Wireless sensor network based on industrial Environmental parameter monitoring system with GPRS

Dr.Nikhil Raj [1], Dr Kavitha[2], Dr. Ganapathi sridhar[3], Dr.D. Kiran[4], Dr. Kishor Krishna kumar[5]
[1,2,3,4,]Professor, [5]Asst. professor, Dept. of ECE,MRCE, Hyderabad

Abstract— The sensor interface device is essential for sensor data collection of industrial wireless sensor networks (WSN) in IoT environments. But, the current connect number, sampling rate, and signal types of sensors are generally restricted by the device. Mean time, in the Internet of Things (IoT) environment, each sensor connected to the device is necessary to write down complicated and cumbersome data collection program code. In this paper, to solve these problems, a new method is proposed to design a smart sensor interface for industrial WSN in IoT environment, in which complex programmable logic device (CPLD) is adopted because the core controller. Thus, it can read data in parallel and in real time with high speed laying on multiple different sensor data. A new solution is provided for the traditional sensor data acquisitions. The device is united with the newest CPLD programmable 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.

Key Terms: CPLD, IEEE1415 protocol, Internet of Things (IoT), Sensor data acquisition

INTRODUCTION

Wireless Sensor Networks (WSN) have been employed to collect data about physical phenomena in various applications such seeing that habitat monitoring, and ocean monitoring, and surveillance [1]–[3]. As an emerging technology brought about rapid advances in contemporary wireless telecommunication, Internet of Things (IoT) has attracted a lot of attention and is expected to bring benefits to numerous application areas including industrial WSN systems, and healthcare systems manufacturing [4], [5]. WSN systems are compatible for long-term industrial environmental data acquisition for IoT representation [6]. Sensor interface device is necessary for detecting various kinds of sensor data of industrial WSN in IoT environments [7]. It enables us to acquire sensor data. Therefore, we can better understand the outside environment information.

With fast development of IoT, the major manufacturers are dedicated to the research of multi sensor acquisition interface equipment [8]. There are a bunch of data acquisition multiple-interface equipments with mature technologies on the market.

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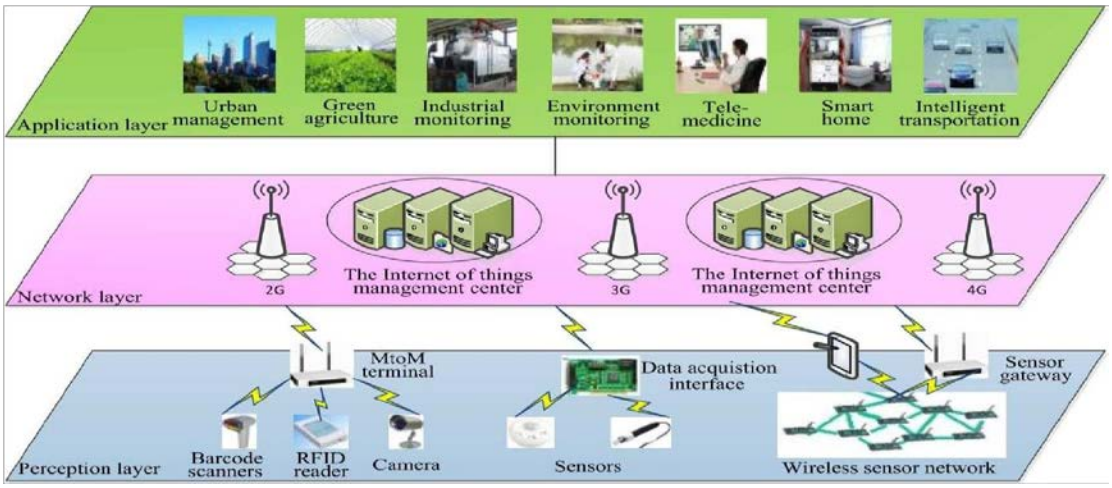

Fig.1.ArchitectureofIoT

But these interface devices are very particular in working style, so they are not individually adaptable to the changing IoT environment [9]. But, the sensors with the protocol standard have a high cost and still lack popularity in industrial WSN in IoT environment. By focusing on the above issue, this paper designs and realizes smart sensor interface for industrial WSN in IoT environment. This design presents a group of advantages as described underneath. The CPLD is used as the core controller to liberate the restriction on the universal data acquisition interface, and realize truly parallel acquisition of sensor data. It have not only enhanced the sensor data collection efficiency of industrial WSN, but also unlimited the application range of the data acquisition interface equipment in IoT environment. In this paper, this design get full advantage of CPLD characteristics, such as high execution speed, flexible organization structure, IP design could reuse, etc. This device better compatible in the field of industrial WSN in IoT environment.

The rest of this paper is planned as follows. The architecture is presented in Section II; water quality monitoring is discussed in Section III. Lastly, we bring to a close our work in Section V.

II.ARCHITECTURE

We design a smart sensor interface device that integrates data collection, data processing, and wired or wireless transmission together. The device can be extensively used in many application areas of the IoT and WSN to collect various kinds of sensor data in real time.

We program IP core module of IEEE1451.2 equivalent protocol in its CPLD.

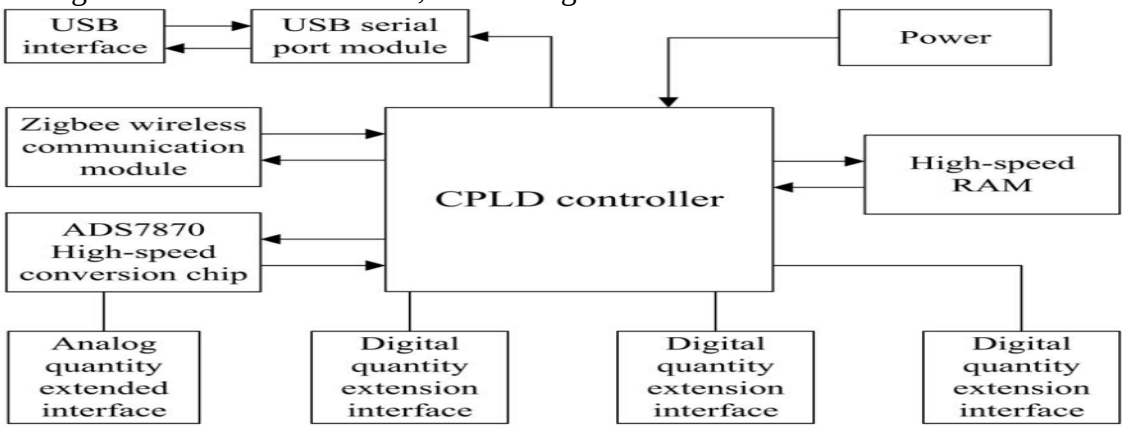

Fig. 2. CPLD hardware block diagram.

Therefore, our interface device can auto-matically discovers sensors connected to it, and

to collect multiple sets of sensor data intelligently, and similar with high-speed.

CPLD is core controller of the interface device. It is used to control data acquisition, processing, transmission intelligently, and make some preprocessing work for the collected data [10]. The driver of chips on the interface device is also programmed inside the CPLD. Multiple scalable interfaces are designed on the equipment. It can be extensive to 8-channel analog signal interface and 24-channel digital signal interface. This ensures so as to our device can connect with a number of sensors amongst the application of industrial IoT or WSN and guarantees the varied collection of the information.

In stipulations of data transmission, our design can achieve wired communication through Universal Serial Bus (USB) interface and wireless communication all the way through Zigbee module. Therefore, we can choose different transmission mode of the device in different industrial application environments.

In practice, the designed device collects analog signal trans- mitted from color sensors, light intensity sensors, and other similar sensors all the way through an analog signal interface. It can also collect digital signal transmitted from the digital sensors, such seeing that temperature sensors, digital humidity sensors, and so on, through a digital signal interface.

The Analog to Digital Converter (ADC) module and signal interface on the interface device are proscribed by the CPLD, which makes it possible to collect the 8-channel analog signals and 24-channel digital signals circularly, and sets these collected data into the integrated Static Random Access Memory (SRAM) on the interface device. The composed data can be transmitted to the host computer side by way of USB serial wired communication or Zigbee wireless communication, so that the user can analyze and process the data.

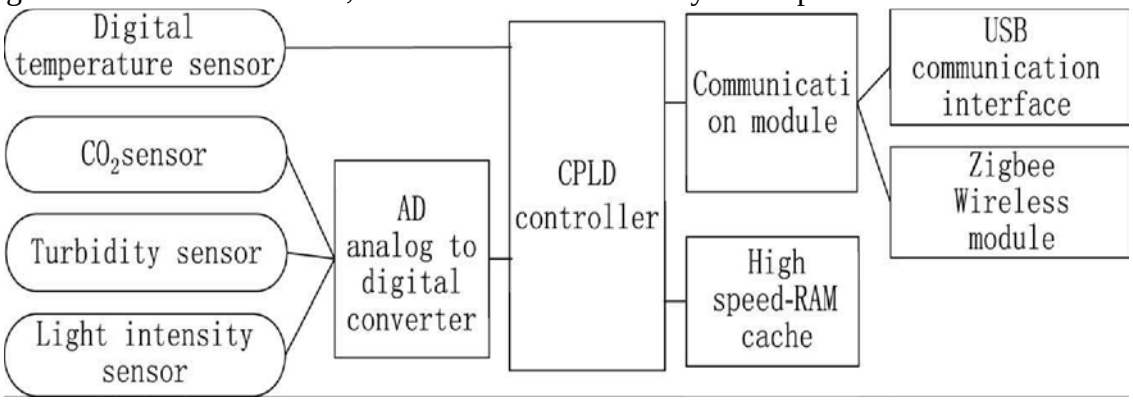

Fig. 3. System's block function design.

. The core module of this system is CPLD-based smart sensor interface device designed by ourselves. It can well meet the requirements mentioned above. Here are the main solutions: Firstly, we suggest that water turbidity sensor, water proof temperature sensor, sensor, and light intensity sensor should be used to collect required data; Secondly, Zigbee wireless module connected to the device is adopted for sending and receiving data; Thirdly, 1.8-V battery is offered to supply power for the system, and one battery can work for more than 10 hour. Block function design of the system is shown in Fig. 3.

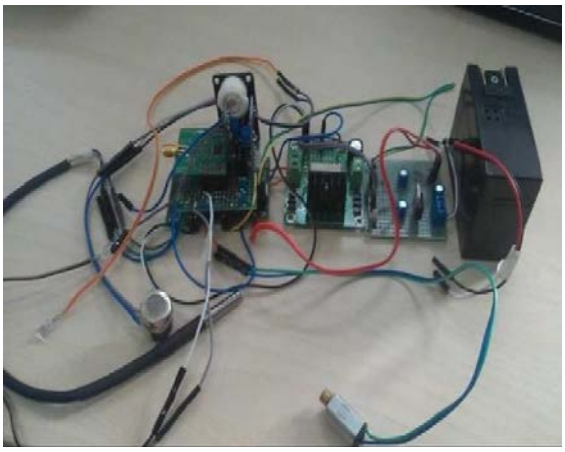

Fig. 4. Water quality monitoring hardware physical map.

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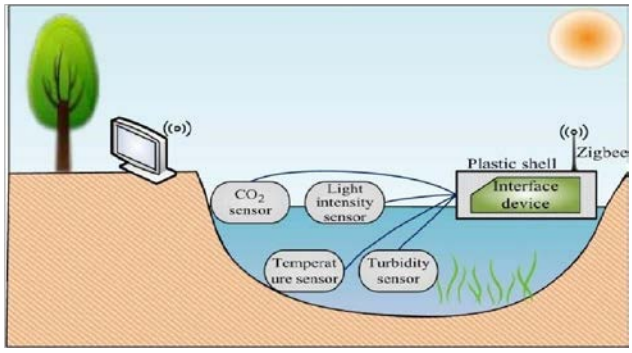

Fig. 5. Schematic diagram of monitoring equipment installation

As it is the monitoring service of pond water, it includes water turbidity monitoring, temperature monitoring, and carbon dioxide monitoring above the water. The device is put into the pool, so that the turbidity and temperature can be measured by using sensors in the depths of water, and the carbon dioxide sensor and light intensity sensor can be exposed above the water. Therefore, the equipment is covered with a waterproof shell to collect data, and good effects have been achieved. We design the schematic diagram of monitoring equipment installation as shown in Fig. 5.

Name	Type
Temperature sensor	DS18B20
Temperature and humidity sensor	SHTxx series
CO_2 sensor	MG811
Light intensity sensor	GY-30
Turbidity sensor	KIE-TS-300B
Pressure sensor	MPX5999D
PH sensor	YBK10-WQ201

TABLE I SPECIFIC SENSOR TYPE

Through actual test, we learn that the system can immediately collect sensor data when it is connected to power. The system has good compatibility and expansibility for different types of sensors. We have successfully tested different types of sensors on this system. Table I is the specific sensor types that we have tested.

CONCLUSION

This paper describes a smart sensor interface for industrial WSN in IoT environment. The system can collect sensor data intelligently. It was designed based on IEEE1451 protocol by combining with CPLD 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 CPLD 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 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.

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