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Smart Water Management with Inteligent Sensing for Metropolitan City using Wireless Communication Protocol

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***Abstract*—** In this project, in order to manage and use the city's water resource reasonably, a wireless monitoring system for water supply based on microcontroller is designed for metropolitan city. This system uses microcontroller of low power and good performance as the main chip, and designs software with μC Windows OS real-time operating system to achieve remote real-time monitoring for water consumption of enterprises. The system will use Zigbee system for communication protocol. The Zigbee is used since the application don't need high speed data rate, need to be low powered and low cost. Each Zigbee node will be connected to the collector node and from collector node the data will be sent to the central computer by using GSM. GSM network with its vast coverage in most countries and also its competitive ever growing market is becoming popular as a medium for machine to machine applications which utilize the GSM network to send its water usage reading using short message service back to the energy provider wirelessly. In a word, this system avoids the work method of the traditional meter-reading and reduces water waste to a certain extent.

Keywords:- *Wireless Communication Protocol (CAN) (Zigbee), GSM, AT89c51, Multiple sensor units*

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I. INTRODUCTION

With continue economic growth, the water demand of enterprises is also increasing. The monitoring of water resource for these enterprises can prevent the occurrence of stealing water and leaking water effectively. Therefore, the monitoring system of water supply in metropolitan has aroused extensive attention in recent years. Such a system is a combination of sensor technology, communication technology and microcontroller technology and this system achieves remote real time monitoring for water consumption of enterprises instead of the traditional meter-reading. There are key elements in a wireless monitoring system: detect water pollution, consumption measurement, meter reading, data transmission, data processing and billing. The system has to be cost-effective. That means reducing the costs of implementation, maintenance, while providing robust and reliable performance. On top of that, the relationship between the customer and the supplier must be considered.

Wireless sensor networks bring advantages in the form of lowering the cost of sensor installation. Lowering the cost is achieved by avoiding the need for cabling, materials and testing which all raise the costs of labour. Secondly, 'the last meter connectivity problem' – cable connectors getting loose, lost, misconnected or broken - is no longer an issue. Wireless automatic meter reading system presented in this text - comprised of a meters with ZigBee radio on one side and database management system on the other side takes into account all of the previously mentioned issues. There some certain specific demands and constraints have to be taken into consideration to provide an effective solution both for the consumer and the supplier, including long battery lifetime, signal range, packet latency, ease of installation and maintenance. Therefore, in hardware design this system uses microcontroller AT89C51 as the main chip. Meanwhile, according to different water consumption and requirements of accuracy, this system uses two different sensors. In software design we use VB.net.

II. SYSTEM OVERVIEW

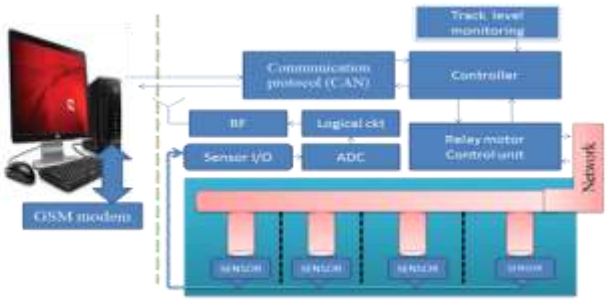

Fig: Block Diagram of System Working

The system will be having digital meter, analog meter, water flow sensor, pH level senor, temp sensor, microcontroller, GSM modem and zigbee module. The output from the digital meter will be pulse .All the data's will be stored in the temporary storage buffer. Output from analog sensor will be amplified by amplifier section send through a serial channel. The microcontroller will be programmed such that sensor data, i.e. meter readings will be sent to the zigbee module. The power source will be operated by the Li battery

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of 5 volts. The GSM module will transmit the reading through the antenna i.e. transreciever. The antenna used in the module is micro strip antenna. Every monitoring point is composed of the controller module, the sensor module and the communication module. The controller module is composed of microcontroller, memory, serial port, led and so on. Controller interface with a zigbee module to transmit and receive a data. The system uses Zigbee module for communication. The communication unit will be consists of a zigbee module attached with a Transceiver micro strip antenna, microcontroller. These features meet the design's requirements of the system. The data which is transmitted from the AMR module will be received in the base station unit. The Base station unit will be consists of a zigbee module attached with a Transceiver micro strip antenna, microcontroller and GSM modem. The data will be collected in the base station unit from each and every node. As the whole user data (user account number, address, water usage etc…) store at remote server. All these user data monitor and handle by software. We introduce a prepaid and postpaid plan for subscriber.

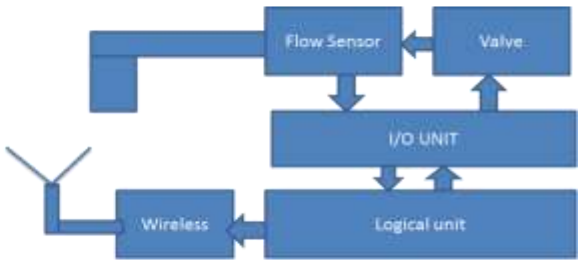

Fig: Block Diagram Of subscriber control section Working

Subscriber control section consists of water flow sensor, water auto valve, logic unit and zigbee. Water flow sensor measure the flow rate of a water flows through the pipeline. As if water flow rate increases at a certain level then microcontroller gives a command to auto valve to block water flow to the user. This will avoid a water stealing. Depend upon use activity all the data receive by a i/o unit and transmit over a wireless. Logical unit follows a decision by a microcontroller.

III. GSM TECHNOLOGY OVERVIEW

GSM (Global System for Mobile Communications, originally Group Special Mobile), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second-generation (2G) digital cellular networks used by mobile phones. As of 2014 it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories. 2G networks developed as a replacement for first generation (1G) analog cellular networks, and the GSM standard originally described a digital, circuit-switched network optimized for full duplex voice telephony. This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems.

Specification

- E-GSM 900/1800 MHz and GSM 1800/1900 with GSM Phase 2 / 2+
- Output Power Class 4 (2W) at GSM 850/900 MHz and Class 1 (1W) at GSM 1800/1900 MHz
- Control via AT commands (ITU, GSM, GPRS and manufacturer supplementary)
- Supply Voltage range: 3.22 V - 4.2 V, nominal: 3.8 V
- Built in SIM Card holder
- Normal operation temperature: -20 °C to +55 °C

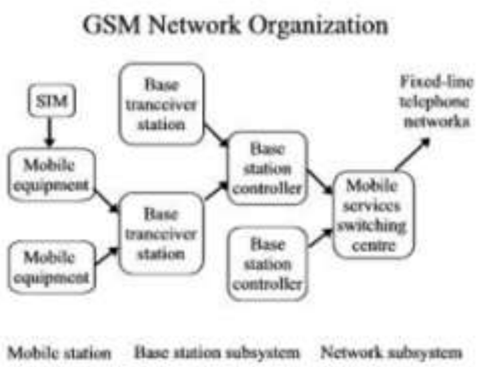

Fig: Network Architecture

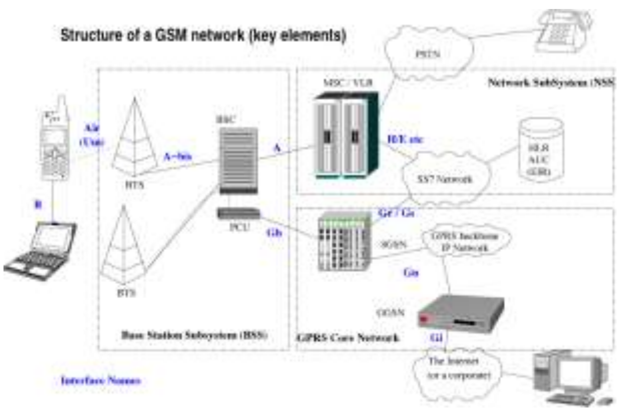

Fig: Key Elements in GSM

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Fig: GSM Modem SIM900

IV. WIRELESS COMMUNICATION PROTOCOL (CAN)(ZIGBEE)

A controller area network (CAN bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a host computer. It is a message-based protocol, designed originally for automotive applications, but is also used in many other contexts. Development of the CAN bus started in 1983 at Robert Bosch GmbH.[1] The protocol was officially released in 1986 at the Society of Automotive Engineers (SAE) congress in Detroit, Michigan. The first CAN controller chips, produced by Intel and Philips, came on the market in 1987.Bosch published several versions of the CAN specification and the latest is CAN 2.0 published in 1991. This specification has two parts; part A is for the standard format with an 11-bit identifier, and part B is for the extended format with a 29-bit identifier. A CAN device that uses 11-bit identifiers is commonly called CAN 2.0A and a CAN device that uses 29-bit identifiers is commonly called CAN 2.0B. These standards are freely available from Bosch along with other specifications and white papers.[2]In 1993 the International Organization for Standardization released the CAN standard ISO 11898 which was later restructured into two parts; ISO 11898-1 which covers the data link layer, and ISO 11898-2 which covers the CAN physical layer for high-speed CAN. ISO 11898-3 was released later and covers the CAN physical layer for low-speed, fault-tolerant CAN. The physical layer standards ISO 11898-2 and ISO 11898-3 are not part of the Bosch CAN 2.0 specification. These standards may be purchased from the International Organization for Standardization (ISO).[3]CAN in Automation (CiA) also published CAN standards; CAN Specification 2.0 part A and part B, but their status is now obsolete (superseded by ISO 11898-1).[4]Bosch is still active in extending the CAN standards. In 2012 Bosch released CAN FD 1.0 or CAN with Flexible Data-Rate. This specification uses a different frame format that allows a different data length as well as optionally switching to a faster bit rate after the arbitration is decided. CAN FD is compatible with existing CAN 2.0 networks so new CAN FD devices can coexist on the same network with existing CAN devices.

ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15.4 standard. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking. ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device.

Features

- Support for multiple network topologies such as point-to-point, point-to-multipoint and mesh networks
- Low duty cycle – provides long battery life
- Low latency
- Direct Sequence Spread Spectrum (DSSS)
- Up to 65,000 nodes per network
- 128-bit AES encryption for secure data connections
- Collision avoidance, retries and acknowledgements

Fig: Applications in Various Fields

Fig: Application of CWPAN

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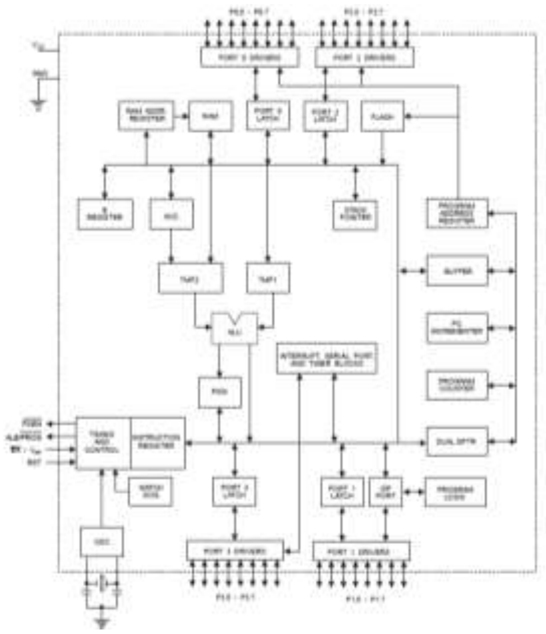
V. MICROCONTROLLER (AT89C51)

The P89V51RD2 is an 80C51 microcontroller with 64 kB Flash and 1024 bytes of data RAM.A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twice the throughput. Another way is to keep the same performance by reducing the clock frequency by half, thus dramatically reducing the EMI. The Flash program memory supports both parallel programming and in serial. In-System Programming (ISP) allows a device to be reprogrammed in the end product under software control. The P89V51RD2 is also In-Application Programmable (IAP), allowing the Flash program memory to be reconfigured even while the application is running.

Features

- AT89C51 Central Processing Unit
- 5 V Operating voltages from 0 to 40 MHz.
- 64 kB of on-chip Flash program memory with ISP and IAP.
- Supports 12-clock (default) or 6-clock mode selection via software or ISP.
- SPI (Serial Peripheral Interface) and enhanced UART
- Four 8-bit I/O ports with three high-current Port 1 pins (16 mA each).
- Three 16-bit timers/counters.
- Eight interrupt sources with four priority levels.
- Low power idle and Power-down modes.
- Power-down mode with external interrupt wake-up.



VI. MULTIPLE SENSORS OVERVIEW

1. Water level sensor

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. This one is suitable to detect flow in water dispenser.

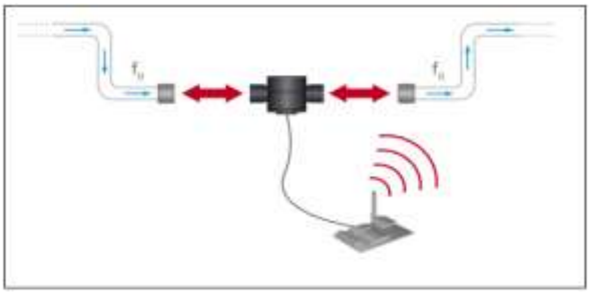


Fig. water flow Sensor diagram

Specifications

- Minimum Working Voltage: DC 4.5V
- Maximum Working Current: 15mA (DC 5V)
- Working Voltage: DC 5V~24V
- Flow Rate Range: 1~30L/min
- Load Capacity: ≤10mA (DC 5V)
- Operating Temperature: ≤80℃
- Liquid Temperature: ≤120℃
- Operating Humidity: 35%～90%RH
- Water Pressure: ≤1.75MPa

2.Temperature Sensor

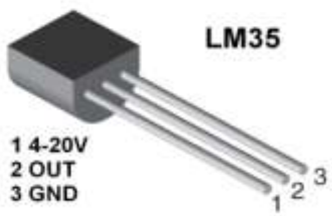


Fig. Temperature Sensor

The LM35 is precision integrated-circuit. Directly in Celsius (Centigrade) with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear range temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical at room temperature and ±¾°C temperature range. Lower cost is assured by trimming and calibration at the typical wafer level. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to read out or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range, while the LM35C device is rated for a −40°C to 110°C range (−10° with improved accuracy).

Specifications

- The LM35 series are precision integrated-circuit
- Linear + 10-mV/°C Scale
- 0.5°C Ensured Accuracy (at 25°C) LM35
- Rated for Full −55°C to 150°C Range
- Low-Impedance Output, 0.1 Ω for 1-mA load
- Non-Linearity Only ±¼°C
- Low Self-Heating, 0.08°C in Still Air over
- Less than 60-µA Current Drain
- Operates from 4 V to 30 V

3. pH Level Sensor

Fig. pH Level Sensor

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 x -14 gram-equivalents per liter - 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 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.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. When immersed in the solution, the reference electrode potential does not change with the changing hydrogen ion concentration. A solution in the reference electrode also makes contact with the sample solution and the measuring electrode through a junction, completing the circuit. Output of the measuring electrode changes with temperature (even though the process remains at a constant pH), so a temperature sensor is necessary to correct for this change in output. This is done in the analyzer or transmitter software.

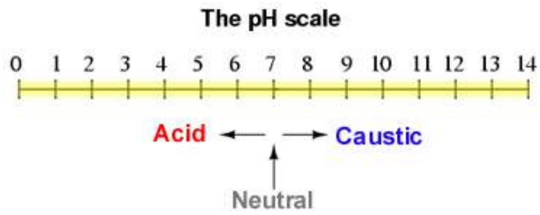


Fig. pH measurement

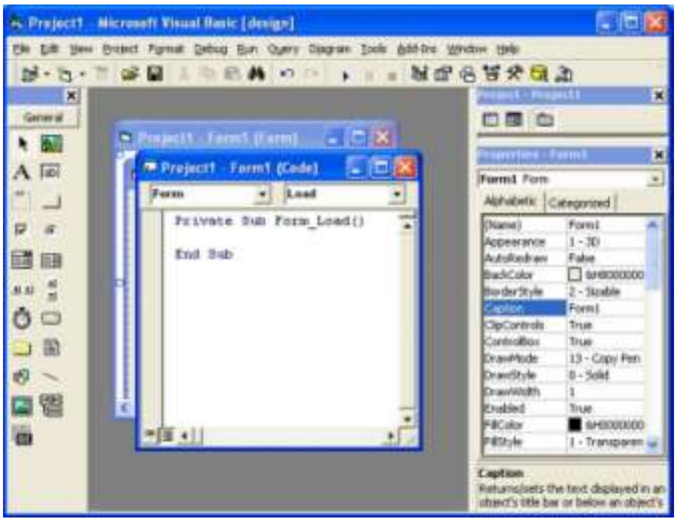
Specifications

- pH Range: 0-14 (Na+ error at >12.3 pH)
- Operating temperature: 1°C - 99°C
- Max PSI: 690 kPa (100PSI)
- Speed of Response: 95% in 1 second
- Isopotential point: pH 7.00 (0 mV)
- Dimensions 12mm X 150mm (1/2" X 6")

VII. SOFTWARE REQUIREMENT

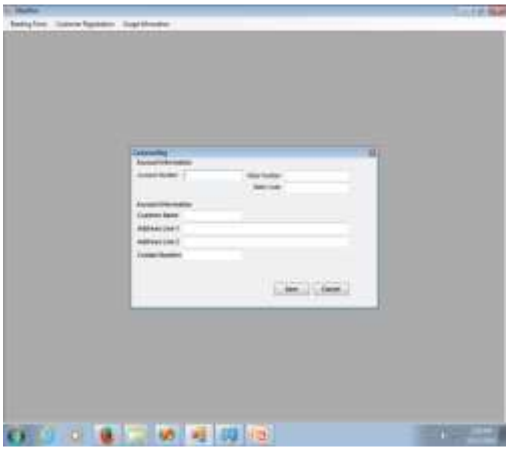
1. Visual basic .net

VISUAL BASIC is a high level programming language which evolved from the earlier DOS version called BASIC. BASIC means Beginners' All-purpose Symbolic Instruction Code. It is a relatively easy programming language to learn. The code looks a lot like English Language. Different software companies produced different versions of BASIC, such as Microsoft QBASIC, QUICKBASIC, GWBASIC, IBM BASICA and so on. However, people prefer to use Microsoft Visual Basic today, as it is a well developed programming language and supporting resources are available everywhere.



2 Graphical User Interface (GUI)

GUI is universal graphical software for embedded applications that provides an efficient processor and LCD controller-independent GUI to applications using a graphical LCD. Designed for single and multi-task environments, µC/GUI is adaptable to nearly any size physical or virtual display with an LCD controller and CPU, and is delivered with all source code. µC/GUI is compatible with nearly all CPUs and, unlike other GUIs that require a C++ compiler, µC/GUI is written entirely in ANSI-C. Processors ranging from 8- to 32 -bits run µC/GUI. 16-bit CPUs (or better) achieve optimal performance



VIII. APPLICATIONS AND FUTURE SCOPE

Use in mega city or metropolitan city.

To make the individual water recycling facilities a sustainable part of the social infrastructure by using innovative membrane technology that can provide low-cost water treatment.

The increasing demand for water arising from global population growth and urbanization in recent years is stressing the water supply to its limits. On the other hand, water infrastructure such as pipes has been deteriorating due to aging. Under these conditions, new technologies in the water infrastructure have been required to enable the distribution of high quality water to users in a safe and cost-effective manner, from the perspective of efficiently using our world's precious water resources.

Can be used at a mega plant to provide pure and safe water to workers.

Urban water systems face sustainability and resiliency challenges including water leaks, over-use, quality issues, and response to drought and natural disasters. Information and communications technology (ICT) could help address these challenges through the development of smart water grids that network and automate monitoring and control devices. While progress is being made on technology elements, as a system, the smart water grid has received scant attention. This system aims to raise awareness of the systems-level idea of smart water grids by reviewing the technology elements and their integration into smart water systems, discussing potential sustainability and resiliency benefits, and challenges relating to the adoption of smart water grids. Water losses and inefficient use stand out as promising areas for applications of smart water grids. Potential barriers to the adoption of smart water grids include lack of funding for research and development, economic disincentives as well as institutional and political structures that favor the current system. It is our hope that future work can clarify the benefits of smart water grids and address challenges to their further development. Due to smart water management and intelligent sensing it avoids shortage of drinking water in exiting generation also introducing indirect awareness to water in future

IX. RESULT AND CONCLUSION

A wireless monitoring system of urban water supply based on the AT89c51 microcontroller is designed. It takes full advantage of low-power and efficient these features make this system work in harsh industrial site properly. At the same time, the use of embedded operating system µC/OS-II makes this system more coherent and concise. Other, the electromagnetic flow meter produces non-linear output because of interference by a strong current .By simulation and debugging, for the work point the first order Taylor expansion's method can solve such problem. The system use ZigBee and GSM system for communication protocol provides low cost and long distance communication which helps in monitoring water supply in metropolitan city. The development of the wireless monitoring system can reduce the waste of water resources substantially, and make the management of water even more effective and convenient in the city

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