Realization of RFID Monitoring Access System

Mitar Simic
NORTH Point Ltd.
Subotica, Republic of Serbia
mitarsimic@yahoo.com

Marin Radak
NORTH Protection Ltd.
Subotica, Republic of Serbia
radak.marin@gmail.com

Abstract— **This paper presents practical development and design's details of low cost RFID access monitoring prototype. System is based on ATmega128 microcontroller and Parallax #28440 read/write module. Device has full stand alone data logging capabilities just as on-line processing on PC. Communication between device and PC is realized through USB. Created report, which consists of date and time stamp with information about user, is stored in PC database and on micro SD card which is connected to the device. PC application compares user ID with entries in database and after verification shows photo and personal information of user. Application also allows adding or removing users and creating PDF reports. Device also has LCD which presents time and date just as status of placed identification card. Realized system can be used in a wide variety of hobbyist and commercial applications, including access control, user identification, inventory tracking, payment systems, car immobilization, and manufacturing automation.**

Keywords- access control, RFID, monitoring systems

I. INTRODUCTION

The term access control refers to the practice of restricting entrance to a property, a building, or a room to authorized persons. Physical access control can be achieved by a human (a guard, bouncer, or receptionist), through mechanical means such as locks and keys, or through technological means such as access control systems like the mantrap. Within these environments, physical key management may also be employed as a means of further managing and monitoring access to mechanically keyed areas or access to certain small assets.

Physical access control is a matter of who, where, and when. An access control system determines who is allowed to enter or exit, where they are allowed to exit or enter, and when they are allowed to enter or exit. Historically, this was partially accomplished through keys and locks. When a door is locked only someone with a key can enter through the door depending on how the lock is configured. Mechanical locks and keys do not allow restriction of the key holder to specific times or dates. Mechanical locks and keys do not provide records of the key used on any specific door and the keys can be easily copied or transferred to an unauthorized person. When a mechanical key is lost or the key holder is no longer authorized to use the protected area, the locks must be re-keyed.

Electronic access control uses computers to solve the limitations of mechanical locks and keys. A wide range of credentials can be used to replace mechanical keys. The electronic access control system grants access based on the credential presented. When access is granted, the door is unlocked for a predetermined time and the transaction is recorded. When access is refused, the door remains locked and the attempted access is recorded. The system will also monitor the door and alarm if the door is forced open or held open too long after being unlocked the requirements for the format of the papers are discussed [1].

Various RFID access control and monitoring systems are available on the market, for example [2]-[7]. Main characteristics are serial communication with PC, optionally USB power supply, LED indicator, beeper, read ranges up to 15 cm, etc.

Design of own RFID access monitoring and control system is challenge for engineers and electronic hobbyists for many years. Some approaches based on Arduino can be found in [8]-[13]. Benefits of developing own system is making custom options related to user specific requirements, easy expansion of system, cheap maintenance, etc. In some cases realization of this approach can be more expensive than commercial available devices, so all requirements must be considered before making of decision. Final solution shall be compromise between price and specific requirements.

In this paper, authors presented practical development of low cost RFID access monitoring system. System is based on ATmega128 microcontroller and Parallax #28440 read/write module. In design process main criterions were availability of components on the market, low cost and open hardware organization for future upgrades and customizations for specific user requirements.

Main contribution of this work compared to commercial devices is additional database realized on micro SD card which ensures stand alone usage of device in areas without PC connection. The format of data logged on the micro SD card is in CSV file format. The design goal for this access monitoring system is portable or convenient for reading by most software analysis tool. The CSV file type is compatible with Microsoft Excel and widely accepted for transferring data between computers or software using different data format. The CSV file can be used on all computer platforms and allows to be converted into many file types including spread sheet files such as XLS, HTML, XML and DBF.

II. BASICS OF RFID TECHNOLOGY

Radio Frequency Identification (RFID) is a generic term for non-contacting technologies that use radio waves to automatically identify people or objects. There are several

methods of identification, but the most common is to store a unique serial number that identifies a person or object on a microchip that is attached to an antenna. The combined antenna and microchip are called an "RFID transponder" or "RFID tag" and work in combination with an "RFID reader" (sometimes called an "RFID interrogator").

An RFID system consists of a reader and one or more tags. The reader's antenna is used to transmit radio frequency (RF) energy. Depending on the tag type, the energy is "harvested" by the tag's antenna and used to power up the internal circuitry of the tag. The tag will then modulate the electromagnetic waves generated by the reader in order to transmit its data back to the reader. The reader receives the modulated waves and converts them into digital data.

There are two major types of tag technologies. "Passive tags" are tags that do not contain their own power source or transmitter. When radio waves from the reader reach the chip's antenna, the energy is converted by the antenna into electricity that can power up the microchip in the tag (typically via inductive coupling). The tag is then able to send back any information stored on the tag by modulating the reader's electromagnetic waves. "Active tags" have their own power source and transmitter. The power source, usually a battery, is used to run the microchip's circuitry and to broadcast a signal to a reader. Due to the fact that passive tags do not have their own transmitter and must reflect their signal to the reader, the reading distance is much shorter than with active tags. However, active tags are typically larger, more expensive, and require occasional service.

Frequency refers to the size of the radio waves used to communicate between the RFID system components. RFID systems typically use one of the following frequency ranges: low frequency (or LF, around 125 and 134.2 kHz), high frequency (or HF, around 13.56 MHz), ultra-high frequency (or UHF, around 868 and 928 MHz), or microwave (around 2.45 and 5.8 GHz).

The read range of a tag ultimately depends on many factors: the frequency of RFID system operation, the power of the reader, and interference from other RF devices. Balancing a number of engineering trade-offs (antenna size vs. reading distance vs. power vs. manufacturing cost), the Parallax RFID Read/Write Module's antenna was designed specifically for use with low-frequency (125 kHz) passive tags [14].

III. HARDWARE DESCRIPTION

Proposed structure of device for RFID access monitoring with data logging is presented in Fig. 1.

The hardware has been built around a microcontroller AVR ATmega128 [15]. The microcontroller is used with a supply voltage of 5 Volts and an external quartz crystal of 16 MHz.

The Atmel AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

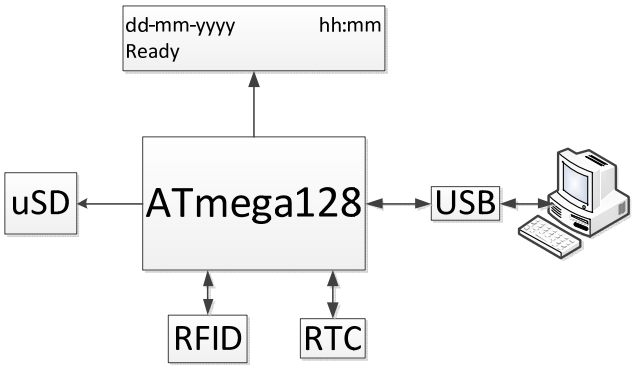


Figure 1. System architecture of device

A serial interface has been included to the device in order to be able to upload user ID readings to a PC. Connection between PC and device is available through USB cable.

Device also has alphanumeric LCD (20x4 characters) for displaying time and date information as well as status of current placed identification card.

User information with date and time of access are stored on 2 GB micro SD card. FAT16 file system is used to allow manipulation of file with results on PC and off-line processing in case that system is not connected to PC. The main advantage for using micro SD card as data storage system is the ease of transferring data directly to other electronic devices such as laptops or smart phones which support FAT format as file system.

Real time clock DS1307 [16] with backup battery is used to provide time measuring. Time and date values are used for displaying on display and for additional information for every saving in report on micro SD card and PC database.

Used RFID module is Parallax #28440. Designed in cooperation with Grand Idea Studio, #28440 (presented in Fig. 2.) Read/Write Module provides a low-cost solution to read and write passive RFID 125 kHz transponder tags up to 3 inches away [17].

Figure 2. Parallax #28400 RFID read/write module

There are many ways to use the RFID read/write module and associated tags, but the three most common are as follows:

- Read Only: Read the tag's unique, non-changing 32-bit serial number

- Read/Write: Read from and write up to 116 bytes of publicly accessible user data on the tag

- Read/Write (Protected): Read from and write up to 116 bytes of password-protected user data on the tag. In this mode, user must enter the correct 32-bit password in order for read and write operations to be successful.

The RFID Read/Write Module is controlled by the host via a standard, asynchronous serial communications interface configured at 9600 bps, 8 data bits, no parity, 1 stop bit, and least significant bit first (8N1). The serial data expected and transmitted by the RFID Read/Write Module is 5V TTL-level, non-inverted. The unit waits in an idle state until it receives a valid header and command from the host, at which time the module will perform the command and return a status/error byte indicating a success or failure and command-specific data (if any). The module will then re-enter the idle state and wait for the next valid header and command.

A visual indication of the RFID Read/Write Module's state is given with the on-board LED. When the module is successfully powered-up and is in an idle state, the LED is green, and when the module is in an active state (for example, searching for a valid tag or performing an operation on the tag), the LED is red.

IV. SOFTWARE STRUCTURE

A. *Program of microcontroller*

Program code is written in C programming language. Flow chart of embedded software that controls device is presented in Fig. 3.

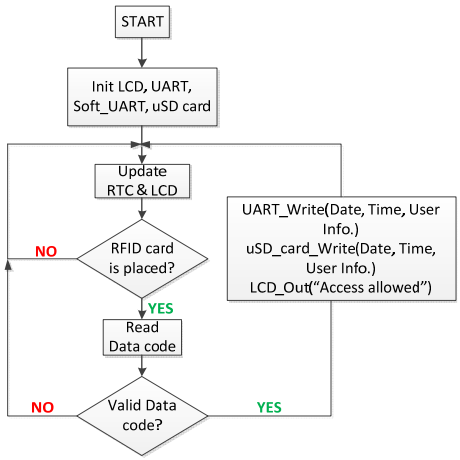
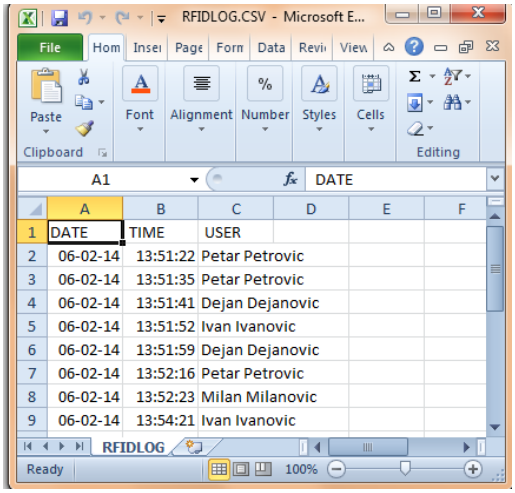


Figure 3. Flow chart diagram of the microcontroller program

After starting of device, program executes initialization routine which enables UARTs and I2C peripherals, LCD and checks if micro SD card is present. There is also routine if new micro SD card is inserted which creates file for saving the readings.

After initialization main screen is activated. Current time and date with "Ready" message are shown on display. RFID module is in active state and system is waiting for RFID card. After detection presence of card, device reads data code from it and compares with data in database. If card is valid microcontroller sends to PC via UART date, time and user information and saves all these values on micro SD card. After these operations are finished LCD shows message that access is allowed. After specific amount of time, system is ready and waiting for new card.

Created report of readings with time and date stamp is stored on micro SD card in CSV format as shown in Fig. 4. The CSV file type is compatible with Microsoft Excel and widely accepted for transferring data between computers or software using different data format.



	A	B	C
1	DATE	TIME	USER
2	06-02-14	13:51:22	Petar Petrovic
3	06-02-14	13:51:35	Petar Petrovic
4	06-02-14	13:51:41	Dejan Dejanovic
5	06-02-14	13:51:52	Ivan Ivanovic
6	06-02-14	13:51:59	Dejan Dejanovic
7	06-02-14	13:52:16	Petar Petrovic
8	06-02-14	13:52:23	Milan Milanovic
9	06-02-14	13:54:21	Ivan Ivanovic

Figure 4. Example of created log file

B. *PC Application*

PC application compares user ID with entries in database and after verification shows photo and personal information of user. Application also allows adding or removing users and creating PDF reports.

In Fig. 5 main screen of PC application for RFID access monitoring system is presented. On the left side of window registration log with user name, date and time stamp with card status is presented. On the right side PC database log is presented.

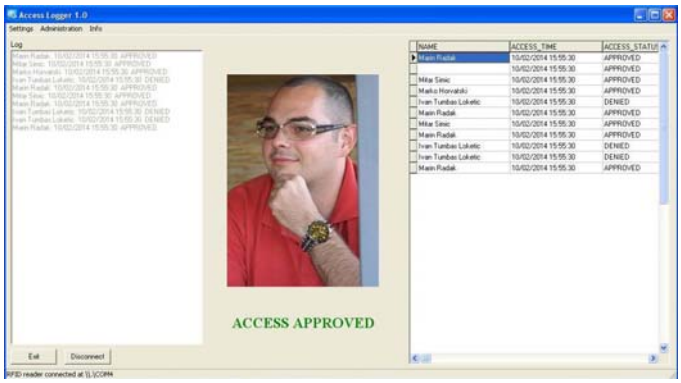


Figure 5. PC application for RFID access monitoring system

PC application also has mode for user administration where cards can be programmed with username and access permission attribute. Picture can be added for visual identification of users as well. In the same window list of authorized users is presented. Previously defined users can be deleted or settings can be edited. In Fig. 6 window of PC application for configuration is presented.

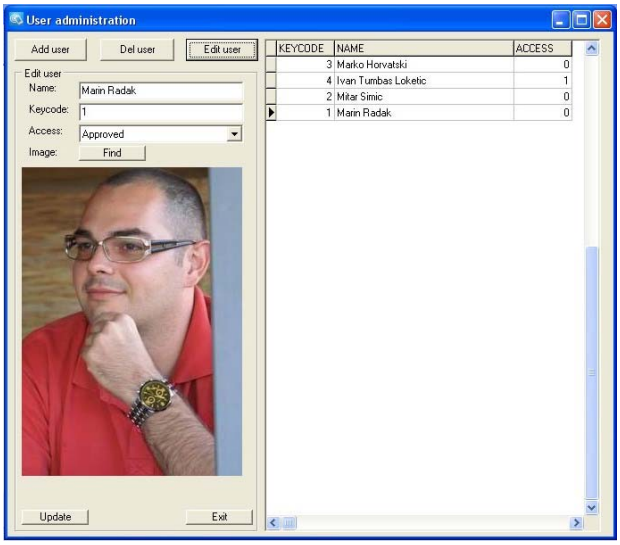


Figure 6. PC application for RFID access monitoring system – user administration

In the main window of application option for generating of PDF reports with log information for specific period of time is also available.

V. HARDWARE OUTCOME

As described before, complete system consists of RFID module, acquisition card and PC application. All these components are shown in Fig. 7.

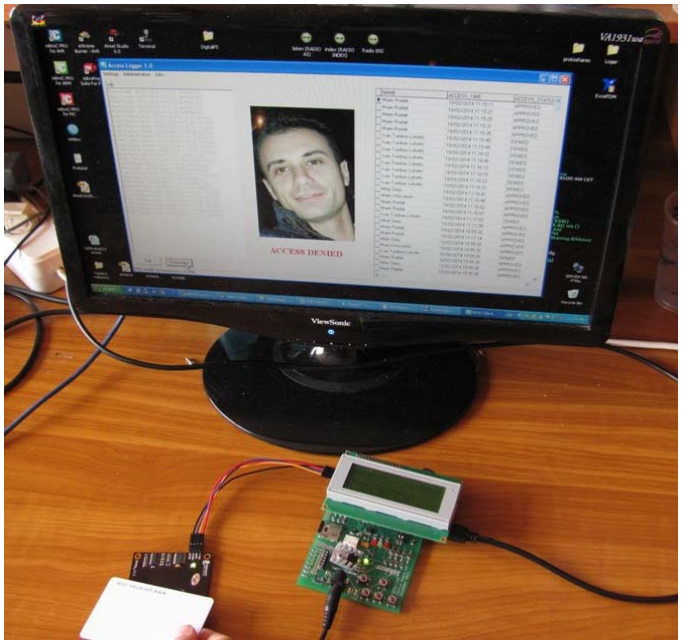


Figure 7. RFID access monitoring system

A prototype hardware outcome of acquisition card is shown in Fig. 8.

Figure 8. Hardware outcome of acquisition card for RFID access monitoring system

VI. CONCLUSION

This paper presented details of design and construction of low cost RFID monitoring access system based on ATmega128 microcontroller and Parallax #28440 read/write module.

The future plans of this work are to improve the functionalities of monitoring access system with adding new hardware and software features.

Hardware expansion can be done with adding electronic door lock to control physical access in specific area. Also installed micro SD card can be used as storage devices for measurements from sensors which can be connected to this device in aim to monitor specific conditions (temperature, relative humidity, pressure, pollution, etc.) in area of interest.

Software expansion can be done such as adding built-in web server. A global positioning system (GPS) receiver is also needed to provide location information for the reading units in case that system is based on more than one unit for access monitoring in wide areas. Finally, an internet connection is also necessary to forward the log data to a base station. This can be implement using wireless wide area network such as general packet radio service (GPRS) which operates on global system for mobile communication (GSM) network or wireless local area network such as Wi-Fi.

ACKNOWLEDGMENT

This work was financially supported by European Commission in the framework of the FP7 project SENSEIVER, grant number 289481.

REFERENCES

[1] http://en.wikipedia.org (last accessed on 14.8.2013)
[2] http://www.rfideas.com (last accessed on 16.8.2013)
[3] http://www.securakey.com (last accessed on 6.2.2014)
[4] http://www.simplyrfid.com/ (last accessed on 6.2.2014)
[5] http://www.rfidc.com (last accessed on 6.2.2014)
[6] http://www.x-check.co.uk/ (last accessed on 6.2.2014)
[7] http://www.intermec.com (last accessed on 6.2.2014)
[8] I. Korkmaz, C. Atay, G. Kyparisis, *A Mobile Patient Monitoring System Using RFID*, Latest trends on computers (Volume II), ISSN: 1792-4251
[9] K. Chen, H. Tsai, Y. Liu, and J. Shuler, *ARG-US – An RFID-Based Tracking and Monitoring System for Nuclear Material Packages*, Argonne National Laboratory, Argonne, IL, USA
[10] http://www.instructables.com/id/Security-System-and-Access-Control-with-Arduino-an/ (last accessed on 14.8.2013)

[11] http://arduinobymyself.blogspot.com.br/2012/03/arduino-sistema-de-seguranca-controle.html (last accessed on 14.8.2013)
[12] A. Al-Ali, F. Aloul, N. Aji, A. Al-Zarouni, N. Fakhro, *Mobile RFID Tracking System*, Computer Engineering Department, American University of Sharjah, UAE
[13] M. Helmy, A. Wahab, H. A. Kadir, Z. Tukiran, N. Sudin, and A. Johari, *RFID-Based Equipment Monitoring System*, Universiti Tun Hussein Onn Malaysia
[14] www.rfidjournal.com (last accessed on 5.8.2013)
[15] AVR ATmega 128, data sheet
[16] DS1307, data sheet
[17] Parallax 28440, data sheet