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RFID based Authorization Method for Computer Systems in Smart Library Environments

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***Abstract*—In recent years, intelligent systems have emerged with the concept of the Internet of Things. The purpose of intelligent systems is to use technological innovations to improve the quality of life of people. Smart systems are now being used almost everywhere. Concepts such as smart city, smart classroom, smart library, smart hospital and smart transportation have emerged. With the cameras, sensors and many other devices used in smart systems, data from the environment can be analyzed and remote control operations can be performed. In this study, RFID based authorization system has been developed in the publicly available computers used in smart libraries. In many places, as in universities, there are common computers or laboratory devices that can be used by everyone. The aim of this study is to ensure the common use of devices belonging to common use against existing users. The devices are controlled by an RFID based system developed for these devices. Using the ID cards of the students or staff, the person is authorized to use the devices for the defined period of time. This study has two main contributions. First, a modular system compatible with all electronic devices except the computer has been made by using RFID technology. The second is to provide a more efficient working environment by ensuring fair use of computers and other devices accessible.**

Index Terms— **Internet of Things, Library management systems, RFID, Smart library.**

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I. INTRODUCTION

NOWADAYS, THE use of intelligent systems is generally aimed at regulating the work of end users and providing important advantages to the end user on time basis. In addition, the most important advantages of these systems are to save the end user from certain workloads, to enable the system to make decisions on its own, and to automate the periodic processes. From this point of view, it has been observed that serious problems and imbalances have been experienced especially in computer use by students. In addition, it was found out that the computer services provided by the library unit and generally provided for use in catalog scanning and research and development activities were used by the students against their purpose and the computers were constantly occupied due to this situation. In addition, the use of these computers as a personal computer by some students causes them to occupy them for hours and prevent a user from searching for catalogs or research activities.

Technological advances ensure that the existing systems are carried out quickly, reliably and consistently. It also plays a major role in the emergence of new systems. The technological devices produced to meet the requirements of the era continue to be inspired by the human mind. Thus, they have gained the ability to decide on their own by exceeding the feature of executing only the given command. These developments in almost every field have also started to be used in library systems. With the development of computer-aided search systems, the disadvantages of man-based systems were eliminated. Library software, which is widely used in our country, provides a fast and reliable service in many fields such as questioning, tracking, loan / return transactions and placement of books and documents. Moreover, with the protocols they use, they gathered the database and hardware resources known as necessity in the existing library automation under a single roof. Thus, the installation of a database and hardware was prevented over and over again in each area where the system was installed [1].

As a result of the researches, it has been found that RFID technology is used in many different fields and it is seen that it is one of these fields in its libraries [1-6]. In a study conducted for libraries using RFID technology, it was

provided to control the library as a whole by using Motorola MC9090 series handheld terminals. Each book in the library is equipped with a label and each of these books is assigned a separate electronic code, which is completely related to the database. Thanks to this developed system, a misplaced book, a missing book or undelivered books can be identified exactly. Furthermore, manual system was prevented with the developed system and problems in the library were minimized as much as possible [7].

RFID technology has an important place especially in the Internet of Things (IoT) concept [8, 9]. IoT is basically the process where devices can communicate between each other, share information and organize the working principle in this context [10, 11]. IoT applications take place in a wide range of areas [12, 13]. Some of these areas; health care, supply chain, logistics, mining, transport, firefighting, smart homes, building automation, smart cities and energy management [14-19]. Naturally, RFID technology plays an active role in almost all of these areas. Therefore, the concept of IoT and RFID are highly interrelated [20-23]. RFID, a core of IoT technology, was first used to identify friendly or enemy aircraft systems during the second world war [20]. This refers to a type of non-contact automatic identification system [21]. In other words, it identifies the object via radio frequencies and provides access to the associated data without the need for physical contact with any humanoid [22]. RFID systems are basically composed of 3 sections. These sections are RFID Tag, RFID reader and server sections, respectively. A block diagram summarizing the architecture and operating principle of RFID systems is given in Fig. 1.

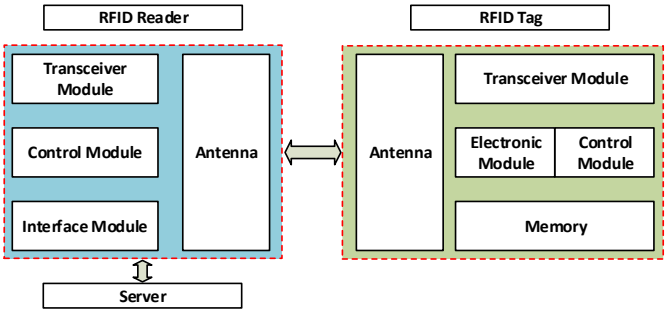

Fig. 1. RFID system architecture [22]

In another study on the subject, an RFID based application was developed for the medical health system. In practice, developed primarily for the purpose of medical confidentiality, patient ID, drug management and patient information are stored on RFID cards, and access is provided only to readers [24]. With RFID technology, the identification process allows the data to be collected and differentiated from each other by clarifying the characteristics of the object or living thing. Barcodes, smart cards and biometric technologies are widely used in recognition technology. The common feature of these systems is that they allow data to be received by contact or close distance. In RFID technology, data acquisition is provided by the object or living being within the range of the reader. In addition, physical problems such as impacts, scratches caused by user-related problems in similar technologies make data retrieval difficult. RFID tags do not cause such problems. The possibilities of RFID technology are shown in Fig. 2.

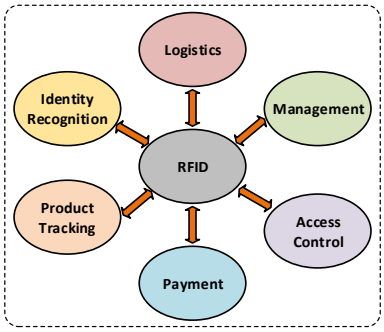

Fig. 2. The possibilities of RFID technology

II. Proposed Method

With this project, which is aimed to be developed and realized, all these situations are prevented and the computers used actively in the library unit are made smart and students are provided to use the computers in a more fair and orderly manner. With the hardware and software improvements to be realized within the scope of the project work, students can activate these computers with their own school ID cards, then use the computers for a period of time defined for each student and finally the system turns itself back to passive position. In the first stage of this proposed study, a hardware PCB board was developed. For this purpose, a card reader / writer interface has been developed and USB connection has been provided to the computers in the library unit. In the next stage of the system, software development process was applied for the computers in the library unit. With the help of this software, the Ethernet port of the computer is activated and the computer is ready for use by logging on to the card reader. In the last stage of the system, the software automatically shuts down the computer at the end of the specified period, the Ethernet port is disabled and the student's computer usage is terminated. A block diagram showing these stages and the relationship between these stages is given in Fig. 3.

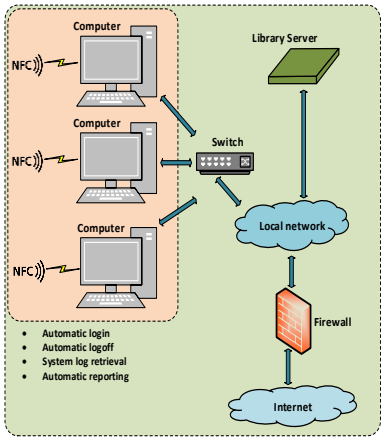

Fig. 3. A block diagram summarizing the proposed system

As shown in Fig. 3, the system expects to first read the user's ID card. With the designed ID card reading system, the information stored on the user's card is transmitted to the web service to be provided by the university over the local network. Upon the arrival of the student ID information to the web service, the query is performed in the database and information is obtained whether the student has the right to use the computer. Then, this information is returned to the computer in the library unit and the student is logged in through the software. After the user login, the system receives the date / time and starts to process the time for that student. The student can use the computer for a predefined period of time and after the expiration of the period, the computer turns itself off. The hardware and software unit developed in this study has a modular structure. Thus, it is aimed that card readers can be used in different units and areas in the following processes.

In the first stage of the proposed system, the hardware development process is completed. For this purpose, Arduino Pro Mini programming card is used primarily. The main reason for this is that these cards allow to recognize various additional cards and their cost is low. In addition, RFID RC522 series card reader which is compatible with these cards was used in the first stage. At this stage of the system, the integration of the processor and the RFID card series is provided and both read and write operations are performed from the student ID cards. In the next stage of the system, USB communication is made for these card readers to connect with the computer. Readers will be supplied with power via the USB line and a communication line will be installed. In the third stage of the system, a web service was prepared to communicate with the existing university server and to withdraw student information from the system. With this web service, the authentication process of the students who read their ID cards is performed. In addition, depending on the information taken, the time, date and time information defined for the students is recorded on the card and the student's session is started. In the fourth stage of the project work, a printed circuit board was prepared for the processor and rfid card and these cards were made compatible with each other on a single platform. In the fifth stage of the system, the previously prepared software and hardware modules will be brought together and the integration of the modules is ensured. In the sixth stage of the study, the product was packaged and made ready for use. The hardware connection of the developed system is given in Fig. 4.

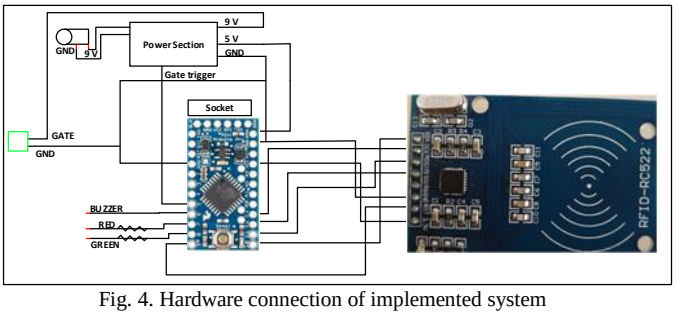

Fig. 4. Hardware connection of implemented system

As can be seen in Fig. 4, the hardware module of the system consists essentially of two parts. The first part is the processor part. This unit is the part that will process students' cards. The second part is RFID-RC522. With this equipment, the information in the student ID cards can be read and writing process can be provided by this card if necessary.

Another module of the system is the software section. On the software side, a platform is established to communicate with the university server. The information obtained through the hardware module from the student ID card is transmitted to the university server via a web service and the accuracy of the student ID card is ensured by the inquiry to be performed at that point. At this point, the user logs on to the computer with the information to be returned from the server and again, this login status and date, time information is processed on the student's card with the hardware module. A block diagram summarizing the steps of the software development process is given in Fig. 5.

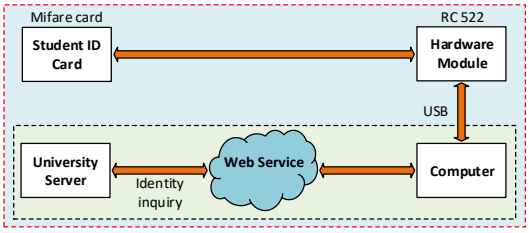

Fig. 5. Software block diagram of realized system

The final printed size of author photographs is exactly 1 inch wide by 1.25 inches tall (25 millimeters x 38 millimeters / 6 picas x 7.5 picas). Author photos printed in editorials measure 1.59 inches wide by 2 inches tall (40 millimeters x 50 millimeters / 9.5 picas x 12 picas).

III. Experimental Results

Thanks to the intelligent computer control application performed in this study, students' use of computers is provided in a fair way, usage periods and movements are recorded and computers are made more secure. Especially considering the fact that illegal movements are frequently experienced in the virtual environment, it is extremely important to obtain information on which computer, on which days and hours the students use.

Experimental studies conducted are basically under two headings. The first of these studies is the hardware side of the system. On the second side of the system, simulation process of the developed hardware card was performed. These studies are presented in sub-sections below.

A. Hardware Module

The developed system can be integrated with existing ID cards and allows the system to be modified and used for many different purposes. Although the proposed study was developed for the library unit, it can be used in laboratory environments, university exits and collective environments such as dormitories upon request. Considering the limitations of the system, in order to be able to use the existing ID cards in this system, these cards must have 125 KHz Proximity Card feature and be open to read / write operations. In

addition, in order to use the developed system actively, a web service should be opened by the university server and student inquiry can be made through this web service. The names and models of the hardware used in the developed system are given in Table 1.

TABLE I
HARDWARE MATERIALS USED IN THE DEVELOPED SYSTEM

Name	Model
Programming Card	Arduino Pro Mini
Card Reader	RC522
Resistor	1K, 10K,
Capacitor	100nf, 470uf/25V, 1000uf/16V
Diode	1N4007
Transistor	BC337
Power	LM7805
Other	5V Relay, 5V Buzzer

PCB board was developed by using the hardware materials given in Table 1. The programming card on the PCB board is connected to the computer via USB interface. It provides automatic login and management by reading the students' ID cards. The prototype of the system developed in this study is given in Fig. 6.

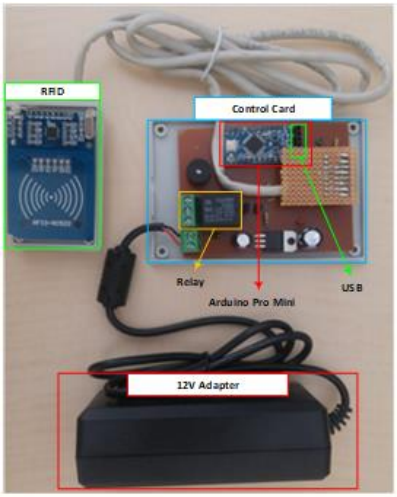

Fig. 6. Prototype of the system developed in this study

B. *Simulation Results*

In order to test the RFID based authentication method proposed in this study, a simulation was developed in MATLAB environment. During the simulation process, 6 different scenarios were planned. The scenario results made are given in Table 2.

TABLE II
SIMULATION RESULTS OBTAINED BY TESTING THE RFID SYSTEM

Scenario	Number of PCs	PC Usage Limit (min)	Number of Users [0-100]	Usage time limit in the current system(min)	Number of users who timed out	Total time in the normal process(min)	Total time elapsed with the developed system (min)	Difference (min)	Performance (%)
1	10	30	27	40	8	526	488	38	7,79
	20	30	28	40	9	644	599	45	7,51
	30	30	89	40	27	2043	1900	143	7,53
	40	30	16	40	3	318	294	24	8,16
	50	30	7	40	3	165	152	13	8,55
2	10	30	89	50	40	2339	1985	354	17,83
	20	30	53	50	11	1076	950	126	13,26
	30	30	68	50	25	1663	1433	230	16,05
	40	30	91	50	39	2314	1938	376	19,40
	50	30	84	50	38	2291	1879	412	21,93
3	10	30	53	60	23	1556	1192	364	30,54
	20	30	86	60	46	2749	2016	733	36,36
	30	30	18	60	10	569	429	140	32,63
	40	30	46	60	27	1518	1091	427	39,14
	50	30	35	60	18	1107	793	314	39,60
4	10	40	40	40	1	937	937	0	0,00
	20	40	45	40	4	1103	1103	0	0,00
	30	40	52	40	1	985	985	0	0,00
	40	40	37	40	0	803	803	0	0,00
	50	40	20	40	0	460	460	0	0,00
5	10	40	28	50	8	755	705	50	7,09
	20	40	13	50	3	329	319	10	3,13
	30	40	58	50	12	1400	1345	55	4,09
	40	40	82	50	14	2018	1959	59	3,01
	50	40	73	50	19	1988	1894	94	4,96
6	10	40	90	60	31	2665	2367	298	12,59
	20	40	20	60	9	701	611	90	14,73
	30	40	68	60	23	2178	1890	288	15,24
	40	40	90	60	35	2793	2476	317	12,80
	50	40	88	60	28	2718	2389	329	13,77

Calculations were made for five different computers for each scenario. In scenario 1, users' time to use computers is limited to 30 minutes for 5 different computers. The number of people using common computers was chosen randomly between 0 and 100 during the simulation of 5 different computers. The number of randomly selected users for Scenario 1 is limited to 40 minutes on computers. This limit value is set as 50 minutes for Scenario 2 and 60 minutes for Scenario 3. In Scenario 1, 27 people are randomly selected for a common use area with 10 computers, and their computers are chosen randomly between 0 and 40 minutes. As a result of this process, if the RFID based system is not used, a total of 526 minutes of time is needed for 27 users, while a total of 488 minutes is required in the RFID-based developed system. Thus, thanks to the developed system, 27 people made the best use of 10 computers in less time. When Scenario 2 is examined, computer usage times are randomly selected between 0 and 50 minutes in the current system. In the third scenario, it is chosen randomly between 0 and 60 minutes. When the first three scenarios are examined, it is seen that the advantage of the system developed when the computer usage time limit increases in the existing system. In scenario 4, the system computer usage time limit is equal to the current system computer usage time limit. Therefore, the advantage of the developed system is not clearly visible for the 4th Simulation. The advantage of the RFID system developed in other scenarios has been revealed. For 6 scenarios in the study, scenarios 1,2 and 3 and scenarios 4,5 and 6 were grouped within themselves. While the computer usage limit for the system developed in Scenarios 1,2 and 3 is 30 minutes, Scenarios 4,5 and 6 are 40 minutes. The average efficiency obtained in these grouped scenarios and the average gain from the whole simulation are presented in Table 3. According to these values, the success results of the method are shown in Fig. 7.

In figure 7-(a) the scenarios of Scenarios 1,2 and 3, that is, the computer usage limit in the developed system is 30 minutes, are given. Here, the “x” axis is the number of computers, the “y” axis is the computer usage time in the current system, and the “z” axis is the amount of time profited in the developed system. The unit of the "y" axis and the "z" axis are given in minutes. In Figure 7-(b), the success results of Scenarios 4,5 and 6 are given. The computer usage limit for the system developed in these scenarios is determined as 40 minutes. In the simulation, if the computer usage limit in the developed system is far from the computer usage limit in the existing system, the success of the system increases even more.

Thanks to the developed system, the number of computers and number of instantaneous users in the common use areas are optimized according to the usage time determined by the administrator. It provides the best and fair use of users from computers in the current common area. Thus, the limited number of computers in common areas are provided with the best service.

TABLE III
AVERAGE RESULTS BY SCENARIOS

Scenario	Average Result (min)	Average for Groups (min)
1	52,6	249,27
2	299,6	
3	395,6	
4	0,0	106
5	53,6	
6	264,4	
	General Avg.	**177,63**

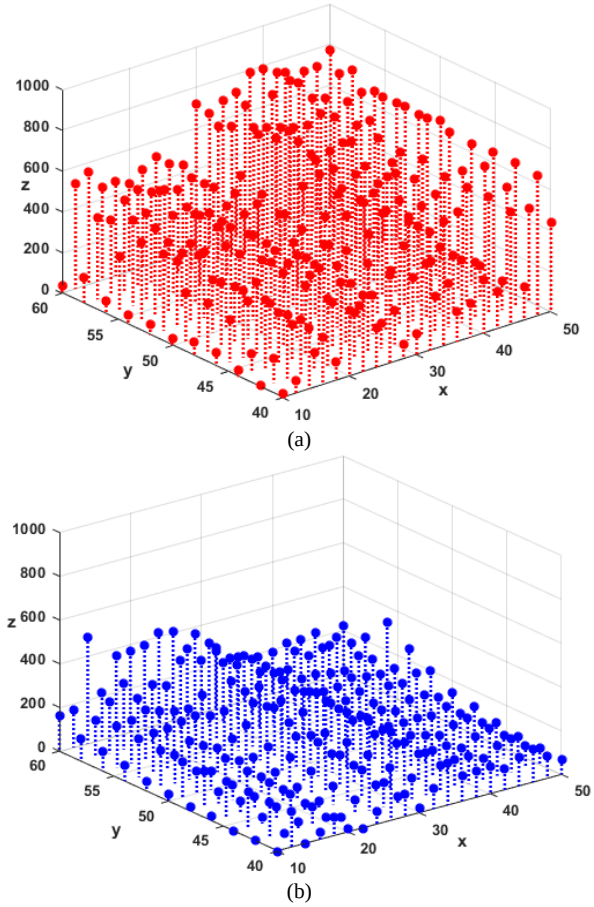

Fig. 7. Displaying the success results of the scenarios in 3 dimensions (a) Scenario 1,2 and 3 result (b) Scenario 4,5 and 6 result

IV. Discussion and Conclusions

With this study, RFID cards, which are frequently used in literature and in the market, are used for intelligent computer control application. As stated in the literature summary, intelligent systems have become an important part of our daily life. Given the operating principle of these systems, it is almost inevitable to use RFID card systems. With the developed RFID card reader system, fair computer usage of the students will be ensured and their usage on the computer can be observed. With the developed smart computer control application, the computers in Ardahan University library unit can be used more effectively and in a suitable way. In the use of these computers where there is no control mechanism in the current system, completely technological and smart solutions have become available. When the studies on the subject are examined in the literature, it is seen that the term

smart systems and industry 4.0 are generally encountered. In addition, it has been observed in the researches that the transactions carried out for this purpose are generally aimed at a specific purpose, the existing order is changed from the identity cards used to all electronic equipment and solutions are produced with very high budgets depending on this situation.

This system developed within the scope of the study was put into use as a pilot in the library unit of Ardahan University. This system, which is used in the library unit, regulates the students' use of computers, restricts illegal movements and limits unnecessary computer use. Studies have shown that RFID card systems are frequently used in campus areas such as book rental, bicycle rental, refectory and turnstile areas rather than libraries. With the proposed system, a different area is provided for the use of RFID cards within the campus. In addition, this system is planned to be used for different service points within the campus.

ACKNOWLEDGMENT

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