# RFID based General Wireless Sensor Interface

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## Abstract

Radio Frequency Identification (RFID) [1][2] technology has been used in various areas including Transportation and logistics, Manufacturing and Processing, Inventory and retail, etc. In this article, RFID technology will be used for wirelessly transmitting data from a sensor to a Central Control Unit (CCU). In this research, Architecture of Intelligent wireless sensor using RFID technology will be introduced.

## 1. Introduction

Wireless connection based intelligent sensor can combine sensing, computation, communication into a single, small device. Because sensor carries its own wireless data transmitter, the time and the cost for installation and maintenance and the whole system weight have been reduced. Recently, Intelligent wireless Sensor becomes more sophisticated and widely being used in various industry including Aerospace, Automotive, Mechanical, Medicine, Agriculture, etc. For example, people are using large-scale wireless sensor network to monitor real-time environment status. Right now, wireless sensor using IEEE 802.15.4 wireless personal area network (WPAN) protocol [3] or Bluetooth [4] is complicate and cost. On the contrary, using radio frequency to implement wireless communication is relatively simple and cheap.

First introduced by Texas Instrument (TI), Radio Frequency Identification is becoming a hotspot of industry. Initially, it was considered as a bar code replacement. Now, it's applications are far from this. It has been used in Transportation, Logistics, Manufacturing, Processing and other fields. Generally, RFID system consists of transponder (or tags) and reader [1]. The transponder can be made in all shapes and sizes. It carries various information of a product. The reader can automatically collect this information quickly, easily through a contactless data link. There are two types transponder: active and passive. Active transponders include a battery while passive transponders obtain their energy from a radio frequency signal sent from reader. Usually, active transponder works at high frequency. It has long read/write distance and fast read speed. Passive transponder works at low frequency. It's read distance is shorter and read/write speed is lower. Currently, TI worked out a high frequency passive transponder that has fast read speed and the read range can be reach 15 feet.

Combining with RFID, a general sensor can be upgrade to intelligent wireless sensor. In the following sections, a RFID based intelligent wireless sensor architecture and the structure of a micro-controller that connects sensor and RFID transponder will be described in detail. An application scenario in automotive industry will also be illuminated.

## 2. System Architecture

Architecture of intelligent wireless sensor system is shown in figure 1. The whole system consists of four components: Sensor, Micro-Controller, RFID and Central Control Unit (CCU).

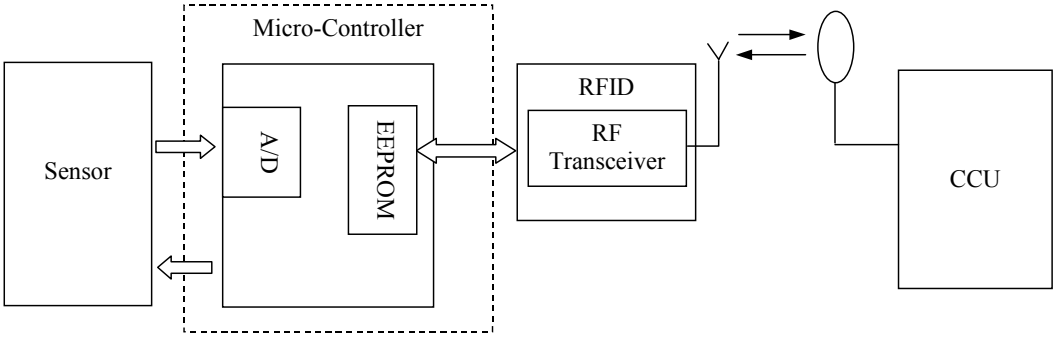


Fig. 1 Architecture of Intelligent Wireless Sensor System

Sensor can be general sensor, which characterized as wired, analog output.

Micro-Controller is a communicator and controller between sensor and RFID. To simplify the system, Sensor, Micro-Controller and RFID share same memory. The data of the whole system are divided into four types and stored in different portion of memory. The memory allocation demonstrated in Figure 2. In the figure, the memory size is 2K bytes.

Because most sensors' outputs are analog signal, we have to convert them into digital data and store in EEPROM. Firstly, A/D module converts the analog signal into digital form. Then, Microprocessor calculates and organizes the data to desired form, and writes it to EEPROM. At same time, Micro-Controller can get the instruction from Central Control Unit, which writes its instructions into specific address in the memory. The instructions are sensors' run-time parameters. Once the Micro-Controller finds the instruction changed, it will set the control interface to on or off status, thus, the sensor's run-time parameters has be changed.

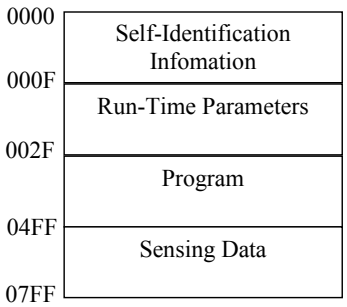


Fig. 2 Memory Mapping

Here, we use 2 pins to control the sensor. Each pin can be set to on or off individually to provide four run-time statuses.

RFID communicate with Central Control Unit. Depends on the requirement, both active and passive RFID can be used in this system. Active RFID can be used when we need a high read/write speed and passive RFID can be used when the system is not time critical.

The Central Control Unit send request signal to RFID to retrieve data. Also it can write data into the memory. The data can be sensor run-time parameters or Micro-Controller program variable. Each time the CCU request data, the self-identification will be sent back to CCU along with the sensing data. Thus, the CCU has the capability to identify the sensing data belongs to which sensor. This is very useful in a high volume sensor system.

The features of this system include:

- Self-identification: identifying the signals emanating form a specific sensor.
- Reconfigurable: Central Control Unit can set the run-time parameters of the sensor.
- Self-calibrating: to match the changing conditions, the sensor can correct measure accuracy without significant user intervention.
- Field re-programmability
- Wireless connectivity: provide two-way communication, sending and receiving, through wireless connection.
- Reduce the size of the system by removing physical interface.
- Reduce the installation and maintenance cost by removing the cables.

## 3. Micro-Controller

Micro-Controller is the key component in this system. Sensing data collection, sensor run-time setting, and data exchanging are controlled by Micro-Controller. In this system, we chose Microchip's PIC16F676 Microcontroller [5]. It is a powerful (200 nanosecond instruction execution) and easy-to-program (only 35 single word instructions) CMOS Flash-based 8-bit microcontroller packed in 14-pin package. It features 8 channels for the 10-bit Analog-to-Digital (A/D) converter, 1 Comparator, and 128 bytes of EEPROM data memory. It is "easily adapted for automotive, industrial, appliances and consumer entry-level product applications that require field re-programmability" [5].

Figure 3 shows schematic of the Micro-Controller. Because PIC16F676 has timer and oscillator, it is a minimum system. We don't need to add extra electronic components. In this schematic, micro-controller can accept up to 4 analog inputs and data bus is 8 bits. Both output pins and input pins are program configurable.

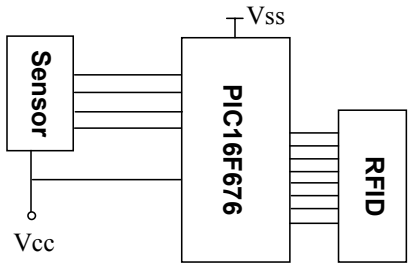


Fig. 3 Schematic of Micro-Controller

## 4. Application Scenario

RFID technology based wireless sensor can be used in a diverse, high volume sensor system. It is very suitable for automotive, aerospace industry. It can significantly save space and improve the reliability. Figure 4 shows an application scenario in car system. As we know, to monitoring the running status of a car needs high-density sensors. As shown in the figure, each sub-system such as suspension, ABS, Emission System have quite mounts of sensors installed. Central Control Unit can poll each sensor quickly to get the sensing data. Since every sensor has a unique identification number, Central Control Unit can easy know the sensing data comes from which sensor and do respective operation.

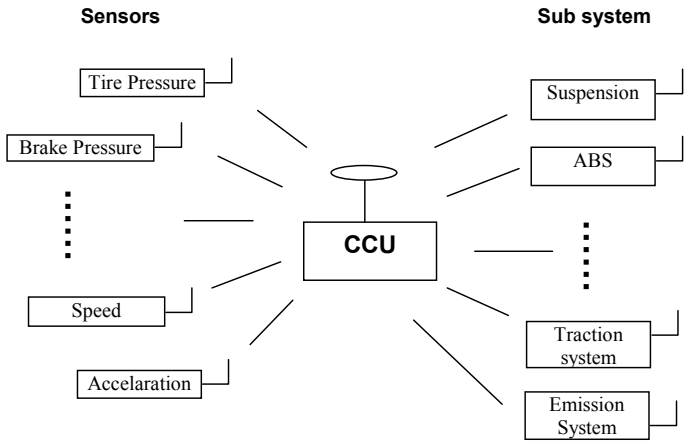


Fig. 4 Application of wireless sensor in automobile

## 5. Summary

By simply using RFID technology, traditional wired sensor could be upgraded to intelligent wireless sensor. In this research, we use a microcontroller to integrate sensor and RFID together. This is an effective way to add intelligence and wireless connection to existed sensor.

## Reference:

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[3] IEEE 802.15 WPAN™ Task Group. http://ieee802.org/15/index.html

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