REAL TIME MONITORING AND TRACKING SYSTEM FOR AN ITEM USING THE RFID TECHNOLOGY

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Abstract: *Describing an application based on the RFID technology is the goal of this paper. This application is designed using RFID technology as a simple and viable solution for online item tracking. It provides an easy to use interface via a website and it follows the same steps and methods as a real world track and trace program. In it, the user has the ability to search, buy and track the item's location in real time, and can easily be modified for other purposes (military, business, personal).*
Keywords: *RFID, database, tracking, Arduino*

1. INTRODUCTION

For the past few years, location systems have become a major studying field, in which more and more field researchers are trying to innovate. Developing new location systems in the outdoor area seems to be covered by the GPS system. However, when apply it to an indoor location system; we see that the precision and accuracy of GPS is not satisfactory. In order to enhance the precision of indoor location systems, there has been a development in a number of fields, each providing their own advantages and disadvantages. Therefore we encounter Wi-Fi systems (802.1x), Bluetooth (IEEE 802.15), infrared, ultrasounds, RFID.

RFID (Radio-Frequency Identification) refers to small sized electronic devices, known as RFID tags, which contain a small chip and an antenna. The chip, usually, is capable of storing 2000 bytes of information (or less).

RFID devices have similar uses to that of a product barcode, or a magnetic strip on the back of a credit card. These offer a unique ID for that object, and just like a barcode or credit card, they need to be scanned in order to extract the information stored.

RFID is a wireless technology which uses electromagnetic fields in order to transfer data, for the purpose of identification and automated tracking of a tag placed on an object. The tags contain electronically stored data.

Some tags are powered by an electromagnetic induction provided by the magnetic field of an RFID reader. Other tags have an internal power supply, in the form of a battery, and can function at hundreds of meters from the reader. Unlike a regular barcode, the tag doesn't have to be in the line of sight of the reader and can be incorporated in the object itself.

RFID tags can be active, semi-active and passive [1]. These tags can store up to 2 KB of data and are built using a microchip, an antenna, and in the case of active and semi-passive tags, a battery.

Active and semi-passive RFID tags use internal batteries to power their circuit. Furthermore, an active tag uses its battery to transmit radio waves to a reader, while a semi-passive tag relies on the ability of the reader to provide it with the necessary power for transmission. Due to the fact that these tags contain more hardware than passive tags, they are more expensive. Active and semi-passive tags are used for high value items which can be read at larger distances - broadcasting at high frequencies of 850-950 MHz and can be read from a distance of 30 m. If it's required to read the tag from a larger distance, additional batteries are added which improve the range up till 100 m.

Passive RFID tags rely entirely on the reader as their power source. These tags can be read from a distance of 6 m, and are significantly cheaper, meaning they can be applied to cheaper objects.

These tags are made to be disposable, along with the disposable consumer goods they are placed on (unlike a military package which contains an active tag, a bottle of shampoo would have a passive tag).

The range of a RFID tag depends on its broadcasting power, reception sensitivity, the environment, orientation of the tag when it's scanned, operating frequency, as well as how it was designed, planned and installed.

2. LOCALIZATION AND TRACKING METHODS

2.1 Overview. A few decades ago, tracking every single object seemed a futuristic and advanced thought, and was considered impossible in the near future. Nowadays, the surrounding world is becoming increasingly "smaller", due to advanced technology.

Surveillance cameras are installed at every traffic light, at work, in stores, as well as in our homes. Now, these cameras are used by new technologies in order to track the location of cars, cell-phones and possibly even our shopping.

This tracking technology is used to ship consumer goods faster, and to prevent their loss or misplace.

Current technologies used to create location based systems include: Geographic Information Systems (GIS), Global Positioning System (GPS), Radio Frequency Identification (RFID) or Wireless Local Area Network (WLAN).

Every tracking system or location based system uses one, or a combination of these technologies. RFID systems require a particular tag to be placed on the object, animal, or person intended to be tracked.

For instance, the GPS receiver of a cell-phone, or the RFID tag on a DVD, can be used to track that particular object through a detection system such as GPS satellites or RFID receivers.

2.2 Object tracking: how does it work? Developing fast delivery systems for orders or products, which are shipped anywhere in the world, has created the need for a system to determine the location of every item, at any point during the day.

Generally, an item is equipped with a barcode, which once it's scanned, contains every detail, from the delivery location, to the seller/sender.

This bar code, "carries" this data all throughout its journey and allows the addressing person to find out it's location at any moment.

The item is scanned, repeatedly, at every sorting and shipping office, and this information is immediately inserted into a database, for better tracking and tracing of its movement.

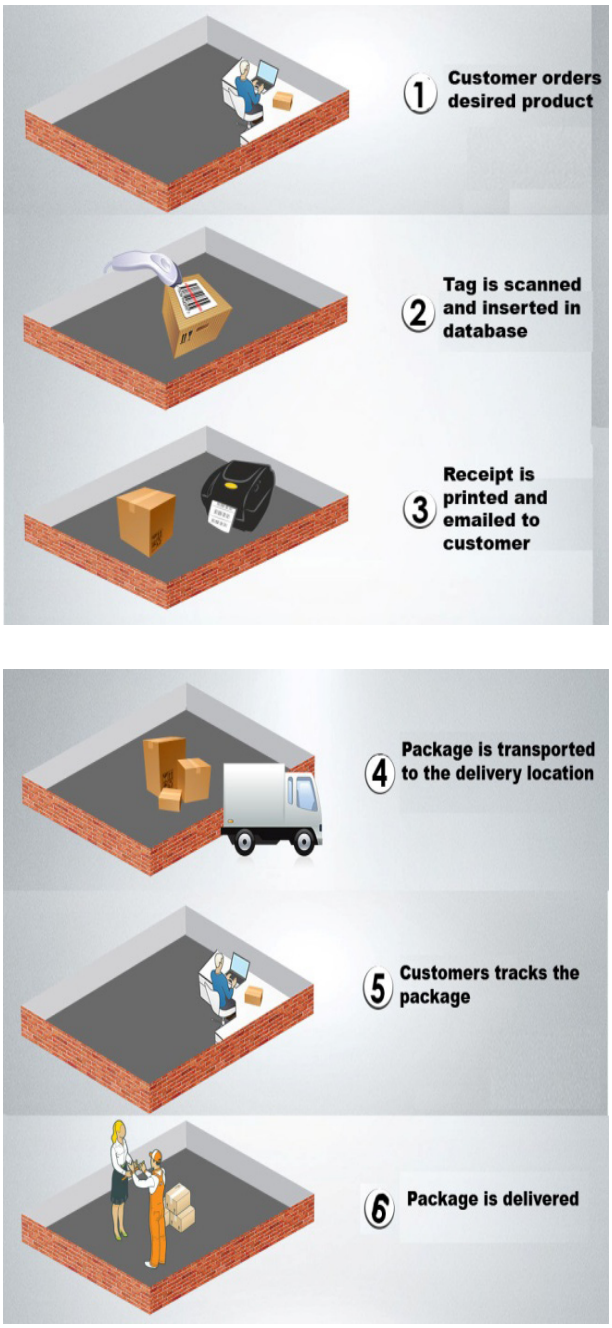

Fig 1. Item delivery and tracking

3. SYSTEM IMPLEMENTATION AND EXPERIMENTAL RESULTS

3.1 Equipment used

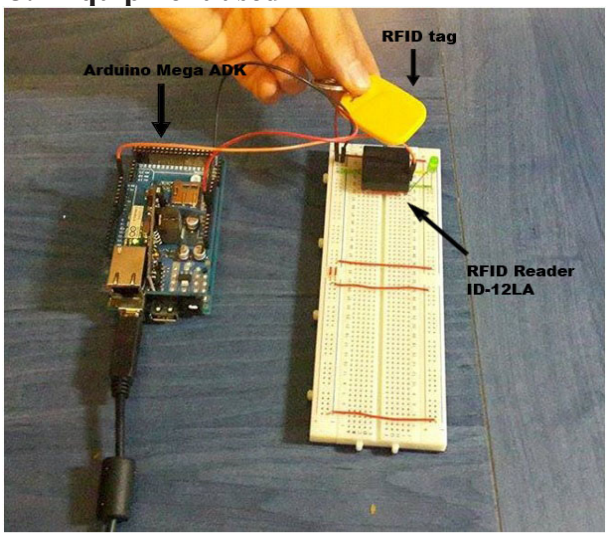

Fig 2. Equipment used

Arduino Mega ADK is a microcontroller based on the ATmega2560. It has a USB interface for connecting with and Android phone, 54 pins I/O (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UART, a power supply port and a reset button.

The used RFID reader is ID-12LA, a simple to use RFID reader, designed by ID Innovations along with other RFID readers: ID-2LA and ID-20LA. ID-12LA is an intermediary reader, with an antenna operating a low frequencies, but with a smaller size than the rest. It contains a built-in antenna having a range of a few centimeters, being used frequently for scanning tags or access cards. The programming language that was used is Java, being a technology which offers support on a wide range of applications, and a database designed in MySQL.

3.2. Application description. In order to track an object, it was necessary to create an e-commerce type website, inspired by online stores available on the Internet. The chosen name was "Music Instruments", and the products available are from the music area.

The application follows a set of rules and can easily be adjusted for other purposes, for instance tracking military equipment, vehicles, personnel or the shipment of packages on the field of operation.

A database was used in order to insert the instruments in the created application. The number of products is relatively small, used only for simulations, but more can be added easily as the application evolves.

Once launched, the application displays a welcome page for the user containing information about the contents of the website and the available products.

At the top of the page, there's a docked menu that is displayed on every page of the website, thus helping with a easier navigation of the user.

Depending on the type of request the user wants, it needs to press the according button, and the pages will automatically load.

The types of instruments available on the website are guitars, drums and keyboards. Every instrument has a detail description, a price and a "Add to cart" button.

The user can browse any section of the website, and when he wants to buy a certain instrument, the "Add to cart" button needs to be pressed.

After that, the user can continue browsing the website, in order to buy more, or he could proceed to the next step.

Fig 3. The "Guitars" page of the website

At any moment, the user can press the button "Shopping cart", and a page will display all of the items placed in his cart, as well as the quantity of them and the total price.

The user can return to any page in the website via the menu located in the upper part of the web page.

If the user decides to check-out his cart and pay, the button "Proceed to checkout" is pressed and the shipping details and billing information are required.

For this, the user must enter all the required details in the spaces provided, which are: First name, Last name, Email, Street, Zip Code, City, and Country followed by a click on the "Checkout Button".

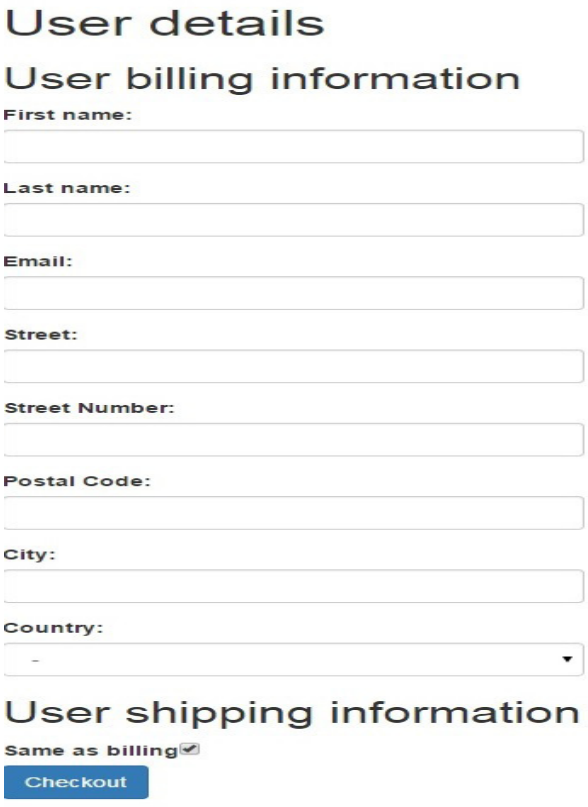

Fig 4. The form for billing and shipping

A confirmation message is displayed, "Order Completed", and the order will be placed and ready to be tracked by clicking the button "Order Management", where all the details of the order are present.

At this point, the order is not yet processed, simulating its packaging: being tagged and placed in the delivery vehicle.

In order to tag and process the order, we find the "Attach RFID" button.

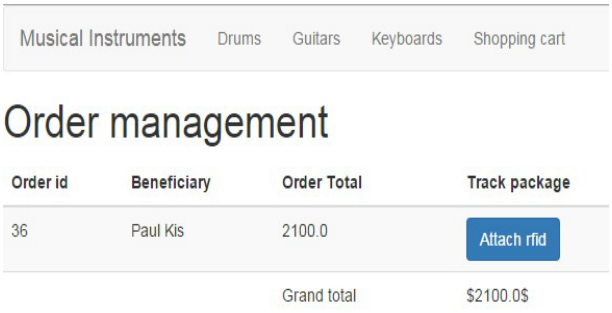

Fig 5. Details of a placed order

Once pressed, this requests the scanning of the RFID tag that will be used for the duration of the transport via the message "Scan RFID".

This is exactly what's happening in real life: before the order is processed, it needs to be scanned and placed in the database for user notification. When the card is scanned (see the Fig. 2), the order will be processed and the website will display a page containing the location details of the item.

The location details provided are the current city and country, by default being New York, USA, and also the destination city and country. This simulates the fact that the web-store, "Music Instruments", is based in New York, USA.

In reality, the item will be constantly moving, from one collection center to the next, where it will be scanned and the tracking details are refreshed, all the way to the delivery. The same thing happens in this application: the location of the item will change with every new scanning of the RFID tag. Also, similar to how a barcode works for a certain product, the RFID tag used for processing the order, will be used for the duration of the transport, meaning that if a different RFID tag is used for the original order, the website will have no modification.

This scanning process will be repeated until the current city and country matches the delivery (Fig 7).

At this point the item has been delivered, and the current city and country matches the destination city and country.

The user has followed the same steps to place, track and receive the desired product similar to the behavior of a real life online order.

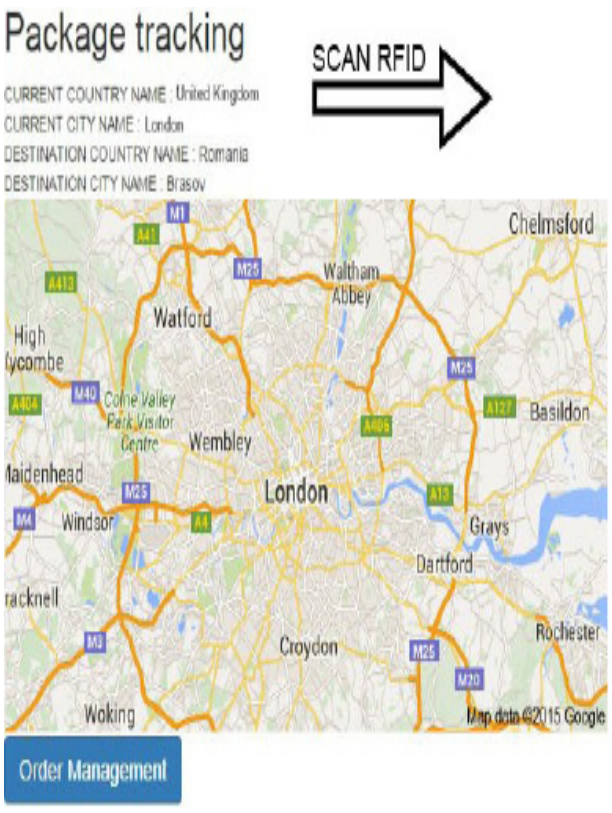

Fig 7. The RFID tag is scanned and it eventually reaches the destination

CONCLUSIONS AND FUTURE WORK

The whole premise of the application was building an e-commerce website with products, adding them in the user's shopping cart, filling in the desired billing and shipping information and having the possibility to track the location of the item anytime and anywhere throughout its transport.

An easy and effective management of item tracking within a company or business is achieved by gathering all the useful information within a database.

This application provides that as well as an easy to use interface and designed specifically for object tracking with very few costs in developing.

Without having a specialized program, keeping track of every information will prove to be difficult, especially with a high number of data which is constantly changing.

For the time being the application can only be used by accessing it from a laptop or PC, but it can be upgraded by adding new functionalities such as:

- push notifications for the user when the item changes location
- developing the application for smartphone use
- adding a credit card type of payment in a secured environment.

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