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RFID TECHNOLOGY AS A PART OF MONITORING SYSTEMS

Abstract. The Internet of Things (IoT) technologies are getting more popular and being implemented as a solution for many relevant problems in information technology purposing low-costed, secure, and controlled remotely systems. Radio Frequency Identification (RFID) system is used as a type of IoT technology, which has three basic parts: tags, reader and system that manages tag identification (ID) number and its real time location. RFID systems are used in financial institutions, healthcare industry, mobile phones, cars, supply chain management, smart retails, smart house, object localization, security systems and various types of applications for positioning, managing people, assets, and inventory. This paper discusses performances of RFID technologies that use passive tags. Role of RFID technologies in monitoring systems and system architecture are reviewed and compared. Significance of RFID technologies and challenges are also considered for future works.

Keywords: RFID, internet of things, passive tag, monitoring system.

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Аңдатпа. Заттардың Интернет технологиялары (IoT) неғұрлым танымал болып, аз шығынды, қауіпсіз және басқарылатын қашықтан жүйелермен байланысты ақпараттық технологиялардың көптеген өзекті мәселелерін шешу ретінде енгізіледі. Радиожиілікті Сәйкестендіру Жүйесі (RFID) үш негізгі бөліктен тұратын IoT технологиясының түрі ретінде пайдаланылады: тегтер, оқу құралы және тегтерді сәйкестендіру нөмірін (ID) және оның нақты уақыттағы орнын басқаратын жүйе. RFID жүйесі қаржы мекемелерінде, денсаулық сақтау индустриясында, ұялы телефондарда, автомобильдерде, жеткізу тізбектерін басқаруда, «ақылды» бөлшек сауда дүкендерінде, «ақылды үй», объектілерді оқшаулауда, қауіпсіздік жүйелерімен және жайғастыру, адамдарды, активтер мен қорларды басқару үшін қосымшалардың әртүрлі үлгілерімен пайдаланылады. Бұл мақалада пассивті белгілерді пайдаланатын RFID технологиясының сипаттамалары талқыланады. RFID технологиясының мониторинг жүйелеріндегі және жүйелік архитектурадағы рөлі қарастырылады және салыстырылады. RFID технологиясының мәні мен мәселелері болашақ жұмыстар үшін де қарастырылады.

Түйін сөздер: RFID, интернет заттар, пассивті таңба, мониторинг жүйесі.

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Аннотация. Технологии Интернета вещей (IoT) становятся все более популярными и внедряются в качестве решения многих актуальных проблем информационных технологий, связанных с низкозатратными, безопасными и управляемыми удаленными системами. Система радиочастотной идентификации (RFID) используется в качестве типа технологии IoT, которая состоит из трех основных частей: тегов, считывателя и системы, которая управляет номером идентификации тегов (ID) и его местоположением в реальном времени. Системы RFID используются в финансовых учреждениях, индустрии здравоохранения, мобильных телефонах, автомобилях, управлении цепочками поставок, «умными» розничными магазинами, «умным домом», локализацией объектов, системами безопасности и различными типами приложений для позиционирования, управления людьми, активами и запасами. В этой статье обсуждаются характеристики технологий RFID, использующих пассивные метки. Роль технологий RFID в системах мониторинга и системной архитектуре рассматривается и сравнивается. Значение технологий RFID и проблемы также рассматриваются для будущих работ.

Ключевые слова: RFID, интернет вещей, пассивная метка, система мониторинга.

Introduction

The Internet of Things (IoT) is being known as the main component of the new technological revolution called Industry 4.0 that focuses on automation, real-time data, interconnectivity and machine learning. Number of Internet enable devices that are increasing and they can interact each other through the network to be informed and control the sequence of actions of users. Embedded sensors invisibly gather very big amount of data from the environment around us for storing, processing and analyzing, which are used while making decisions for both real-time and future actions. The IoT technologies use this data for controlling their systems according to the decisions made. There are several ways of collecting the data by their types and purpose of use such as sensor network technology and Radio Frequency Identification (RFID).

RFID technologies are one of the main components in the IoT systems that works with a tag, reader, and system. Between reader and tag are not needed direct connection because of radio channels. Installed RFID systems simplify and accelerate the working procedure. It gives very good choice on monitoring people using tags on ID cards in real time location and attendance monitoring. There are two types of RFID tags: active and passive. Passive RFID tags are powered by the reader's power and no additional battery is needed in it. The

applications that use passive RFID are found in access control applications and transportation. The active tags are powered by batteries and they can be identified in a long distance used in port containers for monitoring cargo [1].

In current RFID systems, data about cardholders is registered and stored in the memory of the system's reader for the processing and computing. The data is available only when controlled manually. The importance of using RFID technology in the monitoring systems is that the data is stored in the server and can be controlled remotely.

This work introduces architecture of RFID technologies and its use in monitoring systems proposed by previous authors. Actuality of this technology and its performances are discussed.

Radio Frequency Identification

Radio Frequency Identification (RFID) is an automatic technology and identifies tagged objects from environment through radio waves. RFID system is consisted of readers and tags [2]. The tag is a microchip that is attached to an object to identify the reader. The reader communicated with tag through radio waves. The main benefit of using RFID technology is the identification process is done automatically. RFID systems are used for real-time monitoring purpose. The components of RFID system are as follows: tags, reader, and application system. When object with a tag is tagged to the reader, the reader identifies ID number of the tag, which is unique in every tag. ID number is sent to the server, or as in most standard RFID systems, it is stored in the controller for checking whether it is correct ID or not [Fig. 1].

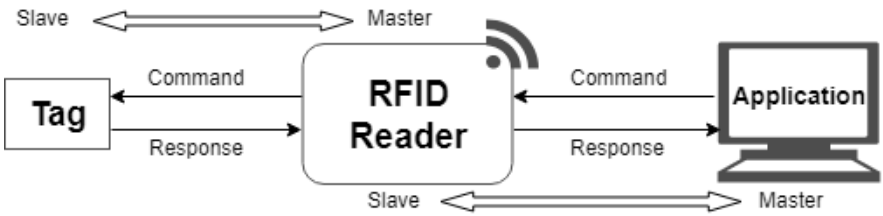

Fig. 1. Architecture and data flow of a RFID system

Tag is a transponder (transmitter/responder), whereas reader is transceiver (transmitter/receiver). There are two types of tags: active and passive. Active tags are powered by batteries, and can communicate with other active tags. Passive tags have no built-in power source, and they take power from electromagnetic energy transmitted from the reader during identification [3]. Tags are made up of coiled antenna and a microchip. Xiaolin et al. [2] classified active tags into five classes according to its functionality. Active tags can be detected from long distance: up to 30 meters. Maximum distance for passive tag

is 6 meters. The advantage of using active tag is its long distance and highest data. However, it costs more expensive than passive tag (around 15-20$ per tag for active, 0.1-0.2$ per tag for passive). The benefit of using passive tag is tag life does not depend on battery, and it is more resistant to physical damage. Disadvantage of passive tag is the read range is limited and communication depends on the antenna size and shape. Norsaidah at el. [4] tested two types of UHF RFID passive tag: AZ-9640 and UPM DogBone for different distances. UPM DogBone is better in terms of detection, and outperformed AZ-9640 in terms of data transfer. AZ-9640 is more compact and discreet. Both types were experimented in the monitoring system. The tags mostly attached to the ID cards, trinkets, wearable devices, etc. In Offline Intelligent Payment System Mifare Classic 1K card was used, which is divided into 16 sectors protecting each sector by two different keys, called key A and key B [5].

Fig. 2. RFID Passive tag types

RFID reader is responsible for communication with tags within its operation range and send sending the tags' data to server or presenting in application. Attached antenna emits signals to the tag and then receive from it [6]. Reader can be many different sized and has many types. For example, Mifare RC522 reader in Attendance and Information System [11], RS532 RFID reader in Security and Monitoring System [7], PN532 NFC/RFID Controller in Smart Home project [3], ITEAD PN532 NFC in Smart Restaurant system [6], and MFRC522 in Offline Intelligent Payment System. Reader can be affixed in different positions, on the table, in door, in tourniquet, etc.

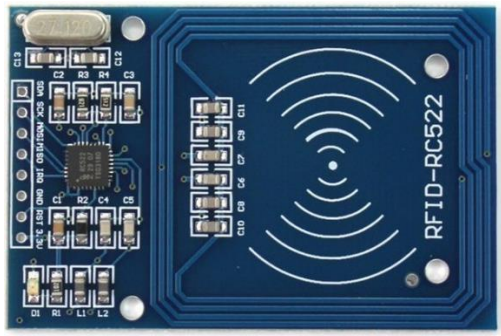

Fig. 3. RC522 RFID Reader

Data received from tag by reader is presented in an application. The data is used directly when it is tagged in many systems. Although the data is stored in server (fog, cloud) for monitoring remotely and in analytics. RFID applications are implemented in healthcare, monitoring systems, security, etc.

Comparative review of RFID based monitoring systems

Application of IoT technologies in the both closed and open areas make huge changes that increase the working process of the system and decrease human power on making actions. The most of the monitoring systems are developed using IoT hardware platform with RFID reader, which makes the hardware part of the system and send data to the server for controlling it in application part. In Table 1, RFID based monitoring systems are compared and discussed by their RFID reader type, IoT hardware platform, and main findings.

Table 1. Comparative review of previous authors' works

System	RFID type	IoT hardware platform	Main findings
Smart Restaurant System [6]	ITEAD PN532 NFC module	Raspberry Pi 3 model B	NFC module is placed on the table, and tags are under plates. The systems offers faster ordering scenery than manual ordering.
Robotic Control System [8]	RFID reader	Raspberry Pi, Arduino Uno	RFID reader services for capturing data. The data is sent to the robotic arm via web app by using embedded computer.

Offline Intelligent Payment System [5]	MFRC522 RFID reader	Raspberry Pi 3 model B	The authors tested the system according the time, distance (between tag and reader), and special cases of algorithm. The results show that time is less for declined operation than successful operation.
RFID Ecosystem [1]	RFID reader	n/a	The system includes 44 RFID readers, and each of them equipped with up to four antennas. The readers positioned at the entrances, on the stairwells, and throughout the corridors.
Smart Home project [3]	PN532 NFC/RFID controller	Raspberry Pi 3	The authors used RFID technology for monitoring real-time attendance at home by web user interface app.
Security and Monitoring System [7]	RFID reader	Raspberry Pi module B+	Data is stored in database located in raspbian SD card, and computing is done in Operating system of the microprocessor.
Wireless Sensor Node (WSN) with UHF RFID for monitoring system [4]	UHF RFID	Raspberry Pi 3	The author compared two types of tags: UPM DogBone and AZ-9640.
Paid Parking System [9]	RFID reader	ESP8266 microcontroller, Raspberry Pi	RFID reader is connected to the ESP8266 microcontroller, which has built-in Wi-Fi chip that is responsible to

			establish a connection with Raspberry Pi.
Real Time Locating System [10]	RFID reader	Raspberry Pi	The main purpose of the project is to monitor student participation in lectures, teaching and laboratory sections by reading tags from cards.
Attendance and Information System [11]	Mifare RC522	Arduino	Read data from tags placed in credit sized cards.
Smart Classroom Roll Caller System [12]	RFID reader	n/a	The problem of the system is that teacher must control students while taking back ID cards from special places for the ID cards. Another problem is what if student forgets (or loses) his/her ID card.

All of the systems use passive tags planting them into the objects like credit sized cards and tables. RFID reader has a connection to the microcontroller or microprocessor that allows sending the captured data to the server or displaying in the monitor. However, the passive tags are needed to contact to the reader directly by human help. Reviewing the previous authors' works, several questions can be asked: Is it possible to monitor objects that use passive tags without human help? Memory capacity of passive tag is maximum 2KB. Is it possible to increase memory capacity for storing more information? These are the main challenges for future work.

Conclusion

RFID technology is an important and foundational component of the Internet of Things. It is used for different purposes and one of them is using in monitoring systems. Many monitoring systems use passive RFID tags that are low-costed and does not require power. RFID system is a good solution for real-time systems and getting location of objects in the environment. RFID system is analyzed and monitoring systems are reviewed. Two challenges for future work are discussed.

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