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RFID enabled Smart cab payments

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ABSTRACT

When attempting to create a fully functional cashless payments system, one must consider the potential base communication software that can be used to implement the same. Of all probable candidates, for card-based transactions, two candidates stand far above the rest in terms of efficiency, cost-effectiveness, and overall scope for the future: Radio Frequency Identification (RFID) and Near Field Communication (NFC). NFC is a set of communication protocols that enable two electronic devices to establish communication when they are brought within 4 cm of each other. RFID uses electromagnetic fields to automatically identify and track tags attached to objects. These tags have information stored in them previously that have been stored electronically.

Keywords— *RFID, Smart payment, Contactless, NFC, RFID tags*

1. INTRODUCTION

Implementing each method according to our standards and requirements presents different challenges. Elucidating the requirements expected off this project is key to building the system to satisfy all the needs. For implementing NFC protocol, there are a number of NFC shields to choose from out of which the Electro NFC shield offers the best alternative as it provides P2P communication protocols [1]. To work with this shield, the module would require the working of a microcontroller. The Arduino Duo board offers four hardware serial ports, extended serial peripheral interface (SPI) support, and 512-kB static random-access memory (SRAM) [1]. In the case of RFID communication, information needs to be entered into the tags before anything else. When a card is written, it needs to be added to the database to ensure that there won't be any discrepancies. To achieve this, ACR122U is used because it can read and write data on a contactless card [2]. The type of card used is also important. One may prefer Mifare Classic 1K, which is divided into 16 sectors and each sector is protected by two different keys for improved security [2]. The hardware microcontroller component preferred in this case is the Raspberry Pi3 B.

Security concerns for such a system need to be discussed as the system involves transaction of money. As mentioned earlier, the type of card chosen may have an adverse effect on security features. Additional security features such as a fingerprint feature to activate transactions or an SMS feature that alerts the user of a transaction taking place can also be considered. Both RFID and NFC implementations require a GSM shield to achieve internet connection to effect change in transaction data in the respective databases. This GSM shield can be used for sending SMS to users. The SMS is to provide information to the user, regarding the payer, the receiver, and the amount to be transacted [3]. For this purpose, the SIM900 GSM shield can be used [3]. For fingerprint identification, special cards are required, like the FPC-AM3 which is a capacitive fingerprint-based card [1]. The card is to be activated by the user's fingerprint; only then can transactions be affected. The fingerprint authentication is carried out by the FPC1011F3 sensor which takes a 256-pixel grayscale image of the fingerprint of the user [1].

In this era, where the use of technology is at its peak, online transactions turn out to be banal, most of the billing services are now made available online. Universal Transport Billing System,

which uses RFID (Radio- Frequency Identification Card) is introduced, integrating all applications in one making it convenient for the users. The present Public Transportation relies on paper tickets, printed by a small machine that lacks details of the passengers traveling in the bus.

2. REQUIREMENTS OF THE RFID SYSTEM STATED

- Passenger details in order to
- Extend security services during the time of Identification.
- Notify passengers via SMS
- Different Modes of transaction: Transaction is performed depending on the type of mode chosen by the passenger.
- Regular updating of server, every time passenger travel with the RFID based tickets.

2.1 Advantages of the RFID System

- Automatic Ticketing.
- It can be used multi-purposely:
- Buses
- Petrol
- Toll
- Parking
- No need to carry cash.
- Automated and Secured fare calculations.
- Consistent.
- Low cost.
- Durability.
- Reliability.
- User-Friendly.

2.2 Disadvantages of the current system

- Chaos among the public.
- Corruption.
- Reckless wastage of time and money.
- No governmental supervision to keep an eye on transportation services.
- An abrupt increase in fairs.

The accelerating speed of RF-ID tags and detectors make the tracking system of any transport system merely a cup of tea.
Our system provides access to any transportation system within a region reaching out to the entire city by specifying "Source" and "Destination" to the system. The information specified is transmitted to the Server's main database, and is stored in the corresponding system account. By using this automated system, we focus on saving time, on a higher authoritative inspection and to reduce chaos and confusion on roads.

We have done a brief survey on RFID enabled smart card systems by referring the below-mentioned papers citing the use of RFID and agent technologies used for public transport. It has been said after referring those papers that passengers require to show or swipe the card to the Reader at the entrance of the door of the vehicles and the exit of the bus.

The idea was expressed to ensure that each and every passenger should have a card so that we can eradicate the cash transactions and we make bold move towards the cashless economy transactions. However, it should be noted that scanning one card at a time is a lengthy and time-consuming process and people need to be in queue for this purpose and buses can't stop at every stop for that much time. [4][5]. Research has also been carried out in using RFID scanners ID-1, ID-12, ID-20 for scanning RFID cards. But we face the problem with these RFID readers is that they scan one card at a time. In fact, having 2 or more tags in the reader's range will cause it to not read any tags at all. [5]

There has also been researched on dynamic scheduling of buses from the point of view of passenger tracking patterns, which were be noted and included in planning and scheduling the buses. The ticketing records are used to generate an estimate of occupancy on a particular bus so that passengers can easily see the crowd on the upcoming bus. [6] In another research RFID smart cards were used for the same purpose but they were only rechargeable through booths present at certain locations of the city which is not at all convenient as passenger's perspective. [6][7] Research also looked at use of GPS for fare calculation based on distance travelled by the passenger and also were used so that commuters can check the current position of the bus on Google Maps or Android App.

In a research different kind of RFID module was used for the ease of visually impaired persons so that they can easily check which bus is at the stop at that time with the help of voice output to them. There has also been a Research in which passengers have to enter the location manually into the keypad after entering a bus and the ticket was generated with appropriate fare deduction from the account. This is really time-consuming process because each station bus would have to stop for long time until every passenger gets an e-ticket. [5] But here in VIT it won't be an issue because a student needs to scan his or her card at end station so they will be having enough buffer time to scan the card and also it helps to eradicate the chaos caused in the shuttle cab in regards of exchange in money into smaller units.

NFC is a standards-based, short-range wireless connectivity technology that enables simple two-way interactions between electronic devices. With NFC consumers can perform contactless transactions, access digital content and connect NFC –enabled devices with single touch. [8]

To overcome the following disadvantages and to make a user-friendly bus- ticketing system where the entire bus ticketing process will be automated. It will be implemented using the upcoming technology NFC that allows data to be transferred between two NFC enabled electronic devices. Here NFC is used to generate E-ticket. An E-ticket is basically a paperless electronic document that is used by the passenger as a ticket traveling by bus. [8]

NFC permits the secure transaction i.e. passengers and the service provider cannot accuse each other of forgery by ensuring that either both parties receive their desire data from others or neither does. [10]

NFC ticket helps collect passenger's information which will be maintained in the database which in turn will minimize fraudulent activity. Another important aspect is Reusability which helps use tickets multiple times. [10]

Recent advancements in various technologies have made remarkable developments in various fields for public welfare and public transport is one such area. In the near future public transport system with advanced technologies like Radio Frequency Identification Device (RFID), GSM, GPS modules will gain the spotlight due to their advantage of higher

convenience and greater life standards as compared to the conventional bus systems. The study brings out solution in terms of cost, convenience, user satisfaction, and future implementation. [9]

RFID over Ticket Vending in conventional paper-based ticketing, the bus conductor prints and seals lots of tickets with the fare and the date on the ticket. These tickets are thrown away after the travel by the passengers polluting the environment and causes loss of trees from which the paper is manufactured [9]. Using automatic ticket systems time and personal costs of the transportation authorities can be saved. It enables an organized way of fare collection. Low maintenance costs and reduced fraud-induced losses are further advantages [9].

3. WHAT CAN NFC DO IN PUBLIC TRANSPORT?

Connection, access and transactions, all these three have applications in transport. For example, an NFC enabled phone can connect with an NFC enabled kiosk to download a ticket, or the ticket can be sent directly to an NFC-enabled phone over the air. The phone can tap a reader to redeem that ticket and gain access. [8] Anytime-anywhere access to information and applications are easy to download over air and manage on the phone, with NFC travelers can experience a host of new, intuitive and rewarding experience on their mobile phones. [8]

The emergence of NFC-enabled phones with trusted execution environments makes it possible to not only integrate mobile phone ticketing with existing and future transport authority ticket readers but also to construct secure protocols for non-gated travel eliminating many associated possibilities for ticketing fraud. [10]

Electronic payment systems for public transport, introduced in many cities all over the world during the last decade, are able to capture system transactions and provide comprehensive data records on the usage of public transport. [15] Processing and analysis of this data open new opportunities in transportation and travel behavior research and are becoming an emerging research topic. [14] We present an analysis of one full day of public transport smart card activity for the entire city-state of Singapore and investigates its potential for characterization of public transport systems and urban travel behavior. [16] In particular, an assessment of spatial and temporal travel behavior including mode choice, travel-and waiting times is performed using statistical tools and data mining techniques. Thereby data reveals country-specific preferences and behaviors as the influence of high passenger volumes and seat availability on route choice decisions and travel times. [14, 15] Furthermore data's ability to detect travel patterns and infer people's travel purposes and locations of regular activities is investigated and strategies for modeling of home and work locations are presented. Additionally, household survey data from 2008 is used for comparison of multimodal travel patterns involving public and private transport. [16]

Electronic fare collection as the most advanced form of Automatic Fare Collection (AFC) systems for public transport offers many advantages and benefits for operators of public transport as well as their customers.

Convenient, easy and almost instantaneous payment process saves customers time and makes use of public transport more attractive. [16] Furthermore, lower operation costs, high efficiency, and reliability, as well as new opportunities for implementation of flexible fare schemes, are additional benefits for operators. Another important aspect of an electronic fare collection system is the detailed data records that are continuously generated and archived. Analysis of such data can provide valuable insights into usage of public transport and help for better understanding of people's travel behavior and their preferences. [14]

Consequently, processing and mining of these substantial amounts of data are becoming more and more emerging research topics in the areas of mobility and transportation planning. In this context, the example of Singapore represents an interesting study case as a highly dynamic city with a centralized, long-term oriented transportation planning policy and fast-growing commuter population. [15] The combination of a distance-based fare scheme for public transport and the use of contactless stored-value cards, so-called EZ-Link cards, for payment of public transport fares, provide a nearly comprehensive data record of public transportation usage for the entire city. This allows detailed assessment of travel behavior and mobility patterns, which is the topic of this work. [16] The main goals thereby are the detailed detection and description of specific travel behaviour in Singapore and use of AFC data for activity location modeling. [14]

(Automatic face collection system) The AFC system for public transport based on contactless, stored value smart cards, so-called EZ-Link cards, was introduced in Singapore in April 2002. Today, the EZ-Link card can be used island-wide for payment of all modes of public transport, regardless of operator as well as for minor retail transactions, parking, and road toll payment. Though cash payment of single fares at higher rates is still possible, e-payments with EZ-Link card account for 96% of all trips, which makes the data records from EZ-Link card highly comprehensive and the missing cash-paying travelers negligible. The implementation of uniform smart card AFC system allowed the introduction of a distance-based fare scheme for all modes of public transport in Singapore. [15]

The fare charge for each customer is based exactly on the traveled distance, transport mode and demographic attributes as there are prioritized rates for children, students, and senior citizens. Customers have to tap their EZ-Link cards on the reading device every time they enter and leave a train station or a bus. Thus, besides of the information on boarding time and location, the data collected from EZ- Link cards contains detailed records of alighting times and destination location for both bus stops as well as Mass Rapid Transit (MRT) and Light Rail Transit (LRT) stations. [14, 16]

These attributes distinguish the Singaporean smart card data from those collected by the majority of other automatic fare collection systems and allow more detailed assessment of travel behaviour and mobility patterns. Furthermore, as the EZ-Link cards are easily rechargeable, people tend to continuously use one single EZ- Link card with a unique card ID for all their public transport journeys for substantial periods of time. [16] As the technical setup of the system doesn't allow more than one person to travel on a single EZ-Link card, it can be assumed that each unique card ID represents one single person. This enables a highly disaggregated analysis of individual itineraries and opens new ways for understanding people's travel behaviour on short as well as long term scales. [15]

Contactless payments are payments made by waving or tapping your contactless device usually a card or smartphone over a reader, which then accepts the payment. This contactless

payment has been very widely used in metropolitan areas and is highly appreciated by the suppliers and some even claim that they are twice as fast as conventional cash payments, credit or debit cards. This kind of payment does not need any signature or pin because it is limited to a very small area range. Even big car manufacturing companies like MasterCard advisors wrote that RFID transactions have been increasing exponentially after the implementation of contactless payment [23]. Due to its no signature or pin requirements, there is a limitation on cash payment typically set to a maximum amount of transaction known as floor limit. These limits may vary between banks, government regulation of a country or the chip used in the card. The card payments vary from the chips that are used as how many times they are rewritable, their memory, and their frequency. Present-day cards have their limitations but they have mainly used in-game centers also as a form of virtual currency. This virtual currency is very useful in our project that we are going to discuss in further topics [23].

Several frequencies are used in RFID applications: 125 kHz, 13.56 MHz and 860-930 MHz for passive RFID; 433MHz and 2.45GHz for active RFID. The global standardization of RFID system is an important issue. RFID has been implemented by different manufacturers in different ways. There is no global standard that can be used everywhere. Various standards or protocols are proposed for different RFID applications [22].

These standards include hardware physics specification, tag-reader air interface specification and reader-host command specification. A number of organizations have set standards for RFID, including the International Organization for Standardization (ISO), the International Electro-Technical Commission (IEC) and global. A shortlist of RFID standards follows ISO 10374, ISO 10536, ISO 11784, ISO 14443, ISO 15693, ISO 18000, EPC global [23].

These standards manage the communication between an RFID reader and a tag. These standards work on selected frequency bands (e.g. 860 – 915 MHz for UHF or 13.56 MHz for HF). This paper will provide different aspects of RFID technology [22] [23].

[22] RFID Components A combination of RFID technology and computing technology is called RFID system as shown in figure RFID system consists of the following components:

a) Tag/Transponder (electronic label).
b) Antenna (medium for tag reading).
c) Reader /Interrogator (read tag information).
d) Communication infrastructure (enable reader/RFID to work through IT infrastructure).
e) Application software (user database/application/ interface).

4. CONCLUSION

We are using contactless payments as our main agenda for our project as it is fast and reliable. When we travel in-cab, we don't have sufficient change to pay but if we implement contactless payment through virtual cash it is more reliable, fast, and secure and saves time for cab drivers and they can work fast. We are in a fast, smart and digital world, we need to grow with the world. We got this idea to make VIT a smart campus where technology is a synonym for our university. Our idea has a very promising future that if implemented can be used to save time, energy and also create employment opportunities on our campus. We are implementing this smart cab payment system to improve the environment of students and also the workforce of VIT.

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