Design and Implementation of an Active RFID Tag

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Abstract— The Active Radio Frequency Identification tag that is RFID tag with battery is promising for RFID low power consumption and precise localization in indoor cluttered as well as for outdoor environment. In this paper, Design and Implementation of an Active RFID tag is proposed, with far reading distance, high reliability, low cost, low power consumption, and long life. The Active RFID tag is a transmitter designed using the 8051 microcontroller and wireless data transmission chip CC2500. The objective of tag is achieved by optimization of the circuit design for continuous Tag ID transmission; each Tag has its own unique ID. The transmitted Tag ID is captured by receiver we call it as RFID reader, the hardware and software implementation are presented in this paper with measurement in a typical indoor environment.

Keywords-— RFID, Low Cost, Active Tag, Short Range Communication

I. INTRODUCTION

As a new kind of automatic identification technology, radio frequency identification (RFID) is the fundamental principle to realize the automatic recognition of the static or moving objects by radio frequency signal. Usually, RF system consists of RF tag, reader and host as shown in Fig.1. RFID tag can be roughly classified into passive and active types of tags. The passive tag does not incorporate a battery and responds with the energy provided by a reader/writer [4] [7]

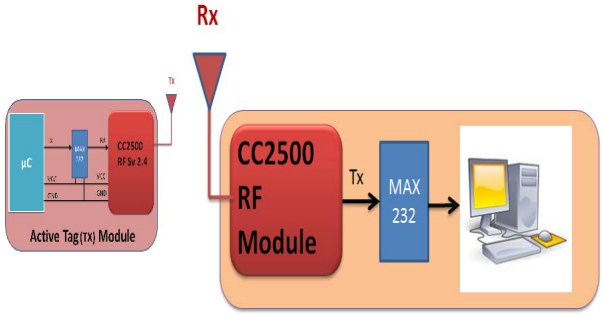

Fig.1. RF system using active tag

In passive tag system communication range is short, but the cost is low. This type of tags are expected to be applied to improve efficiencies in the area of the cash register, picking work at a delivery center, inventory control, and distribution / traceability. On the other hand active tag's communication range is long, but coverage of application is limited because of its cost. Both passive and active types of tags are being applied to various areas for their best use case. At present, most RFID systems adopt passive tags which get power from the reader by RF signal; it is beneficial to reduce the label size and cost, but the reading range and data storage capacity are limited. While the active tag with battery can provide larger range of reading ability and higher reliability. Now the breakthrough of low power consumed IC technology created favorable conditions for the development of small size and low power active tag. Active tag is designed using Single-chip MSP430F2012 and wireless data transmission chip CC1100 as presented in reference [1], The active tag always transmits ID at constant intervals, the design aimed to implement active tags based on 8051 µC and RF module having on chip antenna for wireless data transmission with the lowest possible hardware cost.

II. DESIGN OF ACTIVE RFID TAG

The Active RFID tag is a transmitter designed using the 8051 µC and RF module which uses CC2500 chip for wireless data transmission. Since an active RFID tag uses the battery as power supply; we will look forward for low power consumption performance to prolong the service life of battery. Low-power design requires both the choice of components and optimized reasonable run timing.

A. Selection of Microcontroller

In this the µC performing two important functions i.e., (a) store the unique ID which is referred as tag ID (b) continuously transmit tag ID for further wireless transmission. Another name for a µC, therefore, is "embedded controller". For instance, a typical µC will have a built in clock generator and a small amount of RAM and ROM (or EPROM or EEPROM), meaning that to make it work, all that is needed is some control software and a timing crystal (through some even have internal RC clocks). Micro-controller will also usually have a variety of input/output devices, UARTs or specialized serial communications interfaces like I^2C, Serial Peripheral Interface. Often these integrated devices can be controlled by specialized processor instructions. [9]

µC's are dedicated to one task and run one specific program is stored in ROM (Read Only Memory). The program is prepared in assembly/embedded c language for performing the above functions. Finally, it must be mentioned that some Micro-controller architectures are available from many different vendors in so many varieties that they could rightly belong to a category of their own. Chief among these are the 8051 family. Also 8051 series is a recognized as MCS51 in the industry. Taking into consideration of our present requirements and application of active RFID system we conclude 8 bit µC will suffice the application. 8051 µC is adopted in this paper. [9]

B. Selection of RF chip

Choosing RF chip is the most crucial part of the Active RFID card, it directly related to tags read range and reliability, but also the power consumption. Wireless transmitter CC2500 [8] with small size, low consumption, supports programmable control; with internal address decoder, modulate processor and so on, is very easy to use. In our design we select CC2500 with operating frequency of 2.4GHz. CC2500 have on chip antenna. [5]

Features of RF module:

- 2.4 GHz carrier frequency.
- 255 possible channels.
- RS232 UART interface with variable baud rate.
- Standard configuration baud rate 9600 bps.
- Power LED indicator.
- Input Supply 5V to 12V.
- 2 run mode: Packet Mode and Single Byte Transfer.
- Variable packet length (0 to 40).
- Programmable channels (0 to 255).
- Programmable device address: 255 per channel.
- Compact size, plug and play.
- On board EEPROM for saving settings.
- Supported Baud Rate 300, 600, 1200, 2400, 4800, 9600 bps.

Parameter	MAX	TYP	MIN
Input Voltage	12V	5.5V	5V
Current consumption	42mA	40mA	30mA

C. Battery supply

Battery is used as power supply directly. It saves quiescent current brought from voltage regulator circuit, prolongs the service life of battery. To adopt battery as power supply, the key point is to solve the random wrong operation because of incomplete reset, which resulted from mechanical contact with the battery wires will produce power supply noise when replace the battery.

III. HARDWARE DESIGN OF ACTIVE TAG

The active tag should have the following characteristics: miniaturization, low cost, high reliability, adjustable reading, distance battery-powered, and so on. The block diagram of the tag is shown in Fig. 2.

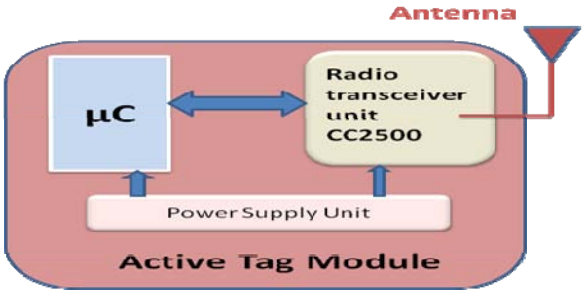

Fig.2 Block diagram of active tag module

A. System Structure of Tag

RFID tag consists of µC unit, radio transceiver unit and power supply unit. Of these, the µC unit with its own memory, which is responsible for the operation of RFID tag, data deposition and processing. The radio transceiver unit contains RF chip with on chip antenna, to achieve information transmission between active tag and reader. The power supply unit supply power for tag.

B. Serial Communication

µC supports four modes of serial Communication. The diagram of active tag is shown in Fig.1 Here we are using µC in continuous Transmission mode.8-bit UART (Universal asynchronous receiver transmitter) with variable baud rate.

IV. SOFTWARE DESIGN OF TAG

A. Design of Workflow

Recent µC's integrated with on-chip debug circuit accessed by In-circuit Emulator enables a programmer to debug the software of an embedded system with a debugger. The software development of system uses C language on Embedded Workbench keil to program. The intercommunication between µC and RF module is done by using RS232 cable.

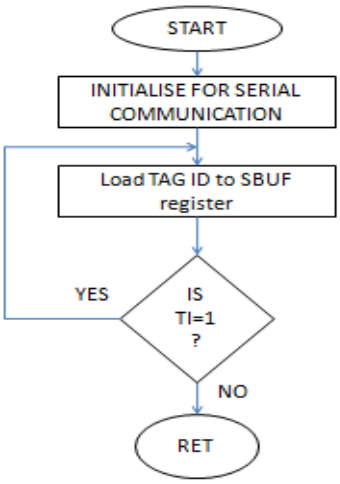

Fig. 3 Flowchart of tag ID transmission

B. Realization of Driver

(a) Microcontroller communicates with RF module by standard Serial Peripheral Interface (SPI), which includes two data lines.

(b) USB to DB9 serial adapter is needed for the pc or laptop without serial port. For that it is necessary to install USB TO RS232 Driver Installer

V. SYSTEM SIMULATION

µC Combined with configured reader, we get that the program is correct through keil simulation, then burning the program by emulator and Flash Magic, and using serial debugging tools to test, test result is shown in Fig4. Form the debug result of continuous ID transmission for active tag using keil is in Fig.4.

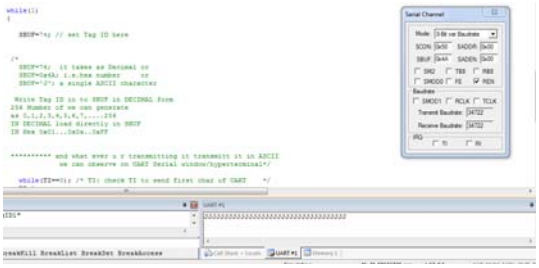

Fig.4. Result of simulation of program using keil

VI. HARDWARE TEST

To verify the proposed method, we made a prototype model of 2 active tags having ID 74 and 104. We are able to see ID in ASCII equivalent of the same tag ID number. The ID's are given through programming µC. Their radio frequency is 2.4 GHz, the frequency for transmitter and receiver is same. Receiver has only one on chip antenna and it works as transceiver. It receives the tag ID so it is as good as RFID reader. We tested tag read system using HyperTerminal and terminal. The results obtained for Sending two active tags ID are shown in Fig. 5 (a) and Fig. 5 (b); and for receiving tag ID in Fig. 5(c) and Fig. 5(d).

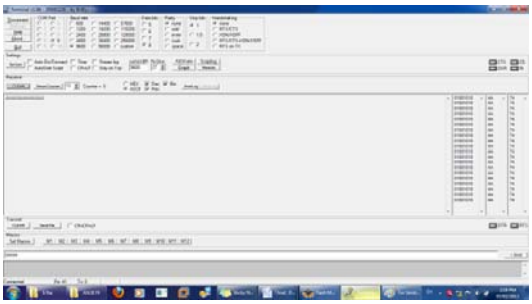

Fig (a) For Sending active tag ID 74

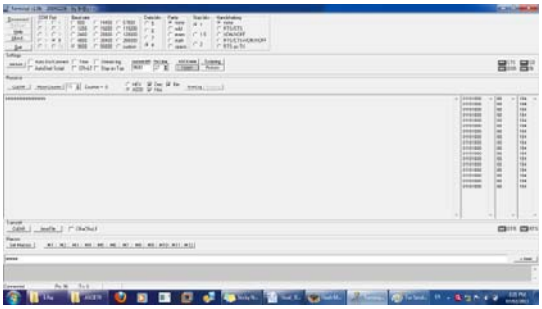

Fig (b) For Sending active tag ID 104

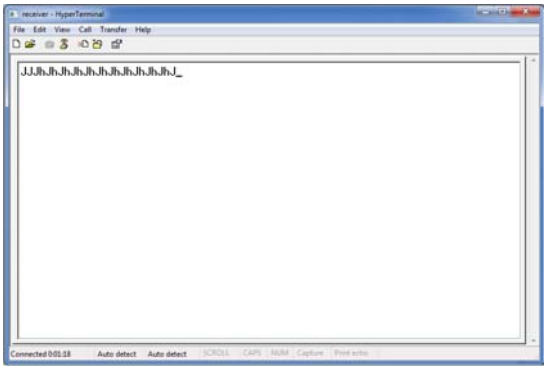

Fig (c) For receiving tag ID's on HyperTerminal

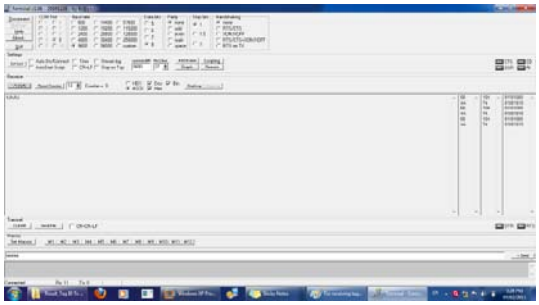

Fig (d) for receiving tag ID's on
Fig.5 Result of Hardware Test for Prototype Active Tag Read System Using HyperTerminal

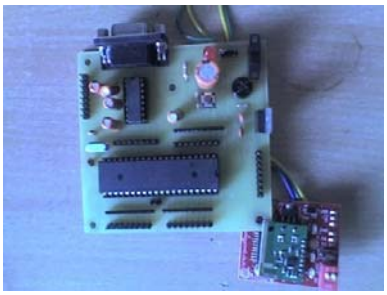

Fig.6 Photo image of working prototype model of active RFID tag

We observe that active tag is transmitting the Tag ID continuously to reader. The reader sends it to serial debugging software here it is HyperTerminal and Terminal of host computer by RS232 interface, to show the Tag ID. In the Fig. 5 (a) (b) result is received when two active tags sending their Tag ID; and Fig. 5 (c) (d) for receiving the Tag ID. The simulation and debug results proved the feasibility of RFID design.

Applications

Local informer: the positioning system displays guidelines on a person's handy device (battery operated) based on the client's location. [7]

Centralized tracking: In some cases, it's advantageous to keep information based on the location of objects. In this we can store and display the position by single click by means of GUI. Centralized tracking information in real time, of the location of objects is available to an operator on single click. As an example, a hospital can track patients in an operating room to analyze and remove bottlenecks in the flow of work. [7]

Decentralized tracking: This goes a step further than centralized tracking; as a result, centralized station broadcast specific (user defined) object's positions to all clients.[7]

Future Scope

This system can be used for security, automation and monitoring systems like multistoried car parking system, Mining, Fleet Management , Logistics, Artwork Presentation , Construction Site Safety etc.

We can develop application based GUI as per user requirement.

VII. CONCLUSIONS

In this paper the active RFID tags are designed and implemented successfully. Results of hardware test for prototype active tag read system are presented. The tag Solved identification problems as long-distance, big flow, anti-interference, high-speed and at the low cost. RFID tags. Tags can be used for persons or goods recognition, Management and location system, which is widely used in industrial production, national defense security and so on.

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