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Design and Implementation of IoT Enabled Process Station

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Abstract: In this paper a scheme for developing Process parameter monitoring through web server is proposed. A part of IoT that is Wireless Sensor Network (WSN) can be formed using Arduino and Raspberry Pi which is inexpensive, programmable small computer with support network communication. This work proposes a methodology to monitor the process parameters like liquid flow, temperature and level which are involved in a particular process through web server and to control these parameters in local control station. A Web server can be formed at process end by Raspberry Pi which displays sensor data information on a web page. Sensor data can be stored on MySQL database server configured in Raspberry Pi.

Keywords: Arduino, Raspberry pi, XBee, Wireless Sensor Network.

1. INTRODUCTION

The world of automation is an exciting field that has exploded with new technologies and the "Internet of Things" (IoT) is an emerging field now a days. Internet-of-Things visualizes a future in which digital and physical entities can be linked, by means of appropriate information and communication technologies.

The IoT, can be viewed as a highly dynamic and widely distributed network system. The web application associated with this concept gives a dynamic nature to it. It is the network of physical objects, devices and other items which are built with sensors, electronics, software and network, which enables these objects to collect and exchange data. It is a system comprising no of identifiable components that all can be able to communicate and to interact, either themselves or with end-users or other entities in the network. Also it allows sensing and controlling of the objects remotely across already existing network infrastructure, creating opportunities for more direct integration of the physical world into digital world, and resulting in improved efficiency, accuracy and economic benefit.

Wireless automation systems, which can be possible by smart devices that sense physical information and translate them into a stream of information data. It maximizes the safety, security, comfort, convenience and energy-savings. The basic building elements of Wireless automation systems are sensor networks and Local Management System. Using Sensor Web elements, as a unit of IoT, in compare to the standard sensor elements, the communication infrastructure rapidly changes from local to global, moving a Local Management System to global level too. Thus automation systems can be viewed as a mechanism removing as much as human interaction by technically and desirable in various processes and replacing them with programmed electronic systems.

In this work, the physical world to the virtual world interaction can be accomplished by Wireless Sensor Network. WSN combines sensing, computation and communication into a single tiny device. These are autonomous devices to monitor physical parameters or to monitor environmental conditions like pressure, humidity, temperature etc. The most modern networks are bi-directional, that property enabling control of sensor activity. Through mesh networking protocols, these devices form a no of connectivity that extends the physical world to reach cyberspace. The most application of WSN is remote environmental conditions

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monitoring. Unlike wired systems, deployment costs would be minimal. The Lifespan, Coverage and Security are the primary metrics of WSN. It is always advantageous to have the ability to deploy network over a larger area. This can considerably increase a value of the system to the end user. The number of nodes in the system will directly impact the lifetime or sample rate. More sensing nodes in the system will cause more to be transmitted that will increase the power consumption of the network. But the fact is power consumption will reduce the lifetime.

Sensor network, like most embedded systems, needs to be closely coupled to their applications. However, the complexity of implementing wireless sensing and actuation systems have reduced with the help of aforementioned recent advancement in technology and have made it fairly easy to implement a prototype system for proof-of-concept and demonstration purposes. In this paper, we present a WSN system developed using open-source hardware platforms, Arduino and Raspberry Pi, and the ZigBee module. Such a design has the advantages of less in cost, easy to build and maintain, as compared to some previous designs such as the TEO system.

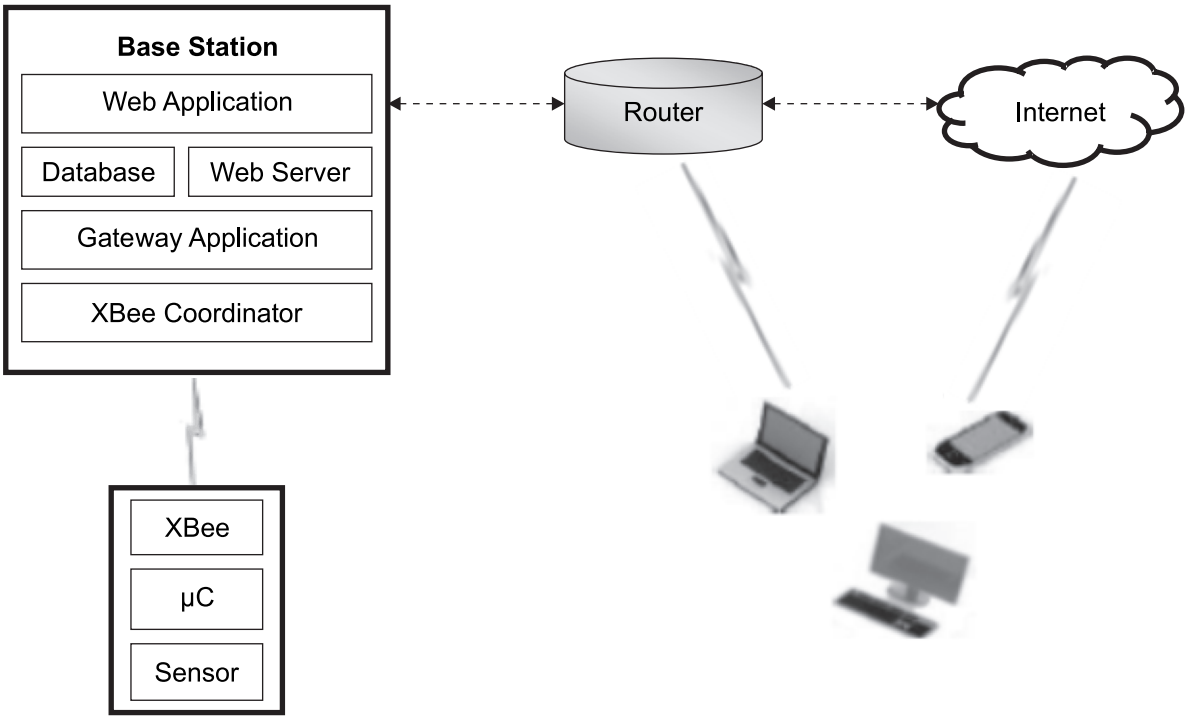

Figure 1: Overall System Architecture

2. SYSTEM ARCHITECTURE

Building a WSN system requires development and integration of many software and hardware components. The system includes a base station and Process station (sensor node). Sensor node is a combination of sensors, microcontroller (µC), and a ZigBee radio transceiver. In addition, the user requirements can be programmed as application program on each sensor node, that program will handle the sampling data from sensors in a well-defined manner and communication with the base station.

The sensor node will collect the sensor data and process the data to interact with digital world and it will work in physical and data link layer. The base station will get the processed sensor data and further it will script the data for web application and it will do network layer function. The XBee module on the base station is configured as coordinator and the XBee module on the sensor node is configured as router. We also implemented a gateway application in the base station to support remote online configuration and management of sensor nodes. It is used to control the behaviour of the distributed sensor nodes and to

query all or to retrieve data from the selected set of sensor nodes. AMP is a open-source web application software stack for network function. The base station also includes a relational database management system MySQL for data storage and management. This will periodically update the data and also request for the data. To access the sensor nodes and the data from the physical world, web application is developed on the base station using the Apache HTTP web server. Figure 1 shows the overall system architecture of the wireless sensor network system that have developed.

A web application is developed to provide users a convenient interface to the system through web. Users can interact with the web application within the Local Area Network (LAN) or from any other terminal on the Internet to access the sensor data or to perform remote configuration and management of deployed sensor nodes.

3. DESIGN OF HARDWARE AND SOFTWARE COMPONENTS

Design of Sensor Node

In this proposed system, monitoring of process parameters like flow, level and temperature of liquid can be done using electro-valve, flow sensor, level sensor, temperature sensor, microcontroller, microcomputer and web server. Arduino and Raspberry Pi will get the physical information from sensors and process it for further application.

The sensor node unit will be formed using Arduino and XBee modules. Arduino is a single board micro controller intended to make the application of interactive objects or environments more accessible. Arduino consists of both a physical programmable circuit board and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board. For wireless communication, we used the commercially available XBee Pro S2B. Indoor communication range of the XBee module is 90 m whereas coverage is nearly 2 miles. With low power consumption property and data rates up to 250 kbps, XBee devices are particularly suitable for fast prototyping for WSN applications. Process parameter sensor senses the Physical reading which is analogue in nature. Arduino will get this data and convert it in to digital stream for interface sensor data into digital world (Internet). Then sensor node side XBee module sends the digital data to base station.

Design of Base Station

A low power single-board Raspberry Pi and XBee module forms the base station unit. It is capable of doing the entire job that an normal computer does Like spread sheets, word processing, Internet, Programming, Games etc. This CPU on the board is an ARM processor family with 700 MHz clock speed. It consist of 512mb RAM, 2 USB and an Ethernet port, HDMI port, 3.5 mm Audio jack, bootable SD card slot, General purpose Input/output pins, runs on 5 V. It runs on Linux based operating systems. It boots and runs the SD card contents. It have only ROM memory and does not have any internal memory. Its GPIO pins are programmed using Python programming language.

The main actions carried out by base station are gateway application, database maintenance, and web application. Raspberry Pi is connected to the XBee coordinator. The gateway application is the intermediate layer between sensor network and database. This layer will sends out configuration and data collection commands to sensor nodes and inserts the data received from sensor ends into the database. The gateway application is programmed in Python that comes built-in with Raspbian. The web application can be built using Apache Tomcat HTTP web server and the web services at server-side are programmed in PHP. Users can access the web interface through Ethernet or Wi-Fi connection within the local area network (LAN) or from anywhere through the Internet when configured on the router.

Design of Web Interface

The web interface at client-side can be implemented using, JavaScript, HTML, jQuery. The configuration requests generated by users on the web interface are asynchronously sent to web service on the server and the requests are added into a command table in the MySQL database. The gateway application periodically monitors the command table for any updates to be sent to sensor nodes. The command table maintain by database is used to share data between gateway application and web application.

The process station and base station can work independent of web application. Authorized users can directly access the data and command tables maintain by the database and remotely configure sensor nodes from Raspberry Pi by logging into its Linux system. The web application can also be updated without interfering or interrupting sensor nodes and the gateway application residing inside the Raspberry Pi. This design makes it very convenient for system which is application-specific and revisable.

4. CONCLUSION

This paper presented designing of a wireless sensor network system with Arduino, Raspberry Pi, XBee and a number of open-source software packages for monitoring process parameters like liquid flow, level and temperature. The system has a number of attractive features, including low-cost, compact, scalable, easy to customize, easy to deploy, and easy to maintain. Major advantage of this design lies in the integration of the gateway node of sensor networks, database server and web server into one single compact, low-power, card-sized computer Raspberry Pi. This work can be extended to liquids that are used in various industries with careful considerations of parameters like pressure, corrosion etc. with appropriate use of sensors.

References

1. Vinay Raghavan and Hamid Shahnasser "*Embedded Wireless Sensor Network for Environment Monitoring*". Journal of Advances in Computer Networks Vol. 3, No. 1, March 2015.
2. Vladimir Vujovic, Mirjana Maksimovic "*Raspberry Pi as a Sensor Web node for home automation*". Elsevier 44 (2015).
3. Won-Suk Jang, William M. Healy, Mirosaw J. Skibniewski "*Wireless sensor networks as part of a web-based building environmental monitoring system*". Elsevier 17 (2008).
4. Kandov, I., Aleksandrov, A.,Goranov, G., Kanev, J "*Web based system for control and measure parameters of sensor network*" Information Technology Based Higher Education and Training (ITHET), 2014.
5. Arduino.cc. (2014). *Arduino — ArduinoBoardMega2560*. Available: http://arduino.cc/en/Main/arduinoBoardMega2560.
6. Vujovic V, Maksimovic M. "*Raspberry Pi as a wireless sensor node: performances and constraints*", The 37th International ICT Convention – MIPRO 2014, ISSN 1847-3938, ISBN 978-953-233-078-6, Opatia, Croatia 2014.
7. Maksimovic M, Vujovic V, Davidovic N, Miloševic V, Perišic´ B. "*Raspberry Pi as Internet of things hardware performances and constraints*", IcETRAN, 2014.