

Remote Water Pollution Monitoring System Using GSM

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Abstract— Water pollution is one of the key threats for the green globalization. To prevent the water pollution, first we have to detect the pollutant. In earlier days, the water pollution was detected by chemical test or laboratory test by using this system the testing equipment will be in stationary and samples will be given to testing equipment. In order to increase the pervasiveness, testing equipment can be placed in the river water and detection of pollution can be made remotely. This paper proposes a Sensor-Based Water Pollution Detection, which will detect the pollutant present in the water and give an alert message to the agent. The sensor pH, turbidity and DO will be kept in the river water surface and the data captured by the sensor will be given to PIC Micro controller, and then the data are transmitted wirelessly using Zigbee module. After calculating the inference from the sensed data, In case of inference value above the threshold value automated warning SMS alert will be sent to the agent. As an additional feature this sensors will be auto powered by Wind based piezoelectric material. The uniqueness of our proposed paper is to obtain the water monitoring system with high pervasiveness, high mobility, and low powered.

Keywords- WSN, PIC 18F4525 Microcontroller, GSM Modem, Sensors, Piezoelectric/Wind Energy: Real time

I.INTRODUCTION

A Wireless sensor network (WSN) consists of spatially distributed autonomous sensor to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one sensor. Each such sensor node has typically several parts radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. There are many opportunities for using wireless sensor networks with in the water/wastewater industries. Facilities not wired for power or data transmission can be monitored using industrial wireless I/O devices and sensors powered using piezoelectric/wind energy or battery packs and also used in pollution control

board. Water pollution is the contamination of water bodies. Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural communities. Water covers over 70% of the earth's surface and is a very important resource for people and the environment. Water pollution affects drinking water, rivers, lakes and oceans all over the world. This consequently harms human health and the natural environment. Here you can find out more about water pollution and what you can do to prevent it. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrheal sickness every day.

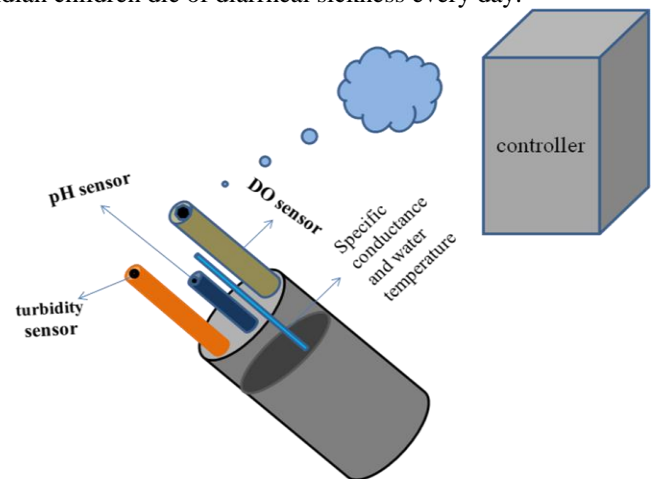


Figure 1. In stream water quality monitor used to continuously measure and specific conductance.

This project automatically measure various water pollution parameter intended using transducer sensor. The output from these sensors is fed to a multi-channel analog to digital converters. This has multiplexed selection of data thus thereby selecting the required input at once [3]. The output of ADC is 8 bit binary data the microcontroller reads the data and then displays in LCD by instructing co running dynamic link library files to read the respective data from parallel port, which is designed with the help of keil C for further communication with ZIGBEE Module [4]. These signals are transmitted through wireless mesh network using ZIGBEE protocol 802.15.4[5]. The collection data from multiple sensors spread over different area. The reading collected by each sensor will be communicated to a Main node /Server /PC Wirelessly. The frequency of operation in ISM band 2.4 GHz or 900 MHz



(Free Channel, No license required). The cost and power consumption of sensor nodes will be minimized by routing sensor data through other nodes in a wireless mesh network using Zigbee. Water is Elixir Of Life essential for human survival & Agriculture However, it is estimated that millions of people worldwide are deprived of safe drinking water. Polluted water is responsible for different kinds of human health problems and accounts for a number of diseases and deaths in India & access to drinking water is a problem for much of the developing world. In India, access to safe drinking water is a challenge. River waters that provide drinking water for population & Agriculture irrigation are considered to be polluted with different types of pollutants coming from industries and mining, untreated sewage and agriculture.

MCU: PIC18F4525 of Microchip Company is introduced as microprocessor, whose interface is rich in resources that can guarantee powerful function, good maintainability and scalability.

GSM: The GSM Association estimates that technologies defined in the GSM standard serve 80% of the world's population, encompassing more than 6 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

RS485/RS232: Maxim series chip is introduced for electrical level conversion.

II. LITERATURE SURVEY

The application of high spectral and spatial resolution airborne remote sensing has developed to an almost operational level. This paper investigates the role of remote sensing especially coupled to the two other available water quality assessment tools: in situ measurements and ecological water quality modeling data. Discussed about the transfer function between water quality and source of pollution. Implemented an automated water monitoring system for west and Rhode Rivers[4]. Author developed a multi-sensor heterogeneous real time water monitoring system using the parameters like ph, temperature, conductivity, turbidity and dissolved oxygen [5]. Monitoring air pollution using zigbee based wireless sensor network with the help of GIS technology [7]. Discussed about the wireless remote monitoring system of water supply based on GPRS had been designed and realized [1]. Environmental water quality, also called ambient water quality, relates to water bodies such as lakes, rivers, and oceans. Water quality standards for surface waters vary significantly due to different environmental conditions, ecosystems, and intended human uses. Toxic substances and high populations of certain microorganisms can present a health hazard for non-drinking purposes such as irrigation, swimming, fishing, rafting, boating, and industrial uses. These conditions may also affect wildlife, which use the water for drinking or as a habitat. Modern water quality laws generally specify protection of fisheries and recreational use and require, as a minimum, retention of current quality standards. GSM was designed with a moderate level of service security. The system was designed to authenticate the subscriber using a pre-shared key and challenge-response. Communications between the subscriber and the base station can be encrypted .The GSM Modem comes with a serial interface through which the modem can be controlled using AT command interface.

An antenna and a power adapter is provided. The basic segregation of working of the modem is as under: voice a calls, SMS, GSM data calls, GPRS.

A. PH Sensor

In the process world, pH is an important parameter to be measured and controlled. The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration- which ordinarily ranges between about 1 and 10×10^{-14} gram-equivalents per litre - into numbers between 0 and 14. On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10×10^0 , 10×10^{-1} , or 10×10^{-2} gram-equivalents per litre) while a very basic solution has a high pH value, such as 12, 13, or 14 which corresponds to a small number of hydrogen ions (10×10^{-12} , 10×10^{-13} , or 10×10^{-14} gram-equivalents per litre). A neutral solution such as water has a pH of approximately 7. A pH measurement loop is made up of three components, the pH sensor, which includes a measuring electrode, a reference electrode, and a temperature sensor; a preamplifier; and an analyzer or transmitter. A pH measurement loop is essentially a battery where the positive terminal is the measuring electrode and the negative terminal is the reference electrode. The measuring electrode, which is sensitive to the hydrogen ion, develops a potential (voltage) directly related to the hydrogen ion concentration of the solution. The reference electrode provides a stable potential against which the measuring electrode can be compared.

The transfer function of the pH electrode is:

$$pH(X) = pH(S) + \frac{(E_s - E_x)F}{RT \ln(10)}$$

pH(X) is unknown solution(x), pH(S) is standard solution 7, E_s -electric potential at reference or standard electrode, F is the faraday constant= 9.6485309 , R is the universal gas constant = 8.314510 , T is temperature in Kelvin.

B. Dissolved Oxygen (DO) Sensor

Dissolved Oxygen (DO) is the term used for the measurement of the amount of oxygen dissolved in a unit volume of water. In water quality applications, such as aquaculture (including fish farming) and waste water treatment, the level of DO must be kept high. For aquaculture if the DO level falls too low the fish will suffocate. In sewage treatment, bacteria decompose the solids. If the DO level is too low, the bacteria will die and decomposition ceases; if the DO level is too high, energy is wasted in the aeration of the water. With industrial applications including boilers, the make-up water must have low DO levels to prevent corrosion and boiler scale build-up which inhibits heat transfer. Although dissolved oxygen (DO) is usually displayed as mg/L or ppm, DO sensors do not measure the actual amount of oxygen in water, but instead measure partial pressure of oxygen in water. Oxygen pressure is dependent on both salinity and temperature.

C. Turbidity Sensor

One of the most important parameters that require monitoring in a wash process is turbidity, a measure of the dirt,

food or other particles suspended in the solution. Industrial grade turbidimeters are used, for example, at water treatment plants to assess water quality in the treatment cycle. These meters are very precise and very expensive Current technology to measure turbidity depends on optical techniques, where water or other fluids pass through a tube or vessel and a beam of light is transmitted through a cross section of the vessel. As the photons that make up a beam of light pass through the liquid being tested, some are reflected by the particles suspended in the solution while others pass through unimpeded. Two optical detectors-one positioned head on to the light source, the other at an angle of 90° to the light source-measure the transmitted and scattered light photons respectively. The dirtier the water, the less light gets through and the more it is scattered. The turbidity of the water is determined by analysis of the ratio of the scattered light signal divided by the transmitted light signal.

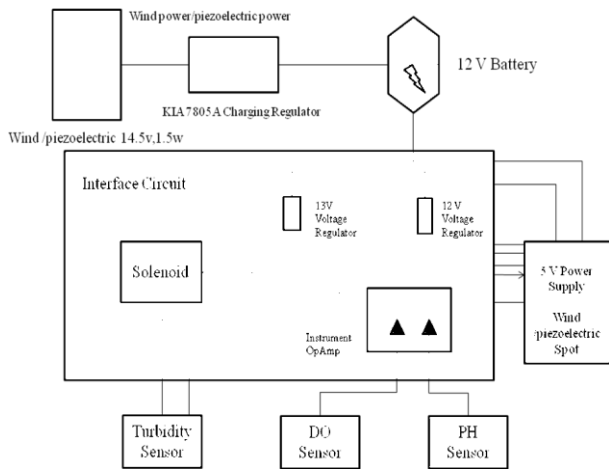


Fig. 2 Detailed Block Diagram of a Sensor Node

II SOLUTION PROPOSED

Pollution is a major problem for environment in the river. Most of the river water is used for drinking purpose and agriculture purpose. Therefore we must identify the collision level in such a way to find the quality of the water at least within limit. The major pollutants of the water or mankind, industrial waste, animal waste get mixed in the river water and pollute it which is unfit for regular usage. In earlier days, the water pollution was detected by chemical test or laboratory test by using this system the testing equipment will be in stationary and samples will be given to testing equipment. In order to increase the pervasiveness, testing equipment can be placed in the river and detection of pollution can be made remotely. Piezoelectric power source is included in this project to drive the power to the controller unit. Moreover alert messages can be sent to the controller via GSM modem.

III SYSTEM ARCHITECTURE

The modules included in the system architecture are as follows,

1. PIC microcontroller
2. ZIGBEE transreciever
3. GSM

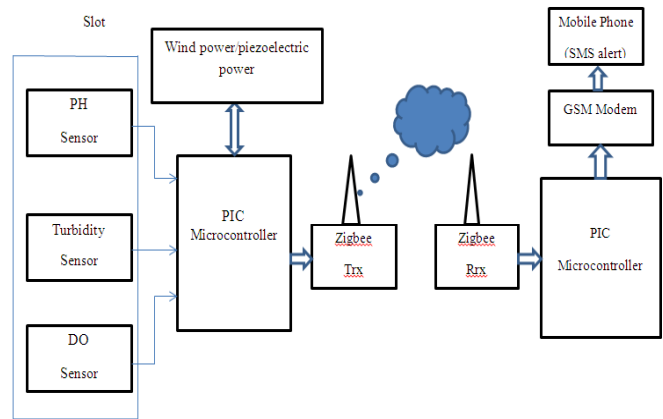


Figure-3 Block diagram for transreciever.

1. PIC Microcontroller

A PIC microcontroller is a processor with built in memory and RAM and you can use it to control your projects. So it saves you building a circuit that has separate external RAM, ROM and peripheral chips.

2. Zigbee Network

Zigbee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks[11]. Applications include wireless light switches, electrical meters with in-home-displays, and other consumer and industrial equipment that require short-range wireless transfer of data at relatively low rates. The technology defined by the Zigbee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. Zigbee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. Zigbee has a defined rate of 250 kbps best suited for periodic or intermittent data or a single signal transmission from a sensor or input device[11][10].

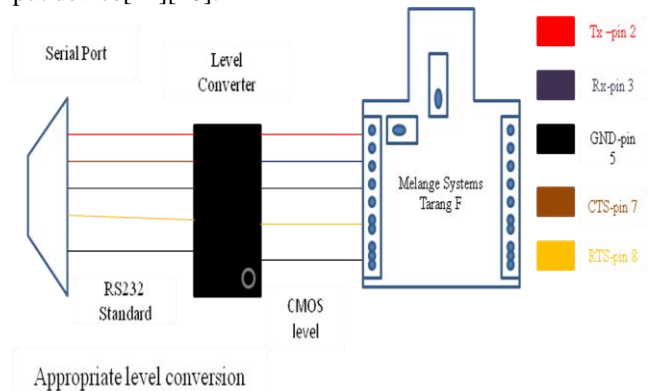


Figure 4-Serial interface with ZigBee

The sensing,transmission and reception has been shown Table 1; depict the presence of sensor for pH, DO and turbidity which obtain the corresponding parameters to be monitored.

3. GSM

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile



operator perspective, a GSM modem looks just like a mobile phone.

A. Hardware Design

The PIC series provides a family of micro controllers which are cost effective, flexible and suitable for a wide variety of applications. PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

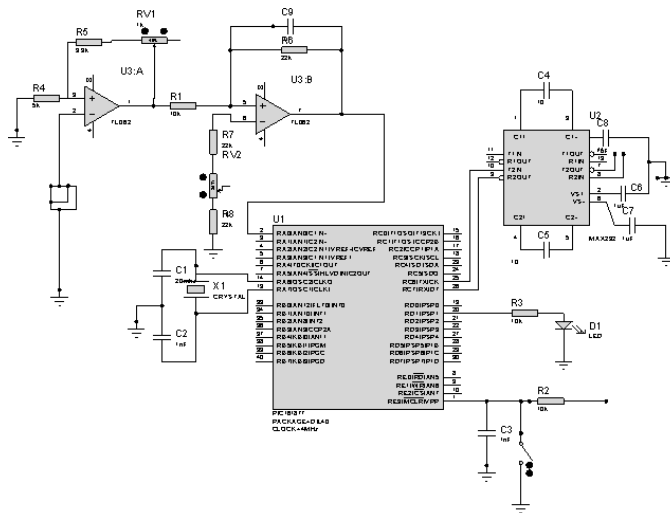


Figure 5- Transmitter Circuit Schematic

A wind turbine is a device that converts kinetic energy from the wind into mechanical energy. If the mechanical energy is used to produce electricity, the device may be called a wind generator or wind charger. The piezoelectric effect converts mechanical strain into electric current or voltage. This strain can come from many different sources

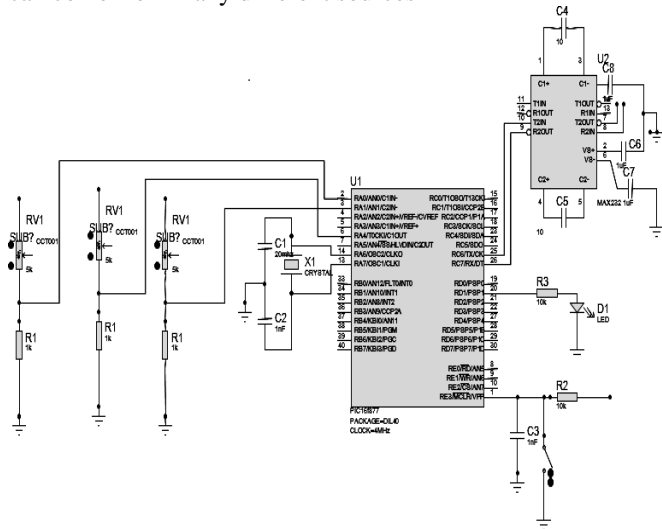


Figure 6- Receiver Circuit Schematic

Data collected by various sensors in the node side such as pH, turbidity and DO Sensor density is sent via WSN to the base station. Simulated signal is given to the PIC microcontroller and there it is changed from analog to digital signal which is

transmitted using the Zigbee transmitter. On the other hand, the transmitted signal is received using the Zigbee receiver. Data are sent out periodically to the nodal agency through automated GSM modem as SMS with detail. In case of measured parameter value is above threshold value automated warnings SMS can also be sent to nodal agency and stakeholders.

B. Software Design

MPLAB Integrated Development Environment (IDE) is an integrated toolset for the development of embedded applications employing Microchip's PIC and PIC microcontroller. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. A project is a group of files associated with languages/tools, such as MPLAB C18, in the MPLAB IDE. A project consists of source files, header files, object files, library files, and a linker script. Every project should have one or more source files and one linker script. Typically, at least one header file is required to identify the register names of the target microcontroller. Header files are typically included by source files and are not explicitly added to the project. The project's output files consist of executable code to be loaded into the target microcontroller as firmware. The monitoring system software of water supply mainly includes the center of network access, data transceiver and safety management, the control of terminal design. The monitoring system software of water supply used for sending and receiving IP packets of TCP protocol realizes communicating with GSM terminal, and can realize real-time or timing data acquisition and the terminal control.

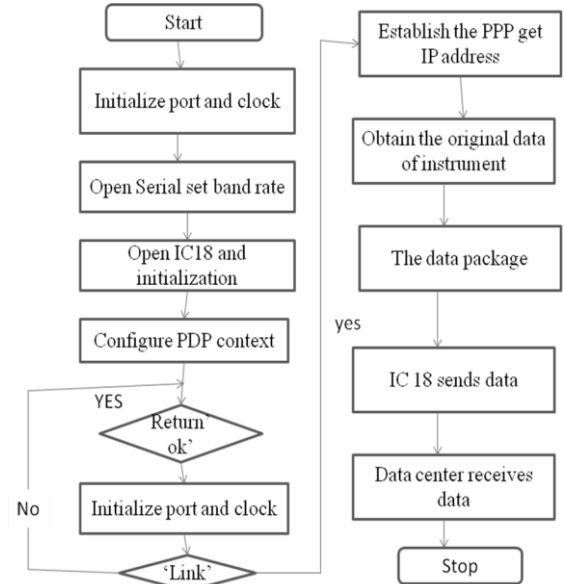


Figure 7- Terminal program flowchart

IV .PROTOTYPE IMPLEMENTATION

The figure 5 shows the simulator board. The main purpose of this board is, to get the analog values from the pH, DO, turbidity and transmit to PC through Zigbee.

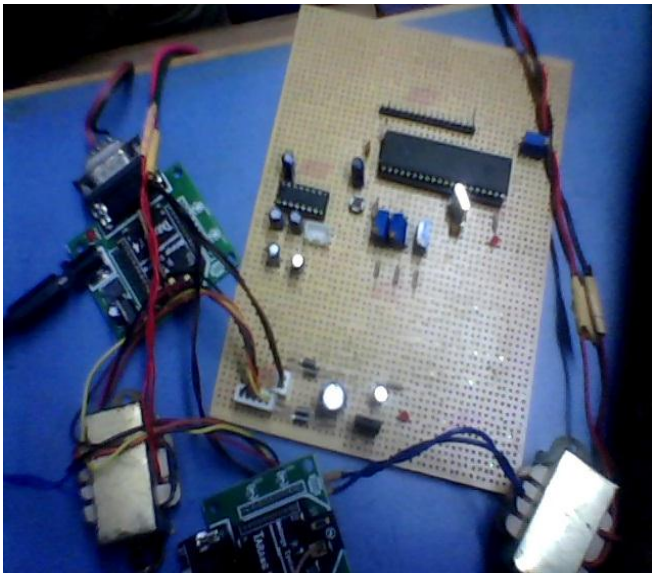


Figure-6- Prototype Simulator Board

V.CONCLUSION & FUTURE WORKS

In this paper, a novel water quality monitoring system based on wireless sensor network is presented. The system is constituted by a base station and several sensor nodes. The sensor nodes are powered by Piezoelectric/Wind Energy module, while data connection between the node and base station is realized using WSN technology (IEEE 802.15.4). In the node side, water quality data is collected by different sensors such as pH, DO and turbidity. This data, after voltage conversion by interface circuit, is sent to Zigbee for wireless transmitting. This paper also presents detailed hardware design of several modules in the sensor node, together with general software flow charts of the acknowledgement receiver and data sender used in transmission. The data transceiver is integrated in Zigbee and is programmable. Finally, the prototype system with a single sensor node and base station is designed and implemented. Real-time water quality data can be seen from a GUI window in PC. The system has advantages such as low carbon emission, low power consumption, more flexible to deploy and so on. In order to monitor water quality in different sites, future works can be focused on establishing a system with more sensor nodes and more base stations. Connections between nodes and base station are via WSN, while connections among different base stations are via Ethernet. The Ethernet can also be connected to Internet so that users can login to the system and get real time water quality data faraway. Another interesting field lies on the optimization of power consumption and data throughput of the WSN.

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