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Wireless Sensor Network for Industrial Environment Monitoring in IoT Application

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Abstract— A sensor interface device is essential for sensor data collection of industrial wireless sensor networks (WSN) in IoT environments. However, the current connect number, sampling rate, and signal types of sensors are generally restricted by the device. Thus, it can read data in parallel and in real time with high speed on multiple different sensor data. The standard of IEEE1451.2 intelligent sensor interface specification is adopted for this design. It comprehensively stipulates the smart sensor hardware and software design framework and relevant interface protocol to realize the intelligent acquisition for common sensors. A new solution is provided for the traditional sensor data acquisitions. The device is combined with the newest ARM technology and the standard of IEEE1451.2 intelligent sensor specification. Performance of the proposed system is verified and good effects are achieved in practical application of IoT to water environment monitoring

Keywords *: Advance RISC Machine Digital Video Disc, Liquid Crystal Display, IoT (Internet of Things)*

I INTRODUCTION

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 . The system gains low cost, low power consumption, small volume, and other characteristics. Compared with the general environment monitoring system using large equipment, it is more flexible and convenient. It is quite suitable for the project of water quality monitoring. Multinode monitoring can be realized through Zigbee wireless module. Under the premise of reducing project cost, the system can collect multiple sets of data as much as possible from different nodes and ensures monitoring of the standard industrial environment. First of all, ARM7 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 multi sensor 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 IEEE1415 protocol standard, the data acquisition interface system can achieve the function of plug and play. This design take full advantage of ARM7 characteristics, such as high execution speed, flexible organization structure, IP design could reuse, etc. The design adopts IEEE1451 smart transducer (STIM) interface standards, which makes our device better compatible in the field of industrial WSN in IoT environment.

Now, micro control unit (MCU) is used as the core controller in mainstream data acquisition interface device. But, it performs a task by way of interrupt, which makes these multi sensor acquisition interfaces not really parallel in collecting multi sensor data. On the other hand, ARM7 has unique hardware logic control, real-time performance, and synchronicity which enable it to achieve parallel acquisition of multi sensor data and greatly improve real-time performance of the system. ARM7 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. 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. Sensor data acquisition surface device is the key part of study on industrial WSN application. 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. The protocol stipulates a series of specifications from sensor interface definition to the data acquisition. The STIM interface standard

IEEE1451 enables sensors to automatically search network, and the STIM promotes the improvement of industrial WSN.

II IOT (INTERNET OF THINGS)

2.1 Survey Internet of Things (IoT)

The term Internet of Things (IoT) has been around for quite a few years. In this scenario, it is gaining ground with the evolution of advanced wireless technology. The basic idea of this concept is the presence of a variety of objects – such as RFID, NFC, sensors, actuators, mobile phones, etc. which, through unique addressing schemes, are able to interact with each other (GIUSTO; A.LERA; L.ATZORI, 2010). When IoT idea came into existence, Radio-frequency Identification (RFID) seemed to be necessary for Internet of Things (WIKIPEDIA, 2013), but in scenario there are lots of new technologies available in the market. Technologies like RFID, Near Field Communication (NFC), Machine-to-Machine Communication (M2M) and Vehicular-to-Vehicular communication (V2V). Upon widespread adoption of different technologies of IoT, the life of the potential user can become very comfortable and safe as explained in

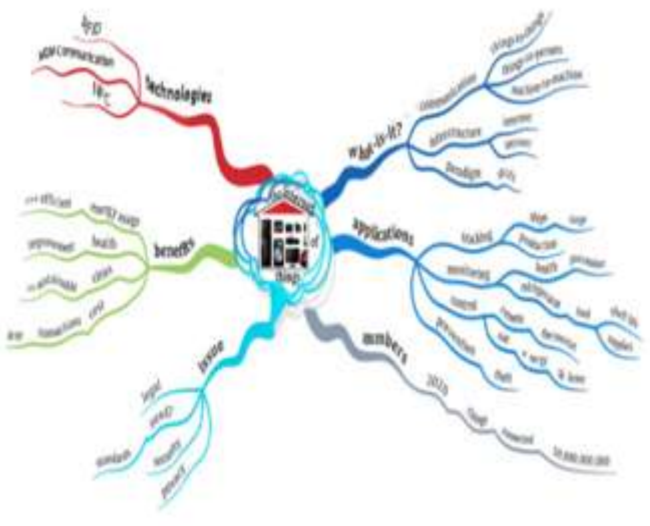

Figure 1 Structure of IoT

2.2 Technologies involved

There are several technologies that can be used to implement the concept of Internet of Things.

[1] Radio Frequency Identification (RFID)
[2] Near Field Communication (NFC)
[3] Machine-to-Machine Communication (M2M)
[4] Vehicle-to-Vehicle Communication (V2V)

2.3 The relation with IoT

With the advancements in Internet technologies and WSNs, a new trend is forming in the era of ubiquity. "IoT" is all about physical items talking to each other, where machine to machine (M2M) communications and person-to-computer communications will be extended to "things" Key technologies that drive the future of IoT are related to smart sensor technologies including WSN, nanotechnology, and miniaturization. IoT is a major drive to support service composition with various applications. It consists of three layers: 1) perception layer; 2) network layer; and 3) application layer. The design of data acquisition interface is mainly applied to the perception layer of IoT.

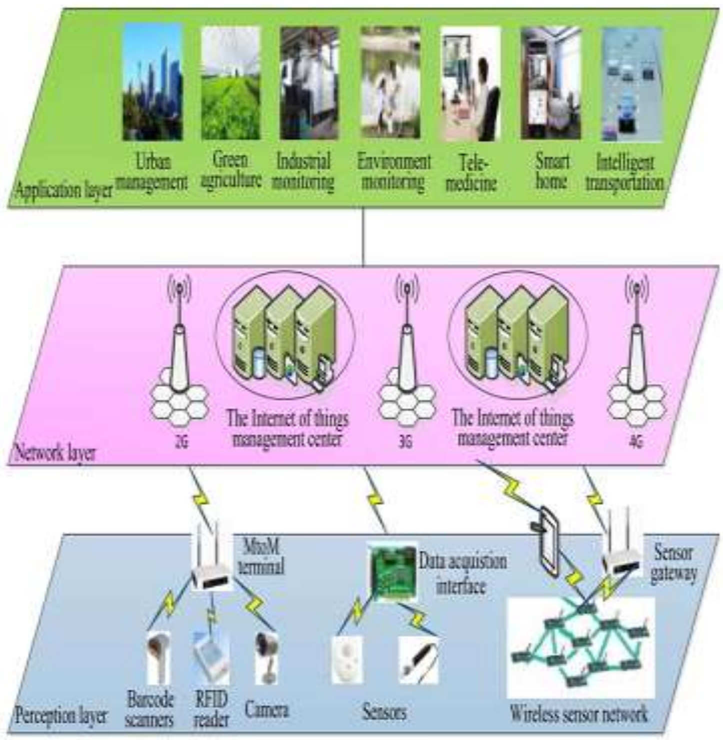

Figure 2 Structure of IoT

The perception layer of IoT is mainly composed of sensors, RFID readers, cameras, M2M terminals, and various data collection terminals. The data acquisition interface is responsible for the integration and collaboration of various environments and collection of sensor data. Examples of such a workflow include a water environment monitoring system that adopts sensors to detect pollution and water quality. Water environment monitoring is one of the IoT application fields, where complex water quality information, is used to determine the water environmental quality at the same time.

III RESULT ANALYSIS

3.1 Overview and Analysis

As technology advances rapidly comes in modernization and in an effort to keep the up to date, we developed wireless sensor technologies for the development of Industrial environment. Performance is one of the most important non-functional aspects of any (hardware, software) system. Performance evaluation applies certain to existing or envisioned systems to assess performance measures of interest. The performance of developed system is directly measured in terms of whether intrusion is occurred or not.

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Table 1 Comparison Previous Systems and Propose System

Parameter	**Manual Monitoring system**	**FPGA base monitoring**	**Algorithm Base Monitoring**	**CPLD base monitoring**	**ARM base monitoring**
Parameter Measurement	Using individual instrument for each parameter	Using all sensor in single system	Using separate node for monitoring	Using all sensor in single system	Using all sensor in single system
Cost	High	Low	Low	Medium	Low
Range Using WSN	< 10 meters	10 meters	10 meters	10-100 meters	10-100 meters
Range Using GPRS	NA	NA	NA	NA	Globally monitoring
Communication medium	NA	Using Bluetooth protocol	Using Bluetooth protocol	Using Zigbee protocol	Using Zigbee protocol, IR Protocol
Power consumption	AC Equipment 230V	5 VDC	5VDC	5VDC	3.3VDC
Processing Speed	Slow	Medium	Medium	Fast	Fast
Online Monitoring	NA	No	No	No	Yes
Complexity	High	High	High	Low	Low
Overall performance	Low	Low	Medium	High	High

3.2 Field side analysis

Microcontroller which measures the temperature, light and CO2and the measured parameters are displayed on a 16x2 LCD, the obtained parameters are transmitted using a Zigbee and GPRS Module and it can monitor different parameter at different areas.

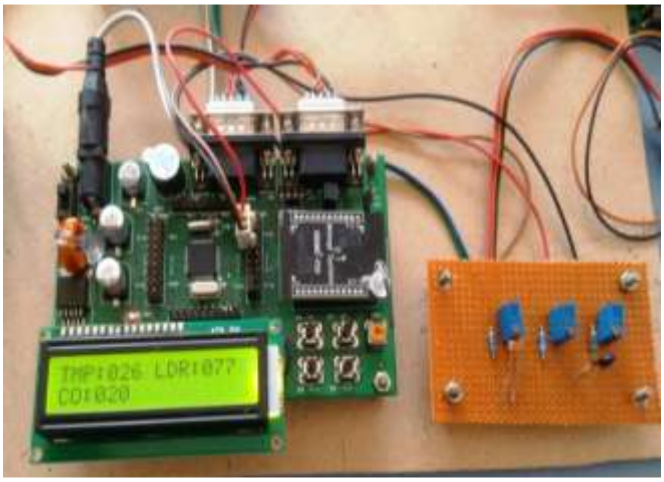

Figure 3 Field Side parameter display.

3.3 Temperature Sensor Analysis:

Temperature sensor (TM103) is used to measure Temperature. The TM103 is designed to be connected directly to a microcontroller. The TMP103 features a two-wire interface that is compatible with both I2C and SM Bus interfaces. The TMP103 has the capability of executing multiple device access (MDA) commands that allow multiple TMP103 is to respond to a single global bus command.

Table 2 Temperature Sensor output Voltage chart

TEMPERATURE	VOLTAGE
30°C	1.08V
40°C	1.44V
50°C	1.8V
70°C	2.52V
80°C	2.88V
85°C	3.06V

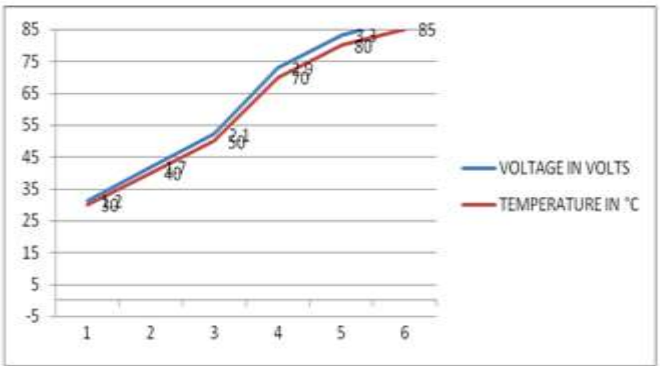

Figure 4 TM103 Sensor Voltages vs. Temperature

x = 3.6 X 40/85

x = 1.7V

Similarly, y = 2.1

3.4 CO2 sensor analysis

Select CO2 sensor PPM range 1000 (Highest range) and 0 (Lowest range).CO2 sensor PPM range is directly proportional to Temperature (°C)

Table 3 Distance of light source vs. Output voltage

CO2 PPM	-5 °c	5°c	15°c	25°c	35°c	45°c
0	36	15	23	26	9	26
1000	1045	1040	1029	1029	1037	1045

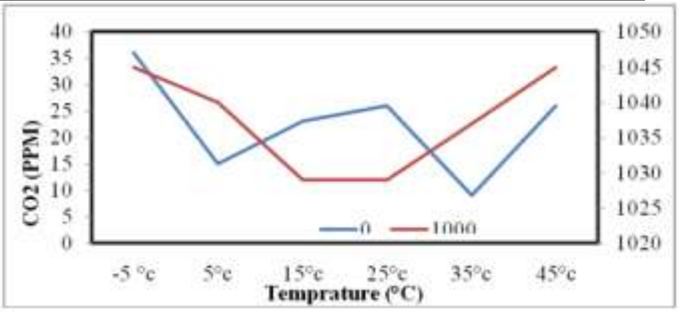

Figure 5 Input vs. Output

3.5 LDR sensor analysis

Two cadmium supplied (cdS) photoconductive cell with spectral responses similar to that of the human eye. The cell resistance fall which increasing light intensity.

1. Dark to 110% RL
2. To 10* RL

RL = Photocell resistance under given illumination

Table 4 Distance of light source vs Output voltage

Distance of light source from LDR/cm	Average/Mv
0	1.0
3	7.3
6	23.3
9	43.4
12	68.7
15	107.5
18	132.0

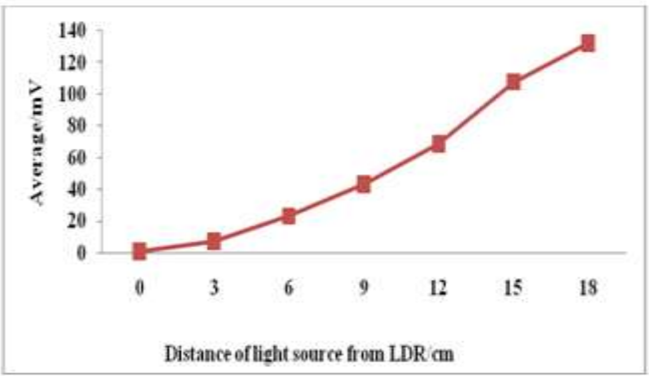

Figure 6 Input vs. Output

3.6 Monitor side analysis

Following window is shown on the PC. The digital value of all sensors is shown using hyper terminal or flash magic with the help of zigbee wireless network.

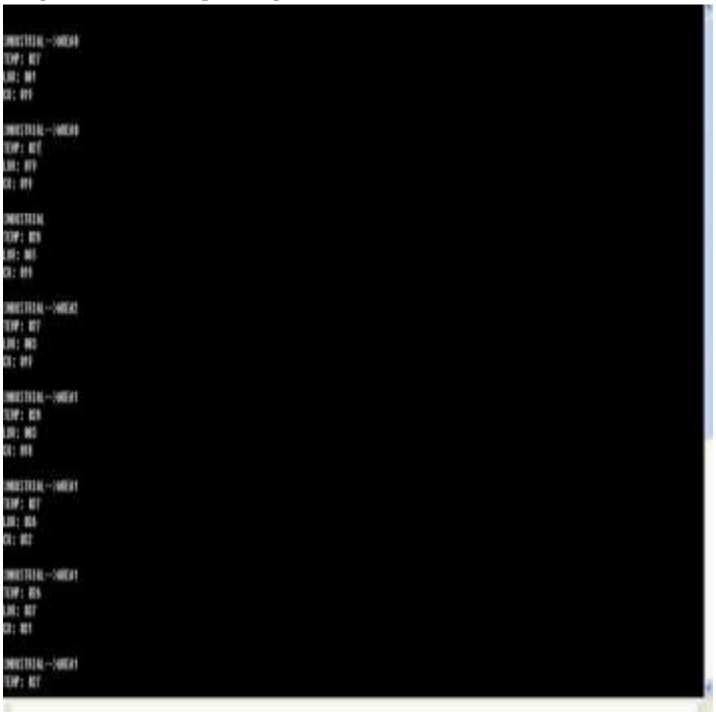

Figure 7 PC Side Monitoring using Hyper Terminal

Figure 8 PC Side Monitoring using GPRS

3.6 Comparison with other approaches

This project gives a different way of approaching the problem. This project approaches the new system that contains inbuilt Zigbee and GPRS with on-line interaction. It makes system more reliable and avoid complications such as cost increment, volume increment, lot of wire connection, WSN etc. ARM processor is heart of this system as it handles two modes at the same time, zigbee and Web Server mode. At the zigbee mode, processor can measure signals which are coming from various external sources and application and control the industry environment by using the different sensor. In this project ARM processor itself act as web server. Have interfacing for inputs and outputs already inside the controller, coding are easily programmed and have an easily understood programming language. But it makes system more complicated. As there's too much work required in connecting wires, there's difficulty with changes or replacements, it's always difficult to find errors; and require skillful work force. When a problem occurs, hold-up time is indefinite, usually long and for data transmission through controller we have develop different system. All these disadvantages of general system can be overcome by using our proposed system.

3.7 Advantages

1] Internet based Monitoring scheme with various protocols and systems providing detailed description of remote process states to the authorized users

2] Sensor data acquisition interface equipment is one of the key Parts in IOT applications.

3] Low power consumption.

4] Easy to implement.

5] Better reliability, low cost, small size, low power system.

3.8 Disadvantages

1. Most of systems based on Internet monitoring require higher operational cost based on bandwidth / data speed requirements and hence is justified only in industrial or biomedical applications in developing countries.

2. In this systems generally do not have alert facilities against occurrence of abnormal conditions. User needs to have PC / smart phone / PDA with suitable software support. Security vulnerability is the most striking alert point of Internet.

3.Internet connections and hosting servers, which may not always fit to the concept of remote controlling.

4. The long term operational cost of Internet and cellular monitoring systems is relatively high due to usage charges incurred in each message transaction.

3.9 Application

1. Can be used in green houses to control the temperature, soil moisture, humidity and light for the proper growth of plants

2. With little modification, this project can be used in Mechanical companies to measure various parameters of operating machines like temperature and light.

3. Temperature monitoring and controlling action can be used in home or various halls like conference room, seminar hall to control the temperature of room

4 CONCLUSIONS

4.1 Conclusion

This project describes a reconfigurable smart sensor interface for industrial WSN in IoT environment. The system can collect sensor data intelligently. It was designed based on IEEE1451protocol by combining with ARM7 and the application of wireless communication. It is very suitable for real-time and effective requirements of the high-speed data acquisition system in IoT environment. The application of ARM7 greatly simplifies the design of peripheral circuit, and makes the whole system more flexible and extensible. Application of IEEE1451 protocol enables the system to collect sensor data intelligently. Different types of sensors can be used as long as they are connected to the system. Main design method of the reconfigurable smart sensor interface device is described in this paper. Finally, by taking real time monitoring of water environment in IoT environment as an example, we verified that the system achieved good effects in practical application. Nevertheless, many interesting directions are remaining for further researches. For example, the IEEE1451 protocol can be perfected and the function of spreadsheet should be expanded. I twill have a broad space for development in the area of WSN in IoT environment.

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