IoT based Interactive Industrial Home wireless system, Energy management system and embedded data acquisition system to display on web page using GPRS, SMS & E-mail alert

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Abstract — **The Concepts of Internet of Things (IoT) are applied to a number of applications ranging from home automation to industrial IoT. Where connecting physical things, from anywhere through a network. Let them take an active part in the Internet, exchanging information about themselves and their surroundings. This will give immediate access to information about the physical world and the objects in it leading to innovative services and increase in efficiency and productivity. The proposal of system is to develop an IoT based Interactive Industrial Home wireless system, Energy management system and embedded data acquisition system to display on web page using GPRS, SMS & E-mail alert. This device is essential for sensor data collection and controlled of industrial Home Wireless Sensor Networks (WSN) in Internet of Things (IoT) environment. It is planned to style a re-configurable sensible device interface for industrial WSN in IoT atmosphere, during which ARM is adopted as the core controller. Thus, it will scan information in parallel and in real time with high speed on multiple completely different device information. Intelligent device interface specification is adopted for this style. The device is combined with the most recent ARM programmable technology and intelligent device specification. By detecting the values of sensors it can easily find out the Temperature, Smoke, and Fire present in the industrial environment on the Website and we can handle any situation from anywhere in the world through IOT. So that critical situation can be avoided and preventive measures are successfully implemented.**

Index Terms — **ARM microcontroller, Internet of Things (IoT), Low power consumption, Sensor Interface Device, WSN. Wireless monitoring station. Embedded C programming.**

I. Introduction

Embedded systems are electronic devices that incorporate microcontroller with in their implementations. The main purposes of the microcontroller are to simplify the system design and provide flexibility. Having a microcontroller in the device means that removing the bugs, making modifications, or adding new features are only matters of rewriting the software that controls the device. Or in other words embedded computer systems are electronic systems that include a microcomputer to perform a specific dedicated applications.

An emerging technology brought about rapid advances in modern wireless telecommunication, Internet of Things (IoT) has attracted a lot of attention and it is expected to bring benefits to numerous application areas including industrial WSN systems, and healthcare systems manufacturing [1],[2]. Wireless sensor networks (WSN) have been employed to collect data about physical phenomena in various applications such as habitat monitoring, and ocean monitoring, and surveillance [3]–[5]. WSN systems are well-suited for long-term industrial environmental data acquisition for IoT representation [6]. Sensor interface device is essential for detecting various kinds of sensor data of industrial WSN in IoT environments [7]. It enables us to acquire sensor data. Thus, we can better understand the outside environment information.

This paper presents the application requirements, the exploration of possible solutions, and the practical realization of a full-custom, reusable WSN platform suitable for use in low-cost Smart Blinds and Energy Conservation System for industrial home in IoT Environment.

II. Related Work

With rapid development of IoT, major manufacturers are dedicated to the research of multisensor acquisition interface equipment [8]. There are a lot of data acquisition multiple interface equipment's with mature technologies on the market. But these interface devices are very specialized in working style, so they are not individually adaptable to the changing IoT environment [9]. Meanwhile, these universal data acquisition interfaces are often restricted in physical properties of sensors (the connect number, sampling rate, and signal types). Now, micro control unit (MCU) is used as the core controller in mainstream data acquisition interface device. MCU has the advantage of low price and low power consumption, which makes it relatively easy to implement. But, it performs a task by way of interrupt, which makes these multisensor acquisition interfaces not really parallel in collecting multisensor data. On the other hand, FPGA/CPLD as unique hardware logic control, real-time performance, and synchronicity [10], [11], which enable it to achieve parallel

acquisition of multisensor data and greatly improve real-time performance of the system [12]. FPGA/CPLD has currently becomes more popular than MCU in multisensor data acquisition in IoT environment. However, in IoT environment, different industrial WSNs involve a lot of complex and diverse sensors. At the same time, each sensor has its own requirements for readout and different users have their own applications that require different types of sensors [13]. It leads to the necessity of writing complex and cumbersome sensor driver code and data collection procedures for every sensor newly connected to interface device, which brings many challenges to the researches [14]–[16].

Sensor data acquisition surface device is the key part of study on industrial WSN application [17]. In order to standardize a wide range of intelligent sensor interfaces in the market and solve the compatibility problem of intelligent sensor, the IEEE Electronic Engineering Association has also launched IEEE1451 smart transducer (STIM) interface standard protocol suite for the future development of sensors [18]. The protocol stipulates a series of specifications from sensor interface definition to the data acquisition [19]. The STIM interface standard IEEE1451 enables sensors to automatically search network, and the STIM promotes the improvement of industrial WSN [20]. But, the sensors with the protocol standard have a high cost and still lack popularity in industrial WSN in IoT environment. Nevertheless, at present, examples of intelligent sensors available on the market and compliant with this standard are still limited [21]. To solve these problems, some dedicated hardware interfaces based on the IEEE 1451 have been recently proposed, and they are capable of interfacing with different sensor typologies [22]. These interface devices are usually based on relatively complex dedicated electronic boards [23]–[24]. It is obvious that such restriction should be released [25], and a reconfigurable multisensor data acquisition interface with good compatibility and normative interface standard needs to be developed in IoT environment.

By focusing on the above issue, this paper designs an IoT based Interactive Industrial Home wireless system, Energy management system and embedded data acquisition system to display on web page using GPRS, SMS & E-mail alert in WSN Environment. This design presents many advantages as described below. First of all, ARM7TDMI is used as the core controller to release the restriction on the universal data acquisition interface, and realize truly parallel acquisition of sensor data. It has not only improved the sensor data collection efficiency of industrial WSN, but also extended the application range of the data acquisition interface equipment in IoT environment. Secondly, a new design method is proposed in this paper for multisensor data acquisition interface that can realize plug and play for various kinds of sensors in IoT environment. The design system applies the IEEE1451 interface protocol standard that is used for smart sensors of automatically discovering network. For the sensors not based on IEEE1451 protocol standard, the data acquisition interface system can achieve the function of plug and play. In this paper, this design take full advantage of ARM7 characteristics, such as high execution speed, flexible organization structure, IP design could reuse, etc., which makes our device better compatible in the field of industrial WSN in IoT environment.

The rest of this paper is organized as follows. The architecture is presented in Section III, and detailed hardware and software implementations are described in Section III. The application in Industrial Home and Energy conservation monitoring is discussed in Section IV. Finally, we conclude our work in Section V.

III. Architecture

Implementation of IoT is based on an architecture consisting of several layers: from the field data acquisition layer at the bottom to the application layer at the top.

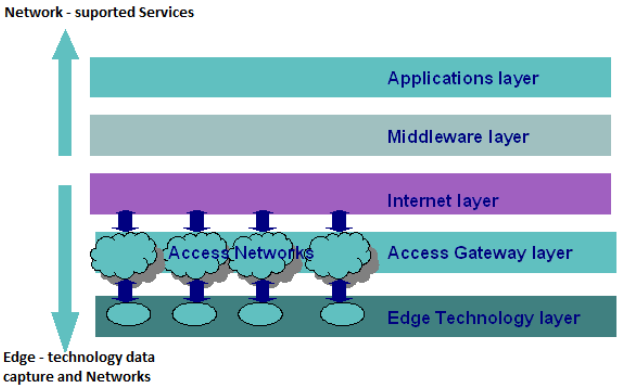

Figure 1. Layered architecture of Internet of Things.

The layered architecture is to be designed in a way that can meet the requirements of various industries, enterprises, societies, institutes, governments etc. Fig. 1 presents a generic layered architecture for IoT [26]. The layered architecture has two distinct divisions with an Internet layer in between to serve the purpose of a common media for communication. The two lower layers contribute to data capturing while the two layers at the top is responsible for data utilization in applications. The functionalities of the various layers are discussed briefly in the following:

Edge layer: this hardware layer consists of sensor networks, embedded systems, Zigbee and GSM module or other soft sensors in different forms. These entities are the primary data sensors deployed in the field. Many of these hardware elements provide identification and information storage (e.g. Zigbee), information collection (e.g. sensor networks), information processing (e.g. embedded edge processors), communication, control and actuation.

Access gateway layer: the first stage of data handling happens at this layer. It takes care of message routing, publishing and subscribing and also performs cross platform communication, if required.

Middleware layer: this is one of the most critical layers that operates in bidirectional mode. It acts as an interface between the hardware layer at the bottom and the application layer at the top. It is responsible for critical functions such as device management and information management and also takes care of issues like data filtering, data aggregation, semantic analysis, access control, information discovery such as EPC (Electronic Product Code) information service and ONS (Object Naming Service).

Application layer: this layer at the top of the stack is responsible for delivery of various applications to different users in IoT. The applications can be from different industry verticals such as: manufacturing, logistics, retail, environment, public safety, healthcare, food and drug etc. These numerous applications are evolving which will be under the umbrella of IoT.

IV. IMPLEMENTATION

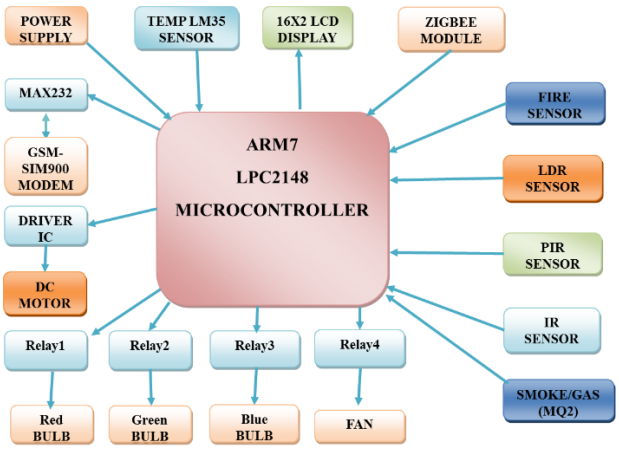

Figure 2. Block diagram of Hardware.

A. The introduction of the Hardware Architecture

The complete block diagram is as shows in figure 2.The Home industrial system [HIS] includes hardware that consists of an ARM 7 TDMI core processor, Zigbee module, GSM module, IR sensor, PIR sensor, Ldr sensor, temperature sensor, DC motor and l6x2 LCD,. The whole HIS works on a 5V or 9V dc regulated power supply. Figure 3 shows the GPS receiver module interfaced with UART1 of ARM processor provides speed and location information. The identity of a vehicle is fixed that is saved in a flash memory of a processor. The temperature sensor provides temperature per degree Celsius to an ARM processor. The temperature sensor is interfaced to an ADC1 of ARM processor. Fire, Smoke measurements, DC motor position and temperature are stored in a SD card. The SD card is interfaced to an ARM processor using SPI (Serial Peripheral Interface). All this information are shown on LCD that is interfaced with a GPIO0 and send it to a monitoring station (receiver side) by GSM module wirelessly that is interfaced with UART0 of ARM processor. Also the same information is given to a concern person to get that information anywhere anytime. The module requires GSM SIM (Subscriber Identity Module). As per the definite event stored in a program and when collision/accident occurs that is sense by an Accelerometer which is interfaced to ADC0 of ARM processor. The detail descriptions of all modules are as follows.

B. LPC2148 ARM MICROCONTROLLER

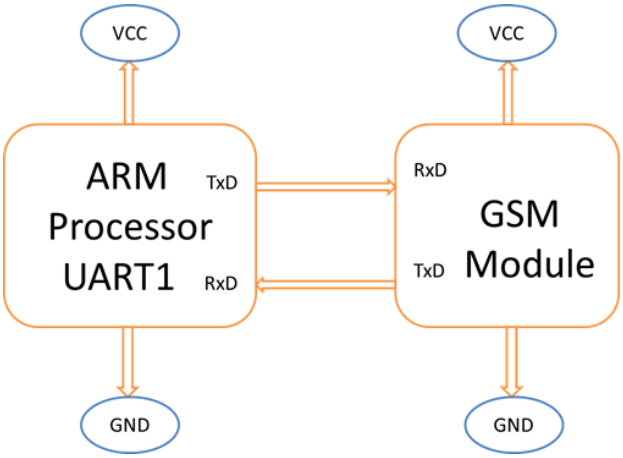

Figure 3. Interfacing between ARM processor and GSM module.

The LPC2148 microcontrollers is based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

C. Sensor

A sensor is a device used for the detection of changes in quantities and it provides a corresponding output, generally as an electrical or optical signal. In everyday, sensors are used in objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the more traditional fields of temperature, pressure or flow measurement. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being

measured changes. Making the sensor smaller often improves its performance of measuring and it can be designed to have a small effect and also introduces many advantages. The smallest change it can detect in the quantity that it is measuring is the resolution of a sensor. Various sensors used here are for measuring temperature, gas, light intensity and PIR sensor, IR sensor. 10 bit successive approximation analog to digital converter.

D. Wireless Transceiver

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 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 used in applications that require low data rate, long battery life and secure networking. ZigBee has a data rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks such as Bluetooth or Wi-Fi. ZigBee protocols are intended for embedded applications requiring low data rates and low power consumption. An embedded system based monitoring and control system for Industrial Home and Energy conserve for industries is designed. In the existing system, Complex Programmable Logic Device (CPLD) is used as a core controller and sensors are interfaced to it. But CPLD is limited in function and logic density compared with a microcontroller. LPC2148 Microcontrollers are more versatile than a CPLD and also denser logic functions may be performed in it while comparing a CPLD. Hence in the proposed system microcontroller is used as a core controller. The programming module is implemented using embedded c coding. The system mainly consists of two units and they are monitoring and control unit. The monitoring unit is placed near the plant the control unit is far away from the plant. The monitoring unit consists of sensors, micro controller and Zigbee. The measured sensor values of the plant or industry are sent to the controller and they are transmitted to the control unit via Zigbee. The control unit consists of the Zigbee, microcontroller and computer. The transmitted values from the monitoring unit are received via Zigbee and they are compared with the threshold values in the controller and they are displayed in the computer and then sent via WAN to the Internet if needed. In case of mismatch the workers will be informed to take corrective measures.

E. The introduction of the Software Architecture

Here we are using a Keil ide , flash magic software for design the project.

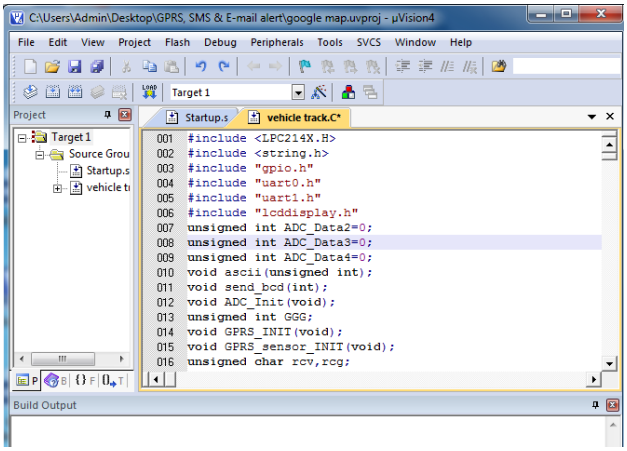

Figure 4. Keil ide uVision4 Software.

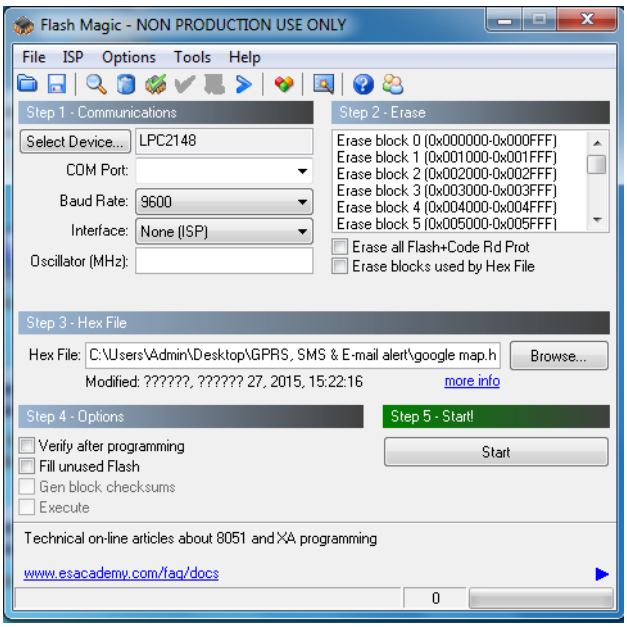

Figure 5. Flash Magic Software.

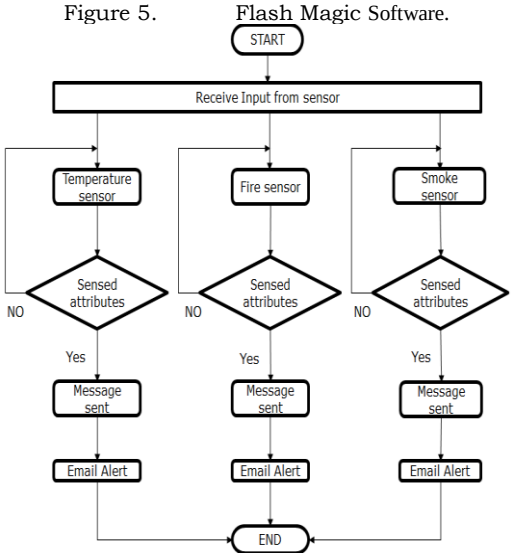

Figure 6. Project flow chart

Install Keil MicroVision-4 in your PC, Then after Click on that "Keil UVision-4" icon. After opening the window go to toolbar and select Project Tab KEIL Software Programming where we write the program in embedded C programming language see in figure 4. For interfacing and dumping the program on the target board LPC2148 using a Flash Magic software shown in figure 5.Here we have programming according to Flow chart as shown figure 6.

V. Application in Home Industrial Monitoring

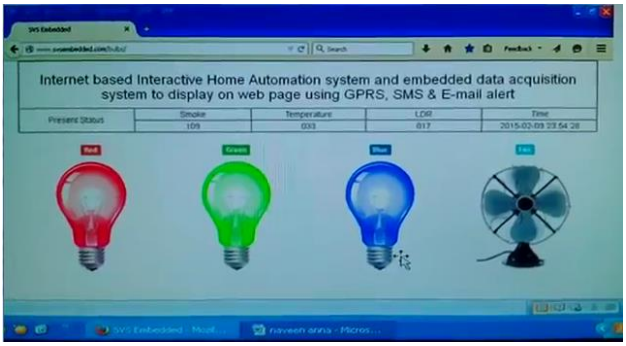

Figure 7. Webpage of monitoring and controlling device

IoT based Interactive Industrial Home wireless system, Energy management system and embedded data acquisition system to display on web page using GPRS, SMS & E-mail alert in this project we are using a website www.gauravtiwari.com/bulbs,in,After insert this website on internet we can see a webpage as shown in the Figure 7.in this project we are using an three blubs and one fan and we are displaying smoke temperature and LDR so we are getting the output values from the website, if there is any changes in smoke alert , temp alert we get from the site through mail.so here we using an mail alert.

Figure 8. Automatic Smart blinds and energy conservation system.

Figure 8 Automatic Smart Blinds and Energy Conservation system are available in industries for monitoring and energy saving of industrial Home WSN. But most of the system in industries are wired and Blinds and energy conservation are controlled and monitor by the control room operator using wire network. The wires are moving through conducts, sometimes inside walls and sometimes underground also. So breakdown maintenance of these wires are difficult task in industries. The second disadvantages of this method is operator console cannot move from one room to another. Every time operator has to go to particular room to monitor and control the operation. In this paper, to solve these problems, a new method is proposed to design a Smart Blinds and Energy Conservation System for industrial home in IoT Environment. We would like to have smart blinds which can open and close automatically depending on the light intensity and temperature outside. So first, we would like to sense the light intensity from outside, if it is bright and above a threshold (let say a number from ADC), then we would like to sense the outside temperature (because if it is summer, outside will be very hot). Next, if the temperature is also above a threshold, we would like to close the blinds regardless if it is very bright outside. However, if the outside temperature is below the threshold, we would like to open the blinds using a motor. On the other hand, when the sun sets, the light intensity will fall below a threshold and we would like to close the blinds. But in this case, we do not need to worry about the temperature sensor. So this is basically what we need to do. Pir sensor is used to monitor the persons in the room. If anybody is there the lights and fan should ON. If nobody is there the lights and fan should OFF.

Conclusions

This paper describes an IoT based Interactive Industrial Home wireless system, Energy management system and embedded data acquisition system to display on web page using GPRS, SMS & E-mail alert. The Device system can collect Data automatically and send to SMS and Mail and continuous show the result on HyperTerminal window. It was designed based on IEEE1451 protocol by combining with ARM controller and the application of Wireless communication It has the advantage of low price and low power consumption make it easy to implement with high speed.

Nevertheless, many interesting application are remaining for future researches. For exam, trough IoT we operate visualizes industries home from anywhere.

Acknowledgment

I would like to thank sincerely to my guide Prof. RIYAJ KAZI whose invaluable guidance, constant assistance, support endurance and constructive suggestions for the betterment of the technical seminar. And I also would like to convey my heartfelt thanks to our PG-Coordinator, Prof. SANIYA ANSARI for giving me the opportunity to embark upon this topic and for his continued encouragement throughout the preparation of this presentation.

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