Finger Print Based NFC Smart Ticketing

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***Abstract*—- Near Field Communication (NFC) technology is the new in-built technology present in smart phones especially android phone. There are a myriad of applications with this and the full potential of it is not yet realised. It is imperative to build a single platform without using the full applications of NFC. NFC along with facial recognition can create a fraud proof system. A combination of both can be used in e-ticketing and integrated with the pre-existing transport system. The very need for digitalizing the fares is to make it error free and give easy access to the public transport system. It is achieved using RFID for access into the public transport, where the user has to top up the card for using it similar to a SIM and when entering the transport system it would check for the availability of funds in the card and would check if the saved finger print sample matches that of the commuter, if available it would provide access to the service, if not it would indicate the same through a message on the LCD screen and if the user has to leave the public transport at desired station, the user has to tap the card at the exit., in this manner it would detect the exact fare for his/her journey. With the proposed system, there is an extra layer of security to the entire transaction and making it less cumbersome.**

I. INTRODUCTION

E-ticketing or online ticketing like the one which proposed is a very intricate model. For the building of a prototype, only a percentage of the features of both, NFC ticketing and the biometric system in discussion, Finger print recognition are used.

NFC is a standard based short range communication technology that enables simple and fast two way interaction between electronic devices[1].With NFC technology, consumers can perform contactless transactions, access digital content and connect NFC based enabled devices with a touch of a button. It is also compatible with global contactless standards which means pre-existing infrastructure agencies that have already employed contactless program have a built in advantage as their equipment might readily interact with NFC chips.

The reason to choose NFC over other wireless technology is summed up in the following table [2]. It explains the data rate and range of the wireless networks. The data rate of NFC is from 106 Kbit/s to 424 Kbit/s. Due to the reason that the pros of NFC outweigh its cons, NFC was chosen has the basis for the proposed model.

Table 1: Comparison of wireless networks

Wireless Network	Data Rate	Range
Wireless USB	100Mb – 1Gb	0.01m – 10m
Wi-Fi	10Mb – 100Mb	1m – 100m
WiMAX	10Mb – 100 Mb	10m – 10km
Bluetooth	1Mb – 10Mb	0.1m – 10m
3G	1Mb – 10 Mb	10m – 10km
NFC	100Kb – 1Mb	0.01m – 0.1m
ZigBee	100Kb – 1Mb	0.1m – 100m
GSM	100Kb – 1Mb	100m – 10km

Fig 1: Use of NFC technology on the phones.

The present scenario in the public transport system in India for commuting within the city has remained unchanged since the time of independence. The system includes a bus driver who doesn't involve in the issuance of tickets to the commuters and a bus conductor whose sole responsibility is everything from maintaining order in the bus and issuance of tickets to the commuters. The present system has a number of problems which are listed as follows.

I. The tickets issued are a chit of paper which comes in denomination of a particular amount. Based on the number of bus stops on the route to the destination, the bus conductor calculates mentally the amount to be charged for the commute and charges the person. This is a tedious process.

II. Along with this is the burden to carry some change so that the entire amount is paid once for all and not wait for the conductor to give the remainder amount. With the use of e wallets, this tussle is completely eliminated.

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III. The third problem is that if there is any theft reported in the bus, there is no log maintaining the people travelling in the bus at that particular journey. With the advent of CCTVs, there has been an improvement in solving the problem of theft. Nonetheless it is impossible to get a list of people travelling in the bus at that moment itself. With the proposed system, there is not only the records of all the people travelling in the bus, but also the time of getting on to the bus and getting off the bus. By this, there can be a filtered list of people traveling in the particular bus at a particular time with the entire record.

IV. A conductor is needed to issue the tickets. With the existing system, there is mismanagement of human resources and mismanagement of time as it requires a minimum of 1 minute to issue the ticket and collect the change.

The advantage of the system developed are as listed below.

I. One of the most important aspects of this that it completely eliminates the need for conductor. With this system, the driver can monitor the person entering the bus for a couple of minutes and no need for an extra person to take care of ticketing.

II. As a country gets more and more developed, we need to completely digitalize currencies. The present government is striving to digitalize currency and with this system, this can be achieved and it is a big step in digitalizing currency. This not only brings in accountability of the money spent, it also prevents any theft which might occur with carrying of physical cash.

III. This system is very fast. The finger print recognition has a reception of 1.4 seconds which is much faster than the time taken by the conductor to issue of ticket. It is not only fast, the commuters need not be bothered by the conductor to ask them whether the ticket has been bought. The entire process from tapping the card on the reader and getting finger print recognition takes over within a matter of seconds. The commuters will have a hassle free commute to their destination. [2] [3]

IV. In a push to have a complete eco-friendly environment, this collaborates it. This makes it completely paper free and saves billions of square feet of paper.

V. India is a country known for its corruption from its grass root levels to the top most level. With the implementation of this system, this problem can be addressed.

VI. The system doesn't use GPS module to track the commute. Since the bus travels on the pre decided route always, each bus stop is indicated with a switch which signifies the bus stop. When that particular bus stop switch is turned on, the microprocessor calculates the fare to be deducted from the e wallet based on the number of bus stops.

NFC smart ticketing payment is known for its P2P transaction. Use of NFC technology in public transport system is aplenty. They can be used for 2 different things-It can be used to download a ticket from NFC enabled kiosk and it can also be sent to the phone directly through internet to the phone [1] [4]. In both the cases, the consumer can redeem the ticket in the reader by tapping the NFC enabled device at the reader.

NFC enabled devices can not only provide the consumer with the ticket, but also the following:

I. Timings of the transport system.

II. Weather forecast in the destination.

III. Map of the entire vicinity.

IV. Special offers available with the transport system.

V. The arrival time of the next bus or train or any transport system (To update the consumer about any delay), cab services or other transport facilities present outside the station to travel to places where the bus/train doesn't go, emergency button to inform the authority or the contact listed as emergency contact (Especially for women travelling alone) and parking pass to park at the local station [4] [5].

NFC forum tags can be situated in posters, products, maps, etc., of the Public transport system. NFC forum tags are one of the reason why the entire system becomes very inexpensive [5].

The system has the utmost security. The NFC card alone cannot be hacked to get any information out of it because to do that the person has to get uncomfortably close to the person having the card and with the system developed, there is an extra layer of security due to the finger print recognition providing a two layer security breach to hack. Thus the system developed is one of the most secure ticketing systems developed for public transport

II. METHODOLOGY

A. *THE CLOUD SERVER*

The server contains the database of every user, where every user database consists of the following

I. NFC ID

II. Finger print pattern

III. E-wallet balance.

B. *Entry*

I. When a person enters the Public Transport, he/she swipes his/ her NFC card over the NFC reader.

II. The microprocessor accepts the NFC tag, which is unique to every user, from the NFC reader and sends

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the NFC tag to the server which maintains the database of every user [1]. The database maintains the user's mobile number and finger print samples for the recognition.

III. The server matches the NFC tag in the database, and returns the finger print pattern of that user.

IV. The finger print module then checks for match of the finger print pattern which is received from the server to the finger print pattern pre-recorded during registration,

V. Upon getting a Positive Match, the processor sends an accept signal to the GSM module which sends a message to the saved mobile number of the commuter. The switch which indicates the

VI. The server updates this information, and the GSM sends the acknowledgement to the NFC chip or the user mobile [6].

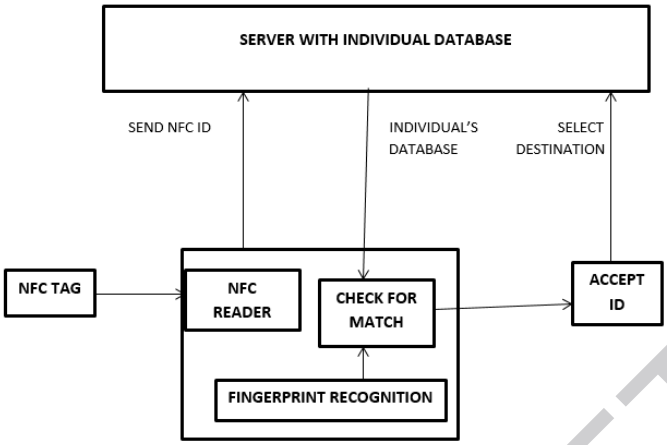

Fig 2: Functionality Diagram of Entry side

C. Exit

I. The user upon reaching the Destination, swipes his NFC card over the NFC reader.

II. The microprocessor accepts this read and searches for the switch activated to select the stop. Based on the stop number, it calculates the stops travelled.

III. The microprocessor calculates the tariff and subtracts the money from the E-wallet [8].

IV. The microprocessor, sends a signal to the GSM to send an acknowledgement to the User mobile number saying the commute has ended and the amount deducted [9].

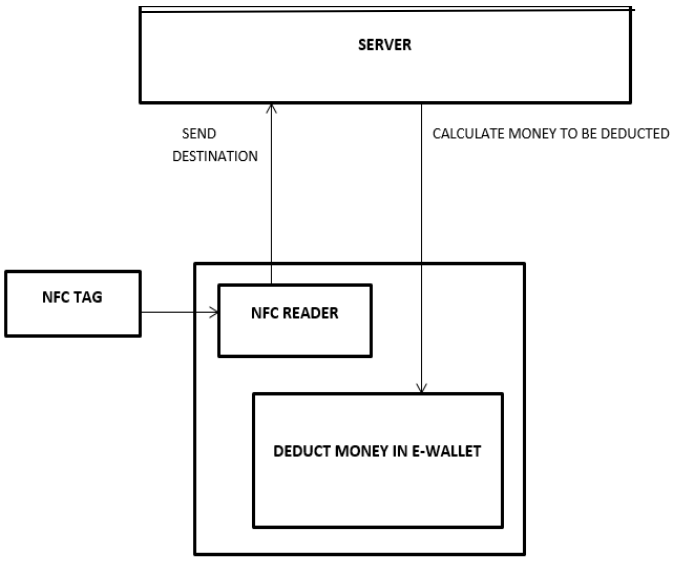

Fig 3: Functional diagram of Exit

D. Finger print algorithm-Minutae Algorithm

A professional fingerprint examiner relies on minute details of ridge structures to match fingerprints. The topological structure of the minute details of ridge structures of a fingerprint is unique and invariant with aging and impression deformations. Eighteen different types of local ridge descriptions have been identified. Among them, the two most prominent minutia details that are suitable for automatic detection from input fingerprint images are ridge endings and ridge bifurcations which are usually called minutiae. [2] [3] The two most important components are

I. minutia extraction which detects minutiae from input fingerprint images

II. minutia patterns to establish the identity of an individual

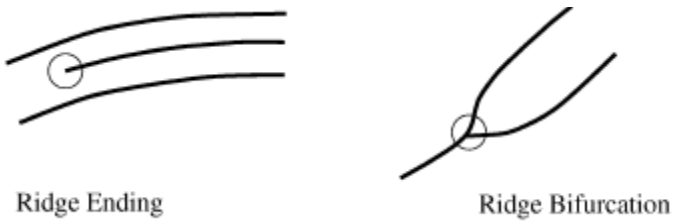

Fig 4: Difference between ridge ending and ridge bifurcation

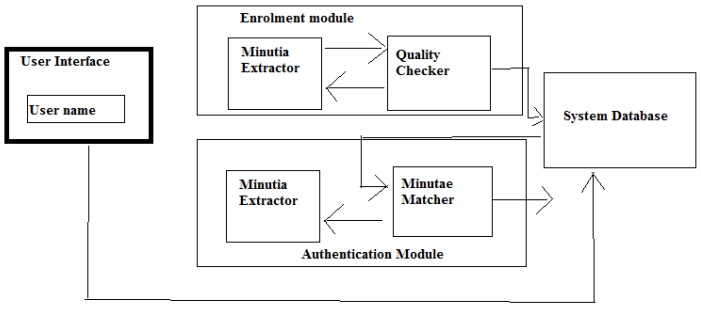

Fig 5: Functionality block Diagram Minutae algorithm

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The figure numbered 4 explains the difference between ridge ending and ridge bifurcation. The figure numbered 5 explains the functionality block diagram of the finger print algorithm used.
The system architecture for automatic identity authentication consists of

I. User interface
II. System database
III. Enrolment module
IV. Authentication module

The system database corresponding to each individual user contains

I. User name of the individual
II. Several minutia patterns of the individual's finger

2.4.1 The minutia extraction

I. Once the individual places the finger for authentication, an image of the fingerprint pattern is captured by the module.
II. The image orientation is then obtained in order to proceed to the next step i.e. minutia extraction.
III. With the orientation in hand the ridge map of the fingerprint pattern is formed.
IV. The ridges give the clear co-ordinates of the minutiae of that particular fingerprint pattern.

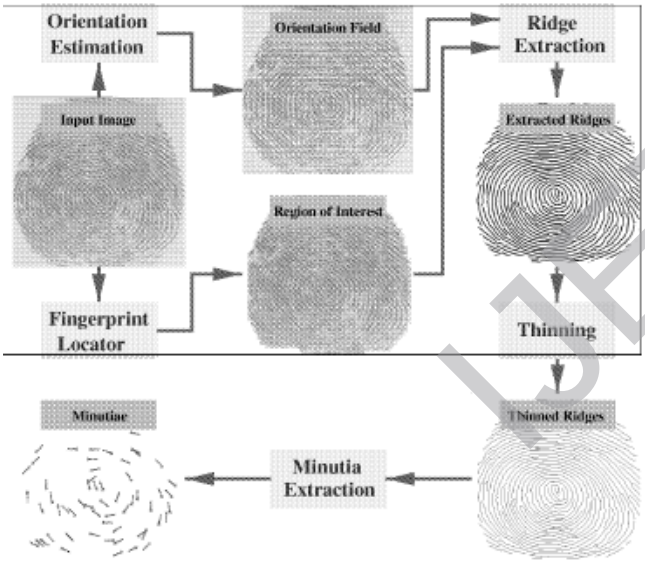


Fig 6: Sequence of images taken for finger print algorithm

III. RESULT

TABLE 2: TABLE EXPLAINING THE MOCK DEMO

E WALLET BALANCE	50.00	30.00	50.00	30.00
ENTRY BUSSTOP	1	3	2	4
EXIT BUSSTOP	3	4	4	2
TARIFF	20.00	10.00	20.00	20.00
E WALLET BALANCE	30.00	20.00	30.00	10.00

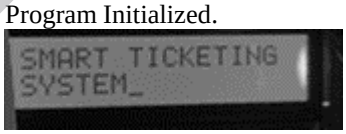
Table 2 is of the test conducted with the prototype.

TABLE 3: TABLE EXPLAINING THE TIME TAKEN FOR THE PROCESS

	Time taken
Process to authenticate the User ID and the finger print sample	5 seconds
Time taken for the message to reach the cell phone	10 seconds

Table 3 shows the time taken for the processes of the system. The prototype was successfully built with the above mentioned trail run as result. The different modules-GSM modules, LCD interface, Fingerprint module, RFID reader were successfully integrated. The sequence of operations are as follows

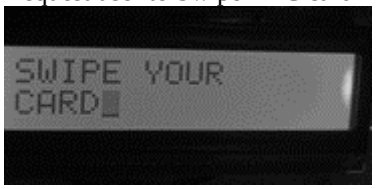
I. Program Initialized.



II. Waiting for GSM acknowledgement.

III. GSM acknowledgement received.

IV. Request user to Swipe NFC card



V. Finger Print verification Request.

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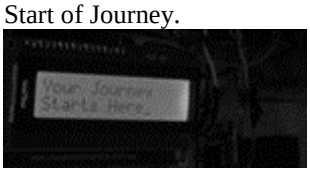
VI. Finding and Comparing Fingerprint Pattern.

VII. User NFC Card and Finger Print Verified.

VIII. Start of Journey.



All the operations of the prototype were received on the cellphone. An the screenshot of the images are as shown below.

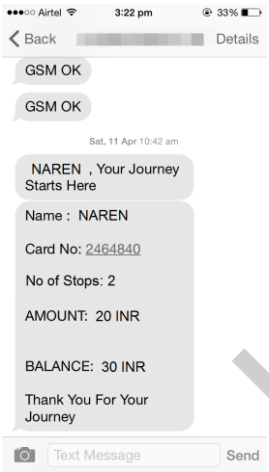


Fig 4: Screenshot of the messages received.

E. CONCLUSIONS AND FUTURE SCOPE

India is country with a population of over 1.27 billion, a major part of it being concentrated in metropolitan cities like Mumbai, Delhi, Bangalore, etc. Recent introduction of Aadhar Card is a means of Unique Identification of every Individual present across the country, but it isn't being replenished to its full potential. The proposed concept in this paper includes a smart Aadhar Card, which contains a NFC chip handling the database of each individual citizen. The database of every individual includes:

I. Unique Individual Identity Number.

II. Finger Pattern of the individual (updated every 5 years).

III. Stop location.

IV. E-wallet.

The entire database is stored in a secure server handled by the Unique Identification Authority of India on behalf of the Government of India. The basic idea is to make an integration of most ritual money transaction, through an E-wallet system.

The Smart Aadhar card which has the potential to become an integral part of day to day activities will eventually become an item which an individual must carry with at all times in order survive the daily ordeal.

The normal facial recognition algorithm with the database of large number of people, would include comparison of the face pattern recorded from the camera to a large number of face patterns to record a match [5]. Since this algorithm includes comparison with only one template face pattern to record a match or mismatch, precious time would be saved.

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