

Smart Ticketing System in Metro Rail Using RFID Tag

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Abstract

One of the most popular modes of transportation in Egypt is the metro, particularly in Cairo, where it carries up to 3.6 million people each day. Beginning here is the concept of our project, which attempts to give an intelligent solution to the issue of line-ups at the ticket counter.

This solution is constructing a mobile and web application that makes it simpler for users to purchase a metro ticket easing traffic at the ticket office to hasten citizen movement and save time, with an admin dashboard to monitor and manage this.

To make this work effective, it is suggested to use RFID Tag with an embedded system to enable smart ticketing in metro trains. This system outlines the placement of an RFID reader circuit in every metro train station to make it easier to calculate ticket prices. The corresponding cost is automatically taken from the user's account based on the distance (number of stations) travelled. An automated database system is used to carry out this activity, which makes the transactions quicker, simpler, and uncertainty-free.

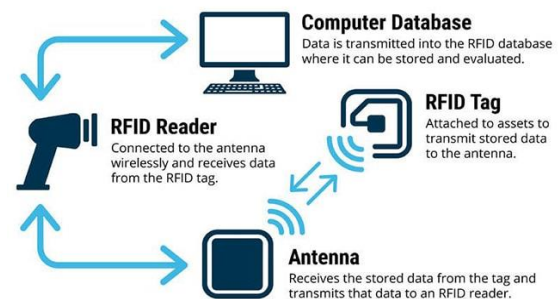
Index Terms— Metro, RFID Tag and Reader, Database system, Embedded system, Smart Ticketing

1. INTRODUCTION

In today's technologically advanced society, everyone is lagging behind. Technology's primary driving force is to create products that are both time and money efficient. since the widespread use of mobile devices our daily lives [1]. Customers and marketers alike have desired for an app that would allow them to use the cell phone in their pockets for activities other than making calls, taking brief images, and sending annoying jokes to one another via SMS. Applications that employ a mobile phone as a payment method for tickets are currently being developed. In a nation with a high population density, such an application will be even more crucial and help individuals save a lot of time by avoiding never ending queues [2].

In recent years, radio frequency identification, or RFID, has become an emerging technology. Due to its propensity for

efficiency, RFID technology can be successfully used in a variety of applications. A technology that uses radio waves to automatically identify and monitor a person, an animal, or a product by applying or incorporating RFID tags is known as radio frequency identification, or RFID. A tag, which is essentially a microchip with an antenna, and an interrogator or reader also equipped with an antenna make up an RFID



system. The reader circuit and tag are the two main parts of an RFID basic system. Through electromagnetic waves, communication is established between the RFID tag and reader circuit [3].

Fig (1) RFID Process.

Most RFID tags contain at least two parts:

- The first one is an integrated circuit that performs particular tasks including modulating and demodulating an RF signal, processing of information, and storing.
- An antenna is used to both receive and send the signal [4].

RFID tags that contain the data respond to readers by converting the reader's radio frequency queries into energy and sending the information back. The reader is controlled by a computer running a specialized RFID program, which also processes the information it sends [5].

1.1. RFID TAG

RFID tags are the components which are used for the purpose of identification. Metal pins are arranged in a particular order on the tag. The distinctiveness displayed by each of them is the most important aspect of this. The tags are categorized into

the following categories according to the power source used and the maximum range:

- Active tag: have a battery circuit within that provides electricity to magnetize the tag.
- Passive tag: The reader supplies all of the necessary power for passive tags.

The main benefit of using active tags is that they can effectively broadcast signals up to a distance of 100 feet, as opposed to the passive tags, which can only do so up to a distance of 200 feet. The tags can be further categorized based on the signal sent. While passive tags totally rely on the signal from the reader to convey information, active tags are able to emit signals independently of the reader [6].

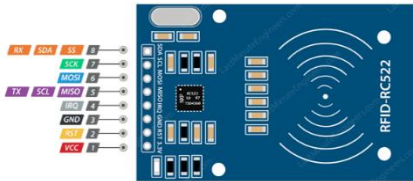


Fig (2) RFID.

1.2. RFID READER

An RFID reader is used to decode the tag's unique digital data. An electromagnetic wave is transmitted by the RFID reader and serves as the tag's input. These electromagnetic waves activate the unusual configuration of metallic pins. It causes the creation of a magnetic field that is contained. Each metallic configuration of the tag has a distinct interference pattern in the confined magnetic field. This interference pattern yields the RFID tag's unique number when read by an RFID reader, which allows for the identification of the tag's address. With regard to the concepts of RF Identification discussed above, the use of the same technology in the ticketing system would induce an enhanced level of transparency and provide a suitable framework for preventing any fraudulent activities. It should be noted that the address defers from each RFID tag, offering complete resistance to duplication.

1.3. NODE MCU

Node MCU is an open-source development board and firmware based in the widely used ESP8266 -12E Wi-Fi module. It allows you to program the ESP8266 Wi-Fi module with the simple and powerful LUA programming language or Arduino IDE.

With just a few lines of code you can establish a Wi-Fi connection and define input/output pins according to your needs exactly like Arduino, turning your ESP8266 into a web server and a lot more. It is the Wi-Fi equivalent of ethernet module. Now you have internet of things (iot) real tool.

With its USB-TTL, the node MCU Dev board supports directly flashing from USB port. It combines features of WIFI access point and station + microcontroller. These features make the Node MCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a webserver or connect to internet to fetch or upload data.

Features

- Finally, programable Wi-Fi module.

- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included plug & play.

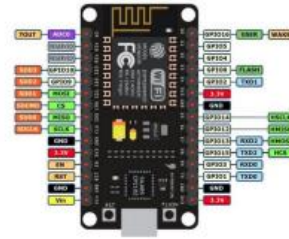


Fig (3) Node Mcu.

- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.
- Wi-Fi networking (can be used as access point and/or station, host a web server), connect to internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna



Fig (4) Servo Motor.

1.4. Servo Motor

- Servo Motor Sg90: Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware, or library to control these servos.
- Torque: 2.0kg/cm(4.8V), 2.2kg/cm(6V)
- Speed: 0.09s/60°(4.8V), 0.08s/60°(6V)
- Rotate angle: 180°
- Operating voltage: 4.8 ~ 6V
- Gear: plastic

This paper is organized as follows. In section 2-Related Work, In section 3-Proposed System, In section 4-Results, In section 5- Further Work.

2. Related Work

Currently, in the metro railway stations, they are using tickets or tokens for traveling.

To travel, the customer needs to stand in the queue, need to buy a ticket for the destination, they need to carry the ticket along with them until they reach the destination.

Fig.5 describes the existing ticketing system. If in middle they miss the ticket they will be penalized by the authority. The process carried out is they use the token system in which they use the RFID tag to give unique to each member[7]. While entering into the train, the customer needs to scan his token, the system will read the RFID tag and validates it and allows him to enter. The token is validated until the destination he cannot drop the train in middle or prolong his travel from his actual destination. After reaching the destination, the customer needs to scan the token with the system, if it is a valid journey the gates will open otherwise, the gates will not open if the passengers lost his ticket during the trip, he will be penalized.

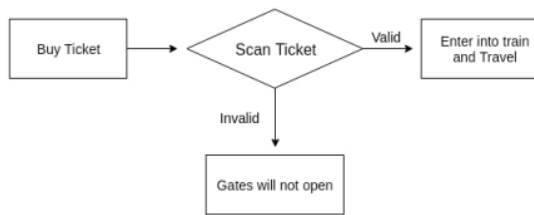


Fig (5) Current Ticketing System

Worldwide, there are subway systems: India, South America, North America, Spain, Asia, Egypt.

- The Cairo metro or Metro Anfaq al-Qahirah is the one of the oldest rapid transit systems of Africa and the Middle East. Operated by the National Authority for Tunnels, it is an efficient and comparatively cheaper mode of transport within the Cairo city. Currently, the metro system of Cairo has three operational lines [8].
- The Madrid Metro (Spanish: Metro de Madrid) is a rapid transit system serving the city of Madrid, capital of Spain. The system is the 14th longest rapid transit system in the world, with a total length of 293 km (182 mi). However, the European debt crisis greatly slowed expansion plans, with many projects being postponed and canceled [9].
- The Delhi Metro Rail Corporation constructed an urban Mass Rapid Transit System (MRTS) with 10 lines and 253 stations to serve the nation's capital as well as adjacent cities in the National Capital Region (Gurgaon, Noida, and others) (DMRC).

- Dubai Metro is a 74.6 km mass rapid transit system with 47 stations and 2 lines located in Dubai. The Metro tickets must be purchased in the form of a Nol Card. No other payment form (cash, credit card) is possible for riding the Metro. A Nol card is like a credit card that holds either a balance or a specific season ticket for travelling on a lot of the public transport in Dubai including the Metro, buses and the tram [10].

Nol Card

The Nol Card is an electronic ticketing card that was released in for all mode of public transport in Dubai services. A Nol Card is a credit-card-sized stored-value contactless smartcard that can hold prepaid funds to pay for fares on buses and trains within one or more of four "zones". The credit must be added to the card before travel. Passengers "tag on" and "tag off" their card on electronic gates at the metro station or electronic terminals in buses when entering and leaving the transport system in order to validate it or deduct funds. The number of daily transactions of Nol cards currently tops 1.5 million transactions; which includes passengers' entry/exit from Metro and bus stations, payment of parking fees, and recharging of cards. In 2012, RTA produces more than 5 million Nol Cards since the day it was launched (August 2009) [11]-[12]

One of the most important features is the "nearest station to me", it will help passengers to locate it quickly that already exist in "Metro de Madrid", "Cairo metro" and also exist in our system "Mertotic". There are also other that features are found in "Mertotic" and are not found in other systems: Subscription details, Digital wallet, Buy Ticket Online and User Information. Fig.6 Explain the difference between Similar Systems and The Proposed system "Metrotic" .

Features	Metro de Madrid	Cairo metro	Dubai Metro	Metrotic
Satellite Map	✓	✓	✓	✓
Picture of Metro Map	✓	✓	✗	✓
Guide	✓	✓	✓	✓
Nearest Station to Me	✓	✓	✗	✓
Ticket Price	✓	✓	✗	✓
Subscription Details	✗	✓	✗	✓
Digital wallet	✓	✗	✗	✓
Current Balance	✓	✗	✗	✓
User Information	✗	✗	✗	✓
Language Changer	✓	✓	✗	✓
Contact Numbers	✓	✓	✗	✓

Fig (6) Similar Systems vs The Proposed system

3. Proposed System

3.1. Motivation

Every day lots of tickets are being printed and sealed showing that date manually by the person sitting in the metro-station counter. After finish travelling, the passengers usually through away the used paper made tickets here & there which ultimately pollutes the environment. Again large number of trees is being destroyed since the current system uses paper based ticketing and the used tickets are just wasted. But in our proposed system the RFID tagged card carried out by the passengers does everything automatically and eventually reduces these mentioned complexities.

Some benefits of RFID based ticketing system over conventional system (both paper-based tickets & magnetic tickets) are mentioned below:

Using automatic ticket systems enables operators such as transportation authorities to save time and personnel costs; fare collection can be organized much more efficiently. These systems' low maintenance costs and reduced fraud-induced losses represent further advantages [13]

The proposed system aims to improve the drawbacks of the existing one and fulfill the following benefits:

- To increase reliability and efficacy.
- To simplify the process
- To make it easy to use
- To give the user accurate information so they may decide based on that information.
- To increase accuracy and productivity [14].

3.1. System Architecture

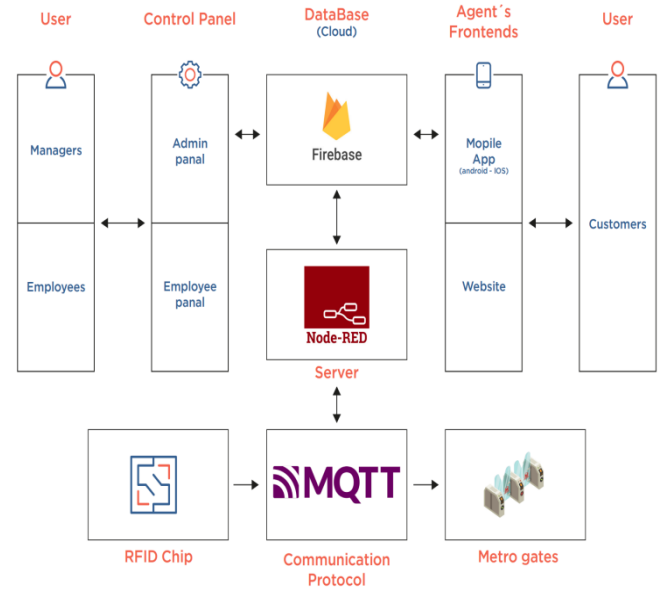


Fig (7) System Architecture of the proposed system.

In this proposed system, the passengers need not to wait in the ticket counter to get the ticket. It saves the time for the passengers. By this system, we can reduce the fraudulent activities and accidents

Each passenger will have a prepaid card with an RFID-based identification number that is specific to them. The card can be recharged using the visa card [15].

The platform gate's entry point and exit both have an RFID reader circuit installed. When the passenger enters the platform gate, the passenger should display the tag in front of the reader circuit placed at the platform gate.

Similar to this, the passenger must display the tag in front of the reader circuit located at the exit point while getting off at the chosen station. While entering and exiting from the platform, the door will open.

As a result, the cost corresponding to the user's trip distance is determined and updated in the shared database system. The

system's precise operation is further outlined below [16].

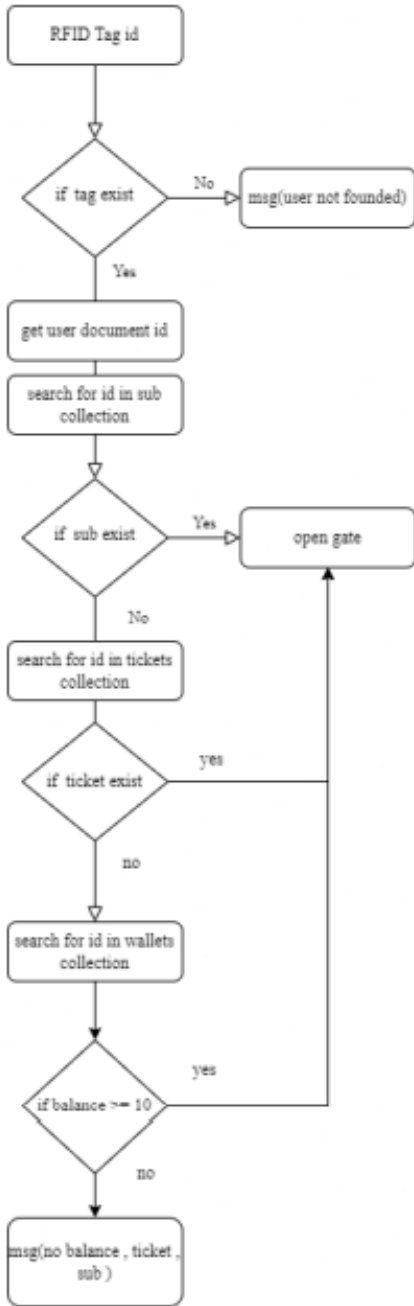


Fig (8) Flowchart of the proposed system.

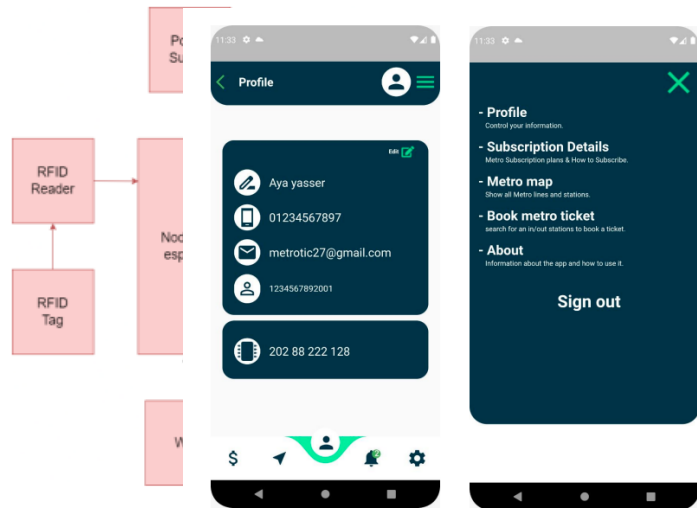


Fig (9) Block Diagram of the proposed system.

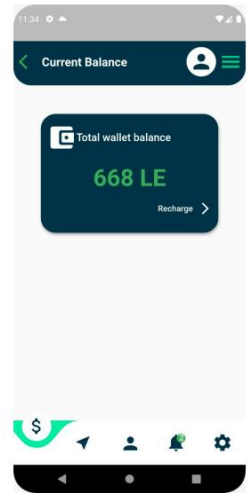


3.2. There are mainly two entities:

- a. Passengers(user):

1. picture of Metro map: it shows picture of metro map stations.

2. Ticket Price: Shows ticket prices.
 3. Subscription Details: Metro Subscription plans & How to Subscribe.
 4. Digital wallet: it shows the current balance in the digital wallet.
 5. Profile: it shows user profile, and the user can edit his data in it.
 6. Change Language: Changes languages from Arabic to English etc.
- b. Admin(employee/manager):
1. Profile Management: in this function for admin that can manage all profiles such as edit, search, and delete users.
 2. Line Management: in this function for admin that can manage all metro lines such as view, and edit stations names.
 3. Prices Management: in this function for admin that can manage all ticket prices such as view, and edit prices.
 4. Staff Management: in this function only head admins can access it with it he can manage all admins such as search, add, edit, remove admin.
 5. wallet Management: in this function for admin that can manage all profiles such as add new wallets, edit, search, and delete wallets data.



3.3. User Interface

We deployed the mobile application and web application using Flutter, Firebase, and admin dashboard using c#.

Fig (10) Mobile application.

Fig (11) Web application.





Fig (12) Desktop application

4. CONCLUSION

By looking over to the present ticketing system in public transport system, it is very complicated with respect to time and money.

This Paper proposes a ticketing system with the aim of developing a mobile and web application for metro train administration. If successful, the operation would be totally automated, effective, upgraded, and affordable. The suggested approach can be used for bus tickets, toll gates, and other locations. Given the efficiency and practicability of implementation in light of the effectiveness of the RFID system mentioned in this study[20].

5. FURTHER WORK

This project helps in eliminating illegal passenger to travel on metro trains. RFID cards are resistant to all weather-related harm. This idea also helps in the trend toward cashless



transactions that will soon be adopted. There is no need to stand in line to buy tickets before boarding a train. There are no set stations; passengers may disembark wherever they like, and fare will be subtracted appropriately. The method saves time by making the process of reserving tickets quicker. A system that can do mass identification, record exact location information, and enable quicker and easier contactless payments is created by an RFID system.

Our vision is making our application used as main transportation program in all Egypt not only for metro adding more features:

- map service
- new options for payment
- More transportation options with available tickets
- A railway ticketing system and public transportation.

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