solar panel powers remaining blocks and battery is in charging mode. When the sunlight become poor, the regulator turns off & the whole sensor node is powered by 12V battery. Solar Charging controller 12 V/DC, 6 A [M149] is used as a regulator to convert 13.5V into regulated 12V DC. Figure 6 below shows the detailed diagram of solar power module.

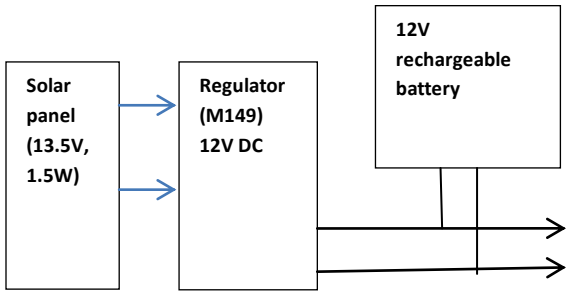


Fig 6 Solar panel power regulation & storage

F.ARM- Base control

All sensors and Zigbee modules are connected to the ARMcontroller board designed for special compact spaceapplication using surface mount technique. RISC processorarchitecture of LPC2148 (ARM7) has many advantages inwater quality monitoring system such as low powerconsumption, low cost, optimum baud rate and maximumoperating frequency (12MHz). On chip ADC is fascinatingfeature of ARM processor that facilitates direct interfacingof sensors to ARM board and reduces space. 3.3V powerconsumption of ARM controller is much lesser thanavailable power from solar module.

IV.SOFTWARE DESIGN

Software design approach for water monitoring system is based on three parts, first is ARM programming, GUI design in VB and MATLAB simulation of results obtained from base module. Detailed flowchart for the working of whole system as well as software design is shown in figure 7.n this system we used MATLAB graphical representation for measuring the various levels of water quality like Ph,turbidity,oxygen level. our proposed flowchart representation is explained as follows

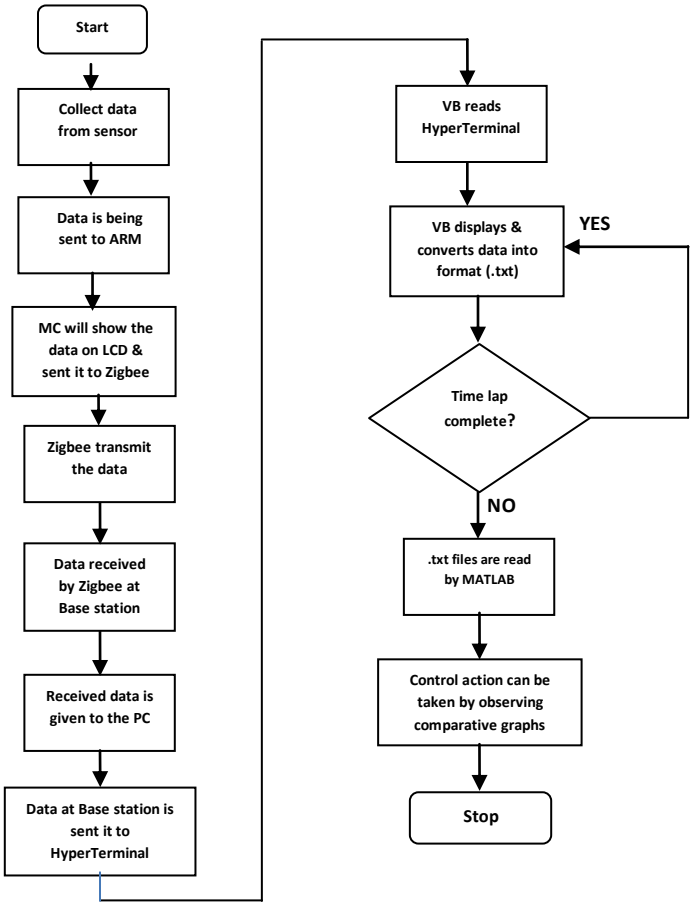


Fig.7 Flow Chart for General Workflow of water quality monitoring system

ARM programming is done in Keil uVision4 IDE software. GUI on PC to display collected data is designed using VB 6.0. For comparative day wise graphical analysis of data collected from sensor nodes is done in MATLAB 7.1.

V.RESULT AND DISCUSSION

The graphical user interface using VB 6.0 is shown in Figure 8. Through WSN channel data collected is sent to the base station. A PC with graphic user interface (GUI) for user is a base stationto analyze water quality data or alarm automatically when water quality detected is below preset standards.

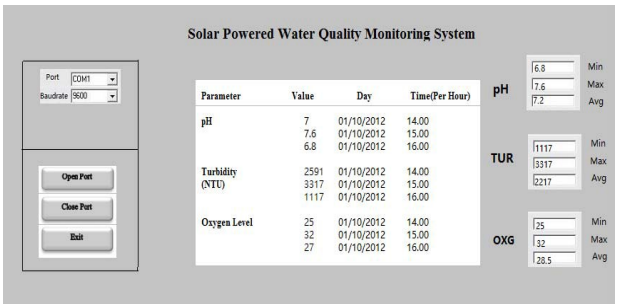


Fig.8 Snapshot of GUI of results displayed on PC.

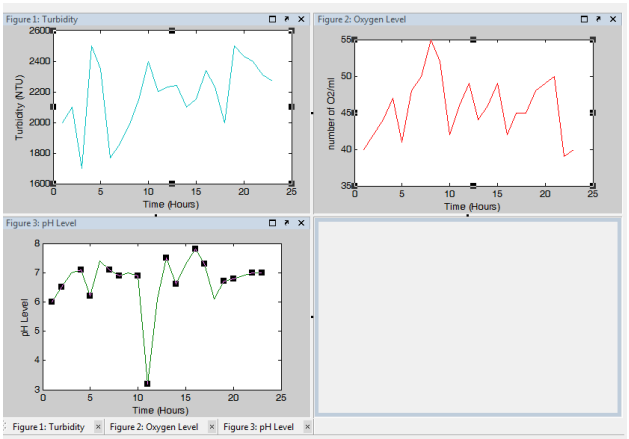


Fig.8 Graphical results in MATLAB displayed on PC

Graphical result in MATLAB is the hourly representation of data collected day wise shown in fig 9. The comparisons between results are used to monitor the seasonal water quality and environmental accidents under water.

VI.APPLICATON & FUTURE SCOPE

- This system checks quality of water at the places where generally it is inconvenient to take frequent tests manually.
- The running water over particular land gets mixed with salt and other materials which change the pH value and turbidity. It is easy to monitored and control the water pollution by this process.
- The higher turbidity and imbalanced of pH in water supply used for drinking, agriculture and industry use is a serious issue. At such place the quality control can be done by monitoring and necessary action for quality improvement.

In order to monitor quality of water in various sites, future works can be focused on establishing a system with more sensor nodes and more base stations. Nodes and base stations are connected as WSN, the different base stations

are connected via Ethernet. The Ethernet can also be connected to internet so the user can just login to the system and get a real time water quality data faraway.

The wireless data acquisition from remote places and database storage is the supporting structure of the system which can be used for further research studies like soil content analysis using different simulators. The simulation can be used for water pollution control in varying conditions. Also it can be used to guess abnormal moments in sea stomach by measuring the turbidity at the sea shore.

VII.CONCLUSION

Sequential follow up of water pollution status in remote region can be archived by monitoring the quality of water & collecting comprehensive data. This system not only provides comprehensive evaluation of water environment but also can quickly discover urgent water pollution accidents or natural disasters, transferring the abnormal water quality information to monitoring center by quicker communication network and provides graphical references for the decision making department to comprehend the status of the disaster to establish the prevention and cure policy.

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