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Remote Monitoring of Industrial Process Monitoring System using Wireless communication

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ABSTRACT: This paper proposes an advanced system for process management via a credit card sized single board computer called raspberry pi based multi parameter monitoring hardware system designed using RS232 and microcontroller that measures and controls various global parameters. The system comprises of a single master and multiple slaves with wireless mode of communication and a raspberry pi system that can either operate on windows or linux operating system. The parameters that can be tracked are current, voltage, temperature, light intensity and water level. This paper provides a survey on implementing wireless sensor network (WSN) technology on industrial process monitoring and control. First, the existing industrial applications are explored, following with a review of the advantages of adopting WSN technology for industrial control. Then, challenging factors influencing the design and acceptance of WSNs in the process control world are outlined, and the state-of-the-art research efforts and industrial solutions are provided corresponding to each factor. Further research issues for the realization and improvement of wireless sensor network technology on process industry are also mentioned.

Keywords: Process Monitoring and Control, Quality of Service, Reliability, Topology Control, Wireless Sensor Networks

(I) INTRODUCTION

Wireless sensor network technology has demonstrated a great potential for industrial, commercial, and consumer applications. Specifically, in process monitoring and control, process data such as pressure, humidity, temperature, flow, level, viscosity, density and vibration intensity measurements can be collected through sensing units and transferred wirelessly to a control system for operation and management. Adopting WSNs for process monitoring and control provides great advantages over traditional wired system. As a ubiquitous technology, general issues regarding WSNs have been extensively researched in the academic arena. However, WSN technology is not considered mature enough to be widely implemented in process control applications. Even though wireless transmission of data has been utilized for over ten years in process control applications such as supervisory control and data acquisition (SCADA), industrial WSN products for process monitoring and control are not commercially available until recently due to its specific requirements and challenges.

Researchers have explored the various aspects on applications of WSNs in process industry. Also, there have been tremendous efforts toward the product research and development in industry. In addition to reviewing the recent research and development achievements, this paper will also analyze special issues for implementing WSN technology on industrial process monitoring and control. The rest of this paper is organized as following. we will briefly introduce the process control system and discuss the industrial trend and achievements toward WSN applications. Wireless communication is very important concept and it plays an important role in various industries of automation field. Today the application of wireless communication in industrial automation is increasing rapidly. The method of communication which was used previously is not so beneficial and efficient for the fulfilment of today's industrial needs. Data Acquisition systems with remote accessibility are in great demand in industry and consumer applications. In some applications human beings have been replaced by unmanned devices that will acquire data and relay the data back to the base. A single person can monitor and even interact with the ongoing work from a single base station. Some applications are built to collect and send data through a modem to a server.

Wireless based industrial automation is a prime concern in our day-to-day life. The approach to Wireless Network for Industrial Applications standardized nowadays. Intelligent and low-cost automation of industrial processes are crucial in order to improve process efficiencies, deliver quality products, and ensure timeliness and accuracy of systems. Wireless is predicted to be one of the fastest growing technologies in the area of process automation sector. Industrial automation systems comprise of various field devices and technologies working in synchronization. These devices are responsible for a variety of functions related to Instrumentation, control, supervision and operational management.

The embedded web server network consists of advanced processor Raspberry Pi. It is having RISC architecture. An embedded web server creates an easy way for monitoring & controlling any device which is at remote place. For designing the system we require remote pc & a Smartphone along with the internet facility at the remote locations. We implement a system which is portable, low cost & having less maintenance by using GPRS technology. GSM network has in-built powerful TCP/IP protocol stack for internet data transfer over GPRS technology. Therefore the status of different sensors installed at working place is monitored at anywhere in the world. The reporting of this real-time data corresponding to the process plants is therefore be of great use for future analysis.

II. LITERATURE SURVEY

Wireless Sensors Network (WSN) is showing wide spectrum of applications in various sectors. In these applications, it is necessary to monitor & control of physical environments remotely with great accuracy & ease. As a wireless sensor network is a system combination of radio frequency (RF) transceivers, microcontrollers, sensors and power supply source. Wireless sensor networks with self-configuring, self organizing, self-diagnosing and self-healing capabilities have been developed to omit problems or to enable applications that traditional technologies could not fix. Wireless sensor network consists of various sensors and an ARM controller.

In Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires‖. The distances involved may be short (a few meters as in a television remote control) or very long (thousands or even millions of kilo meters for radio communications). Wireless communication involves - Radio frequency communication, Microwave communication, Infrared (IR) short-range communication. Applications of this communication may involve point-to point communication, point-to-multipoint communication, broadcasting, cellular networks and other wireless networks. In the last few years, the wireless communications industry experienced drastic changes driven by many technology innovations. There are several systems that allow data to be remotely accessed. As a solution to wireless data collection through the Internet, General Packet Radio Service (GPRS) is a popular choice in several applications.

Here the approach is to develop GPRS based wireless network for the various industrial applications. A GPRS is a new type of data transmission technology based on the existing GSM network. It transmits data in encapsulation way. It has lots of advantages such as super speed transmission, always on-line and charging according to rate of flow. Also we are trying to enhance the various standards by combining new design techniques for wireless industrial automation. A novel approach is to develop a system which helps to minimize the operational costs while operating with a large amount of data with very less time. In this paper, we design & implement a GPRS-based portable low-cost data-acquisition system, which can establish a reliable bidirectional connection for data acquisition. As a data acquisition system is used to collect the data in the simplest form. Th basic idea behind real-time processing is that the embedded system is expected to respond to the queries in time. As Real time should be fast enough in the context in which the system is operating and reliable as well. Real-time system correctness depends not only on the correctness of the logical result of the computation but also on the result delivery time. The system runs on the Linux operating system and is popular choice for many embedded PC systems. Users can monitor & control the remote data and remote system by using the embedded web server. The old system of transmitting the data by using the typical client server system is not so useful as it requires large amount of memory, it require more space for the overall setup. Thus the cost of old system increases and thus it is unsuitable. Thus the old system with central server can be replaced with the help of this advanced embedded web server.

III. PROBLEM STATEMENT & MOTIVATION

In the current highly competitive business environment, the industry is challenged by the demand for productivity, quality, safety and environmental protection. Tight profit margins and networked manufacturing emphasize the need for integration and global optimization of production facilities. The role of information technology in achieving these goals has become critical. Large and complex production systems cannot be efficiently and safely managed without advanced information management and process control. End users expect to get improved functionality at reasonable cost. System integrators need efficient tools for building applications. Manufacturers face the challenge of satisfying customer's needs while still maintaining a sound and profitable product structure in a rapidly changing technical and business environment. Important issues are how to find out user requirements, how to interface different products, and how to reuse existing application software. There is also a gap between research results and real-life applications.

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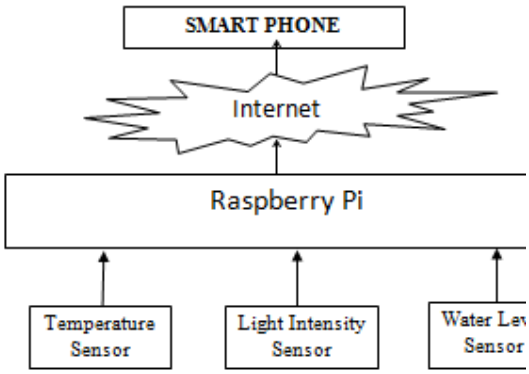
As earlier generations of automation systems have been Combinations of existing automation practices and advances in electronics and information technology. With the emergence of microprocessors in late 70.s, faceplates of pneumatic controllers were transferred to computer screens of Distributed Control Systems (DCS). Since then, PC technology has found its way to industrial applications. Meanwhile, recent advances in the control domain have grown upwards from low-level programming languages and communication standards in the direction of more comprehensive data models and reference architectures. The increasing degree of integration leads to complex applications, which, in turn, calls for more powerful communication and computation models in control systems. So the motivation leads towards the next generation automation systems which will be a combination of new information technology and the domain specific concept found in process automation.

(IV) HARD WARE DESIGN



FIGS 1 BLOCK DIAGRAM

EXISTING METHOD: In the existing system a user needs to be around the single board computer to monitor the parameter since the board is not internet enable.

PROPOSED METHOD: In our system, the single board computer will be internet enabled and hence the industrial process parameters can be monitored from anywhere through a browser interface. Now the users are no longer required to dedicatedly present on-site to monitor the process. Instead any employ of industry can do this task along with his other activities.

If we want to control the devices based on sensor's information we can control through web page from remote location using HTTP protocol. HTTP protocol continuously requests the server for control (turn on or turn off) the devices. In this way we can monitor and control the devices through remote PC.

HARDWARE COMPONENTS:

(A) ARM 11 MICROCONTROLLER: ARM is a 32-bit RISC processor architecture developed by the ARM Corporation. ARM processors possess a unique combination of features that makes ARM the most popular embedded architecture today. First, ARM cores are very simple compared to most other general-purpose processors, which means that they can be manufactured using a comparatively small number of transistors, leaving plenty of space on the chip for application specific macro cells. A typical ARM chip can contain several peripheral controllers, a digital signal processor, and some amount of on-chip memory, along with an ARM core. Second, both ARM ISA and pipeline design are aimed at minimizing energy consumption — a critical requirement in mobile embedded systems. Third, the ARM architecture is highly modular: the only mandatory component of an ARM processor is the integer pipeline; all other components, including caches, MMU, floating point and other co-processors are optional, which gives a lot of flexibility in building application-specific ARM-based processors. Finally, while being small and low-power, ARM processors provide high performance for embedded applications.

(B) RASPBERRY PI BOARD

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers.

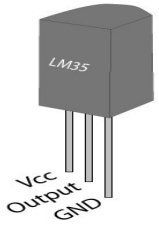
The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage. The Foundation provides Debian

and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux),C, Java and Perl.

(C) Ethernet: Ethernet is a family of computer networking technologies for local area networks (LANs) commercially introduced in 1980. Standardized in IEEE 802.3, Ethernet has largely replaced competing wired LAN technologies. Systems communicating over Ethernet divide a stream of data into individual packets called frames. Each frame contains source and destination addresses and error-checking data so that damaged data can be detected and re-transmitted. The standards define several wiring and signaling variants. The original 10BASE5 Ethernet used coaxial cable as a shared medium. Later the coaxial cables were replaced by twisted pair and fiber optic links in conjunction with hubs or switches. Data rates were periodically increased from the original 10 megabits per second, to 100 gigabits per second.

(D) UVC CAMERA A UVC (or Universal Video Class) driver is a USB-category driver. A driver enables a device, such as your webcam, to communicate with your computer's operating system. And USB (or Universal Serial Bus) is a common type of connection that allows for high-speed data transfer. Devices that are equipped with a UVC driver, such as the Logitech® Quick Cam® Pro 9000 for Business, are capable of streaming video. In other words, with a UVC driver, you can simply plug your webcam into your computer and it'll be ready to use. It is the UVC driver that enables the webcam to be plug and play. A webcam with a UVC driver does not need any additional software to work. Once you plug your webcam in, it can work with a video-calling application, such as Skype®, Windows Live Messenger®, or Microsoft Office® Communicator.

(E) LM35 TEMPERATURE SENSOR LM35 is a precision IC temperature sensor with its output proportional to the temperature (in oC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 oC temperature rise in still air. The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every oC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ Oc



TEMPERATURE SENSOR LM35

(F) LIGHT DEPENDENT RESISTOR: An LDR (Light dependent resistor), as its name suggests, offers resistance in response to the ambient light. The resistance decreases as the intensity of incident light increases, and vice versa. In the absence of light, LDR exhibits a resistance of the order of mega-ohms which decreases to few hundred ohms in the presence of light. It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light. It is made up of cadmium sulphide (CdS). An LDR has a zigzag cadmium sulphide track. It is a bilateral device, i.e., conducts in both directions in same fashion.

WORKING PRINCIPLE: In this project, we are giving the complete description on the proposed system architecture. Here we are using Raspberry Pi board as our platform. It has an ARM-11 SOC with integrated peripherals like USB, Ethernet and serial etc. On this board we are installing Linux operating system with necessary drivers for all peripheral devices and user level software stack which includes a light weight GUI based on XServer, V4L2 API for interacting with video devices like cameras, TCP/IP stack to communicate with network devices and some standard system libraries for system level general IO operations. The Raspberry Pi board equipped with the above software stack is connected to the outside network and a camera is connected to the Raspberry Pi through USB bus. The architecture of the web server has the following layers.

- In the lower level the web server has the physical hosting interfaces used for storing and maintaining the data related to the server.
- Above the Physical hosting interface the server has HTTP server software and other web server components for bypass the direct interaction with the physical interaction with the lower levels.
- The final layer has the tools and services for interacting with the video streams which includes the Image codec and storing interfaces, connection managers and session control interfaces etc.

After connecting all the devices power up the device. When the device starts booting from flash, it first load the linux to the device and initialize all the drivers and the core kernel. After initialization of the kernel it first check weather all the devices are working properly or not. After that it loads the file system and start the start up scripts for running necessary processes and daemons. Finally it starts the main application. When our application starts running it first check all the devices and resources which it needs are available or not. After that it checks the connection with the devices and gives control to the user.

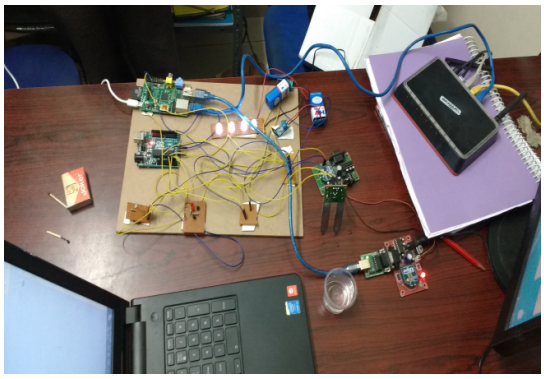


Fig2 hard ware design

Applications:

- Remote device control, automated control of home appliances, Surveillance.

Advantages:

- As ARM11 CPU is used, future modification is done easily according to our need.
- It can be modified & can be applied to other automation applications also.

FUTURE SCOPE

- The cost of ARM11 is more that's why in future we can implement this system using ARM CORTEX A8, Beagle bone etc as well as updated processors with high frequencies will work fine.
- As the storage space is also less in future we can also record these live streaming data by connecting external memory storage.
- We can complete our project using wireless technology.
- In future we can provide more security to data by using encryption, decryption techniques.

Sss

(V) CONCLUSION

The project "REMOTE MONITORING OF INDUSTRIAL PROCESS MONITORING SYSTEM USING WIRELESS COMMUNICATION" has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used and tested. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM 11 Processor board and with the help of growing technology the project has been successfully implemented.

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