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Unified Multipurpose Smart Payments using Radio Frequency Identification

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ABSTRACT:Today, in India we have multiple payment modes viz. the most conventional is the Cash Payment, then comes the Credit and Debit card and the latest in this digitization era we have the Online Wallets. Still, somewhere somehow they aren't the best payment modes. In order to contribute, for unifying all these problems and deriving one discreet solution, this report provides a detailed solution. Here, one simple card called "TapMe" along with fingerprint authentication can be used everywhere to make payments like in public transport, fuel stations, government services, amusement parks etc. The card is easy to carry unlike carrying cash, simple and secured than credit/debit cards as it vanishes inserting/swiping and remembering pin for every transaction and independent, unlike online wallets which are dependent on internet connectivity. Thus this system has the potential to ease our payment mode to a much greater extent.

KEYWORDS:RFID's, Unified Payments, Fingerprint Authentication, Multipurpose, Smart cards.

I.INTRODUCTION

Radio Frequency Identification abbreviated as RFID can be used to solve this problem. Radio Frequency Identification (RFID) is a generic term for technologies that use radio waves to automatically identify and track product, animal, or person by means of using RFID tags that are applied or incorporated on them. An RFID system consists of a tag, basically a microchip with an antenna and an interrogator or reader with an antenna. A fundamental system of RFID consists of two primary components: The reader circuit and tag. The RFID tag and the reader circuit set up communication via waves of electromagnetic nature. Thus using this technology in the form of RFID card similar to that of credit or debit card, can help solving this payment problem. What makes them different, from their competitors is its simplicity. No need to insert or swipe the card in the reader and wait for the server to respond, as it consumes time! What can be done instead, is just tap the card on the reader, and that's it, it identifies.

II.LITERATURE SURVEY

Following table is the brief analysis of some of the finest literature available so far for this domain.

Table 1 Literature Survey.

Title of Paper	Methodology	Advantages	Disadvantages
Passenger Authentication and Payment System Using RFID Based On-Board Unit for Surabaya Mass Rapid Transportation	Passenger taps the RFID card on the on-board bus unit(OBU) while entering into a bus and taps the same while leaving, the fare is automatically calculated and deducted.	Precise and accurate fare calculation, Conductor free buses, Prepaid cards-easy refilling of card(can be recharged online)	Lack of authentication, Security Issues, One OBU isn't sufficient during congestion
RFID Technology: Beyond Cash-Based Methods in Vending Machine	RFID Interfacing with SPI Bus Protocol with pin protected security.	Pin protection,SMS alerts to consumer and owner using GSM.	No Coin / Note Handling

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Applications and Opportunities for Radio Frequency Identification (RFID) Technology in Intelligent Transportation Systems.	The system utilizes tags that are attached to various components to be tracked. The tags store information concerning the details of the product of things to be traced. The reader read the radio frequency and identifies tags.	Once deployed, cashless, easy and secured payments for a variety of services.	Scope further restricted to Intelligent Transportation Systems only.

III.RFID

RFID is an acronym for "Radio Frequency Identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves. RFID belongs to a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and enter those data directly into computer systems with little or no human intervention.RFID system consists of three basic core components: RFID tag, RFID reader, Controller.

*A. RFID Tag:*Tag can also be called as transponder which consists of a semiconductor chip and sometimes a battery attached to an antenna that has been printed, etched, stamped or vapour-deposited on a mount. The chip is pre-programmed with a tag identifier (TID), which is a unique serial number assigned by the chip manufacturer, and includes a memory bank to store the items' unique tracking identifier (called an electronic product code or EPC).

*B.RFID Reader:*Reader can also be called as interrogator or a read/write device, which consists of antenna, an RF electronics module and a control electronics module. They convert electrical current into electromagnetic waves that are then radiated into space where they can be received by a tag antenna and converted back to electrical current.

C. Controller: Controller can also be called as host which acts as a work station running data base and control which is often called as middle ware software.

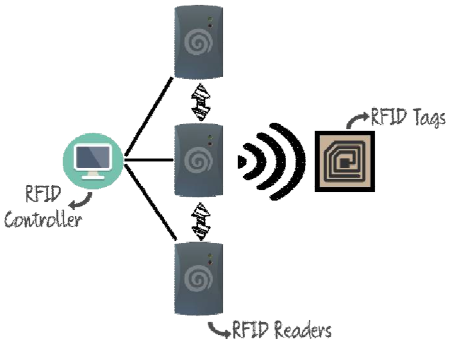

Fig. 1 RFID Components

IV.RFID TYPES AND OPERATING FREQUENCIES

Depending upon the type of tags used, we have two types of RFID systems viz. Active tags and Passive tags.

*A. Active tags:*Tags are said to be Active if they are having an on-board power source called battery. When the tag requires transmitting the data to the interrogator, tag uses the source to derive the power for the transmission. This is same as the mobile phone which uses a battery so that the information is transmitted over longer ranges (up to 100m) and communicates with less powerful interrogators. These tags have large memories up to 128 Kbytes. The life time of battery in the active tag can last from two to seven years. These are Active systems.

*B.Passive Tags:*Tags which contain no on-board power source are called passive tags. To transmit the data they will get the power from the signal sent by the interrogator. Passive tags are of low cost and typically smaller to produce than active tags. The maximum distance that the Passive tags generally operate is 3 meters or less. These are Passive systems.

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RFID systems can be broken down by the frequency band within which they operate: low frequency, high frequency, and ultra-high frequency.

*A. Low Frequency(LF):*The LF band covers frequencies from 30 KHz to 300 KHz. Typically LF RFID systems operate at 125 KHz, although there are some that operate at 134 KHz. This frequency band provides a short read range of 10 cm, and has slower read speed than the higher frequencies, but is not very sensitive to radio wave interference. LF RFID applications include access control and livestock tracking.

B. High Frequency (HF): The HF band ranges from 3 to 30 MHz. Most HF RFID systems operate at 13.56 MHz with read ranges between 10 cm and 1 m. HF systems experience moderate sensitivity to interference. HF RFID is commonly used for ticketing, payment, and data transfer applications.

C. Ultra-High Frequency (UHF): The UHF frequency band covers the range from 300 MHz to 3 GHz. RAIN RFID systems comply with the UHF Gen2 standard and use the 860 to 960 MHz band. The read range of passive UHF systems can be as long as 12 m, and UHF RFID has a faster data transfer rate than LF or HF.

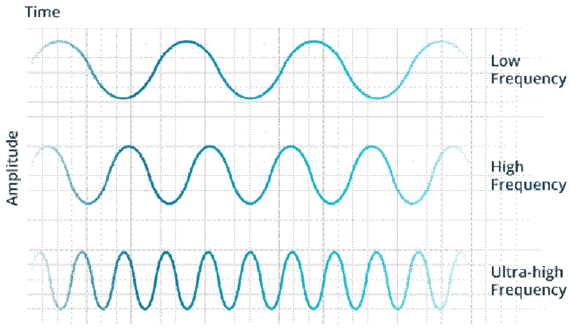

Fig. 2 RFID Operating Frequencies

V.METHODOLOGY

As the scope of this system can be categorized in 3 generic applications viz.; ticketing in local public transport, Payment for government services and Payment for private retail services, the system architecture remains unchanged as same RFID readers, though referred with different names are used in each of these applications. Following chapters will give a detailed description of each of these application separately.

VI.RFID READER UNIT

The RFID reader unit which is also referred as OBU (On Board unit) in one of its application; ticketing in local public transport, is the fundamental unit of this system. The RFID Reader Unit comprises of three subunits and Arduino UNO R3 serve as the main processor. The shield used for Wi-Fi Connectivity is ESP8266, which is an open source Wi-Fi shield module board. Another shield module used is MFRC522 which is RFID reader and writer. This module operates for RFID tags at frequency 13.56 Mhz. i.e. at High Frequency (HF). The above three components are integrated to form a Reader Unit for our application. Following is the connection diagram for connecting RFID reader MFRC522 and Wi-Fi module ESP8266 E-01 to the micro-controller Arduino UNO R3.

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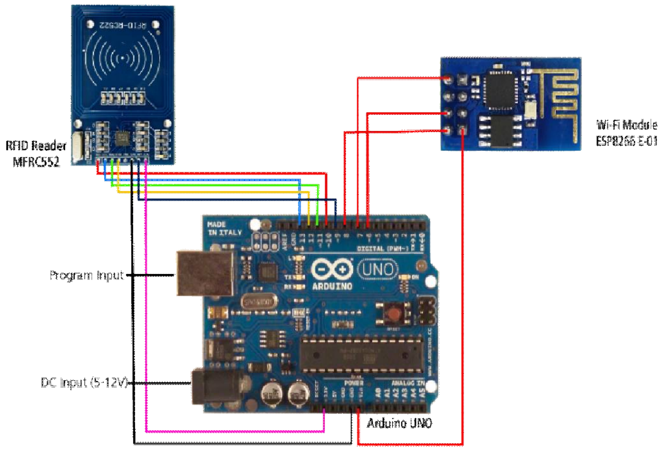

Fig. 3 RFID Reader Connection diagram

VII.SECURITY AND AUTHENTICATION

Input to the system is provided by RFID UID, after system initialization. UID, and biometric password stored against RFID UID of consumer card are the key parameters for providing security in proposed methodology. System checks the information against UID, if that UID is stored against that specific RFID card, then it asks for fingerprint password. This access control system uses two components. First component is a fingerprint reader that is connected to a database to match the pre stored fingerprints with the one obtained by the reader. The second component is an RFID card that transmits information about the person that requests an access. After fingerprint validation, consumer is authorized to transact. Arduino 1.0.6 software uses that UID number to create a database against each RFID consumer, in which details like consumer identity, fingerprint template, current balance, and after transaction balance against his card are stored.

VIII.RFID INTERFACING WITH SPI BUS PROTOCOL

SPI (Serial Peripheral Interface) a high speed, small communication protocol is used to serially communicate data between the devices in SPI mode i.e., from SPI master to SPI slave and vice versa. SPI is used for communication in a small range of distance, and developed by Motorola. RFID's three possible interfaces are SPI, serial UART and I2C. In proposed methodology, only SPI protocol for interfacing RFID is used, because selected RFID model RC522 communicates in a small range of less than 1 meter. Microcontroller Arduino UNO R3 acts as a SPI master, and RFID RC522 as a SPI slave in serial communication from master to slave. SCLK serial-clock generated by SPI master, MOSI master-output slave-input (master to slave serial-data transfer), MISO master-input slave-output (slave to master serial-data transfer), and SS slave-select when low allows that particular slave to start communication with master, are the four prime bus-lines of SPI bus protocol used in communication. SPI data communication is done by 8 bit data shift register i.e., in one clock, one bit data goes from master to slave, and in next clock one bit goes from slave to master, this is how in 16 clocks the contents of 8-bit master and 8-bit slave register is swapped.

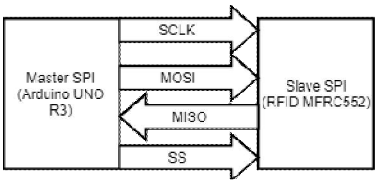

Fig. 4 Master Slave Interfacing

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IX.TICKETING IN LOCAL PUBLIC TRANSPORT

In the system presented in this paper, the restriction put on passengers is, they can enter transportation vehicle only at the stop location. OBU will connect to server when its scanned entries will identify the access points at the stop locations. Each stop is associated with an Access Point Identifier (APID), which shows it identity. After OBU gets connected, it's in standby mode, as soon as the passenger taps his RFID card and authenticates himself, OBU will forward the UID data from RFID through the network to the server. UID is the unique ID registered on RFID card. Server checks if there is matched UID and its balance. If the balance meets the fare requirements, server sends success check-in feedback to OBU and passenger is allowed to enter. When it doesn't meet the requirement, passenger is not permitted to enter and notified to top-up his card. When they want to exit, passenger needs to tap his card once again. However, this time the server calculates their fare by how they travelled. The server calculates by comparing the check-in and check-out APID's.

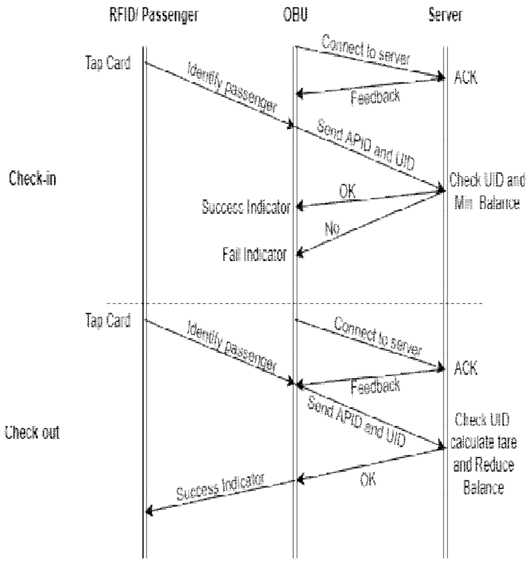

Fig. 5 System Process

Fig. 6shows the process in OBU when makes connection and sends data. IP address is set to blank because it can be filled with any IP address as long as it never changes when connections are made. As for port number, it is better to use dynamically assigned port to prevent connection crash. APXXX is the format of APID located at every stop location. XXXXXXXX represents 8 character unique ID known as UID. When the connection is set, OBU sends data using TCP connections. To send the data, OBU needs to know the server IP address and port. Indicator for success and fail has also been added using LED and buzzer tone.

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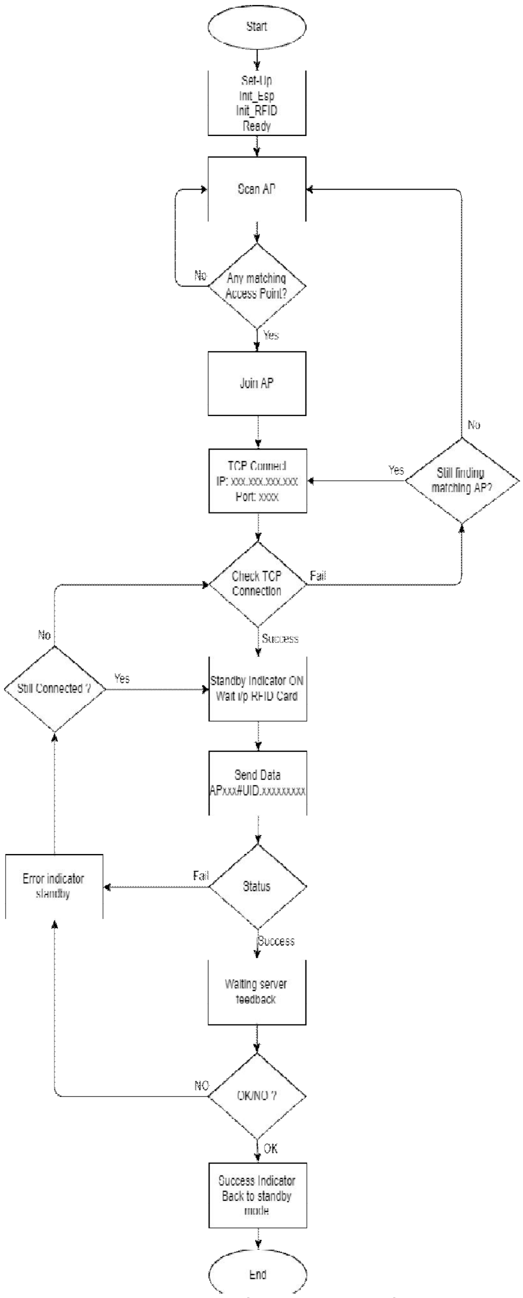

Fig. 6 Flowchart for working of OBU

Thus after understanding working of OBU, Fig. 7 describes the detailed flow of check-in and check-out activity. When there is no movement over the reader, the OBU is in standby mode. When a card is tapped, the reader first checks whether it is a check-in operation or check-out by examining the check-in flag stored in each card. If the flag is 0 it means it is a check-in activity and 1 for check-out. Check-in activity is followed by biometrics scan and its authentication. Once authenticated, it then checks for the availability of minimum balance, if true, the UID and APID are stored and the check-in flag is set to 1 and again OBU goes in standby mode. Now when same card is tapped again, this time the check-in flag being set to 1 will follow the check-out procedure. Here again APID and UID is stored and comparing APID's of start and end location fare is calculated and deducted, and the check-in flag is rested.

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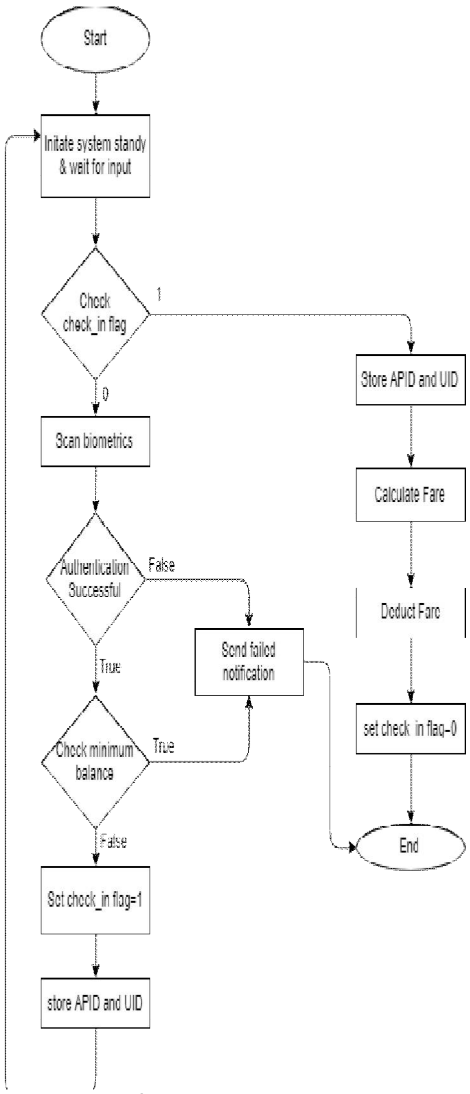

Fig. 7 Flowchart for check-in and check-out activity

X.PAYMENT FOR GOVERNMENT AND PRIVATE RETAIL SERVICES

The next application proposed in this system is the payment of government services like challan payment, processing fee payment for government approved documents, toll payment and the payment of private retail sector services like payments in shopping malls, recreation parks, fuel stations, payed parking, Art and culture centres etc. Such payments can be unified under this single mode of smart payment. The RFID reader or the interrogator used for this payment has a slight different flow of actions. Though the architecture remains same as that of OBU in local transport payment which mainly comprises of Arduino UNO R3 the main processor, Wi-Fi Connectivity Shield ESP8266 and a shield module MFRC522 which is RFID reader cum writer. Fig. 8 explains the flow of actions for this application.

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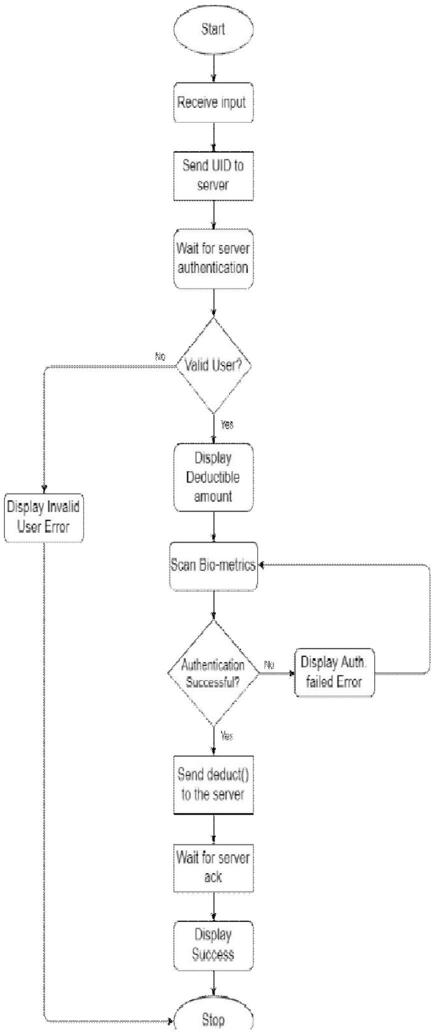

Fig. 8 Flowchart for service payment RFID reader.

XI.RESULTS AND DISCUSSION

After analysing the architectural and technical details of RFID reader and the smart card, the following section explains the prototype of the actual system.

*A. Prototype of RFID based Smart Card-"TapMe":*The RFID tags used in this system, will be embedded in a card. The size of RFID cards will be 85.60 mm × 53.98 mm (3.370 in × 2.125 in) and rounded corners with a radius of 2.88–3.48 mm, in accordance with ISO/IEC 7810#ID-1, the same size as other payment cards, such as credit, debit and other cards. The UID of RFID tags will printed on the smart cards along with the user name and their photograph. Users shall be issued such smart cards and their details will be stored in the central database against their UID. Users can use their UID to recharge cards online.

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Fig. 9 Design of Smart Card-TapMe

*B. Prototype of RFID readers (OBU):*The OBU being the first type of RFID reader will be a device mounted on transportation vehicle. The OBU will be a tall bar like structure with a scanning area of 176.625 cm^2. User can tap over this area to initiate or terminate the transaction.The OBU is further divided into two categories:
i) Check-In Unit
ii) Check-Out Unit
Check in units are the OBU's used when user enters the transportation vehicle. The user will tap over it and initiate his transaction. Whereas, Check-Out units are the OBU's used when user leaves a transportation vehicle. The user will tap over it and will terminate his transaction. This will complete his travel cycle and fare will be calculated after each check-out.

XII.CONCLUSION AND FUTUREWORK

The system is expected to be fully automatic, hassle free, secure, and faster than its rivals. Once implemented especially for metro cities in India, it will not only bring discipline in local transport travel but also will provide its users a better option for payment over cash and debit/credit cards. It may need high investment to set up and install RFID kits, but once the system is on, it will create a major impact on the lifestyle of society. People will not have to worry carrying cash everywhere, or to wait in a long queue as payments via credit/debit card consumes time also people have multiple cards from variety of banks, making it a cumbersome task to remember the pins of each and every card. As this system is based on bio-metric authentication, the practice of memorizing the pins stands obsolete. Also tapping the card is comparatively a faster activity than swiping a card or making payments via online wallets.

Till date there has been such payment technology for variety of individual sectors which mainly includes local transport payments and they are functioning smoothly. But there is no significant system at present being implemented or being proposed which unifies payments for local transport, government services and private retail payment. Hence, through this proposal we suggest "Unified Multipurpose Smart Payment Using Radio Frequency Identification". Reflecting on the benefits of this application, such type of systems would be ready-to time market if they are implemented for smart cities in India.

Commencing from an individual city, which serves as an individual node of a large network, this system once fully operational in such city can be then merged with other cities to form a bigger network. Later such big groups of multiple cities can be then merged to form a regional network, and eventually merging such regional networks will ultimately lead to the formation of a national mode of payment. Hence, this proposed system has the potential to become operational at the national level.

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