***The use of radio-frequency identification in information systems***

Rodion Kharabet

National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute»

Kyiv, Ukraine

Andrii Pysarenko

National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute»

Kyiv, Ukraine

*Abstract.* The article describes the use of radio-frequency identification in information systems. It covers the application of RFID in the housekeeping process, in particular, goods monitoring. The existing solutions and their pros and cons were reviewed. To increase the efficiency and convenience of shopping the software and hardware system based on radio-frequency identification was proposed. The article contains an explanation of its workflow and interaction with users and outlines the advantages of this system compared to existing systems.

Keywords: radio-frequency identification, RFID, information systems, housekeeping, barcode, esp8266, automation.

# Introduction

Information system is a communication system that provides the collection, processing and transmission of information [1].

The Law of Ukraine "On Information Protection in Information and Telecommunication Systems" defines an information (automated) system as an organizational and technical system in which information processing technology using technical and software tools is implemented [2].

Information systems have surrounded us more and more in the last decade. The needs of organizations and users are the main factors that influence the implementation of information systems in various industries and areas of life. Especially this is facilitated by advances in computer technology and telecommunication networks.Information systems are created with the aim of increasing the productivity of everyday processes or reducing the number of unnecessary iterations.

Consider the process of housekeeping in everyday life. Its important component is the provision of housing with necessary resources, such as food and non-food products. A critical factor in this is the awareness of the situation with the resources in the house at the moment. This allows rationalizing purchases, preventing unnecessary waste of money on unnecessary goods. Information systems are created with the purpose to increase the productivity of shopping. The simplest example is a shopping list.

Overview of existing solutions

The shopping list can be created either manually or automatically using special devices. One such device is Hiku [3]. This is a smart device that can receive voice commands to create a shopping list. Hiku has the ability to scan product barcodes with a built-in scanner in addition to voice control. Once the barcode is read, the corresponding item will be added to the shopping list. This method of use is very convenient for everyday foods such as bread, milk, etc.

Similar in functionality is GeniCan [4] – a device that attaches to the trash can and scans the bar codes of the packaging that is going to be thrown into the trash. Like Hiku, GeniCan automatically adds all the scanned items to the shopping list.

The disadvantage of both of these devices is that using a barcode scanner is not convenient enough because the packaging of the item to be identified may be damaged or otherwise unreadable. There may also be difficulties in positioning the package properly. Additionally, in the case of GeniCan, there is limited space for handling the packaging. It caused by the GeniCan is located directly inside the bin.

An alternative solution for the identification of goods was proposed. The solution is to use radio frequency identification (RFID) jointly with barcode identification. This approach to product identification is more convenient because the speed of reading RFID tags is much faster than reading the barcode. Also, the RFID readers can reach up to 1000 of tag reads per second.

Radio Frequency Identification (RFID) is a form of wireless communication that uses radio waves to identify and track objects [5]. RFID is a generic term that covers identification technologies with different standards. These include NFC and RAIN, two technologies that are the most common among others.

The radio frequency identification subsystem consists of three main elements:

1. An item that has an RFID tag that uniquely identifies the item.

2. A device that provides wireless bidirectional communication between the items described above.

3. Software that collects and transforms data from transmitters, providing real-time information to the software above.

# The proposed solution

The above-mentioned RFID technology has been applied to software and hardware system, which aims to automate the household process. A software part was implemented in the form of a web application that contains current information about the available goods in the house and their quantity.

Because the use of RFID imposes an additional cost on the user, the barcode identification option has been retained for ease of use. The user can use the web camera to add or remove a product by barcode using your smartphone camera.

A screenshot of a social media post

Description automatically generated

Fig. 2. The UML sequence diagram for adding new product using RFID

The web application was written using the .NET Core 2.1 platform and the ASP.NET Core framework. These technologies are cross-platform, which allows deploying the application on a server with any operating system: both Windows and Unix-based.

The device with a hardware barcode scanner clings to the recycle bin. It removes goods from the system by a scanned barcode on the package by analogy with existing solutions. The device built with a 1D barcode scanner, a diode distance sensor, and an ESP8266 Wi-Fi module.

The distance sensor is required to activate the scanner only when an obstacle (i.e. package with barcode) appears in front of it. This approach saves energy and does not create the discomfort of constantly active LEDs emitted by the scanner.

Once the barcode is read, the data is transmitted from the scanner to the ESP8266 where it is processed and transmitted to the server by the network.

The RFID subsystem includes two devices. With the first of these, the user adds an RFID tag to the system, while the other device automatically removes the item that was thrown into the trash. Both devices consist of a MFRC522 RFID reader and an ESP8266 WiFi module that transmits the read information to a web application server. The structure diagram of the whole system is shown in Fig 1.

A close up of a piece of paper

Description automatically generated

Fig. 1. The structure diagram of the software and hardware system

Let's look at the operation of each device separately.

The first device aims to add new products to the system. The RFID subsystem assumes that as RFID tags Mifare 1k standard tags are used. To add a product to the system, the user scans the tag by bringing it to the RFID scanner. The scanner sends the received tag ID to the server and marks the tag as free to associate with the product. The next step is to attach the tag to the product or its package and select the product from the web application. The user has to clicks the "bind RFID" button. This tag now identifies a specific product in the web application's product dashboard. The UML sequence diagram for adding new product using RFID is shown in Fig 2.

The second device is mounted to a trash bin and aims to reads RFID tags from packages or items that are thrown into bin. When the tag has been read, data is sent to the server that contains its identifier. Then the item associated with this identifier is marked as discarded. These changes are visible on the main screen of the web application, where all currently available products are displayed.

Since RFID technology supports quite a large tag reading distance, depending on the tags purchased by the user, it is possible to throw products as simple as it could be. The RFID reader will identify the tag on the fly. The larger the area of the antenna on the tag and the more powerful the emission of radio waves from the reader, the larger the possible distance of successful tag reading.

# Conclusions

The proposed solution describes the use of radio frequency identification in information systems. In particular, the application of RFID in the case of housekeeping is considered. The advantages of using this technology in comparison with existing solutions are described. The hardware and software automation complex for housekeeping using radio frequency identification is considered.

The scheme and characteristics of the system are presented. The principle of action and the components of the system are described. In accordance with the description, a working prototype was created. Currently, the prototype is being tested. But general tests have confirmed the advantages of the proposed approach in comparison with existing solutions.

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