

Smart Implanted NFC-based System to Expedite Medical Treatment

Shubham Deshpande¹, GaurangSuki²,
Mayur Giri³, Revati Ganorkar⁴,
Araddhana Deshmukh⁵
[¹⁻⁴] Student, ⁵Ass. Professor,
Dept. of Computer Engineering,
SKNCOE, Pune, India,
shubhamdeshpande123@gmail.com,
gaurang210498@gmail.com,
mgiri6612@gmail.com
revatisganorkar@gmail.com
aadeshmukh@sinhgad.edu

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Abstract

During emergency many times doctor requires patients medical history before initiating any treatment. It is tedious to carry medical record all the time. At times it's impossible, hence to overcome this problem we have proposed a NFC based system which consists of chip implanted in patients body. This chip will contain patients details such as his name, address, blood group, medical history, allergies and other details which will be prioritized as primary and secondary data. Primary data can be availed on the NFC chip itself and secondary data will be present on cloud in case its necessary. By scanning implanted chip,doctor can easily obtain all the details of the patient. It will reduce the doctors time for carrying out tests before treatment. Thus, this model will pace up the actual treatment.

Key Words:NFC implanted chip, Medical Records, Treatment.

1 Introduction

Near Field Communication (NFC) has proved to be one of the most dominant technologies for low range communication. It is a wireless communication technology which allows reliable and high-speed data transfer when devices are in close range. It is based on RFID technology and uses magnetic field induction. NFC provides a reliable data transfer and hence can be used for secure contactless transactions and allows two devices to communicate just by touching the devices. NFC works at 13.56MHz frequency band and can operate at a distance around 20 cm although its optimal operating distance is around 4 cm. [18]

NFC can operate in three modes namely Peer to Peer, Card Emulation and Read and Write mode. For the communication between two device using NFC, one device must have an NFC reader/writer and other must have an NFC tag. The tag is IC which contains data which can be read and written.

NFC supports wide range of applications in our quotidian life which includes using NFC as a payment option so we dont have to provide our credit or debit card details and also NFC can act as our bus or train ticket all we need to do is swipe our device when we are boarding and swipe again when we hop off .Sharing of data between devices can be done in no time.Other uses of NFC comprises of splitting bills , health care , using NFC as ID cards and many more.Imagine using NFC to store our passwords which will eliminate the tumultuous job of recalling passwords for different accounts and websites.[18] Previously there was an attempt to use RFID tag in tracking medical history. But it wasn't enough because of several factors such as security, low storage capacity, need of RFID tag reader etc.NFC eliminates many of these factors which can be beneficial in applications such as medical history retrieval.

2 LITERATURE SURVEY

Previous Work-

Ref no	Concepts proposed or implemented in paper	Protocols used
[1]	The system proposed NFC card for secure pairing between a device and a reader, which allows a doctor's reader to share a key with a medical device within a very short distance. The doctor's device requests the patient to press a button to confirm pairing so that they can securely communicate with each other.	NFC
[2]	The system used SHA algorithm to generate an ID for patient. The Patient's medical information will be stored on a server. The health records of that person will be accessed through their NFC tags. The tests taken and prescriptions will also get updated on NFC tag.	NFC tags
[3]	This paper proposed a health monitoring system where users are identified by NFC-enabled device and different health information collected about the patient can be wirelessly monitored by the professional. The health data is automatically uploaded and can be accessed in future.	NFC
[4]	The authors addressed the limitations of RFID like high cost, lifetime of active RFID, communication range limitation and ability to identify multiple tags. They performed an experiment which concluded RFID gave error in readings after a certain distance.	RFID
[5]	The system consists of small dipole antennas based RFID tag surrounded by a silica glass to reduce the effects of radiation on the human body and the antenna was implanted in the human upper arm of between the skin and fat layer. The antenna was simulated in free space environment and then in human arm which resulted in a decrease in resonance frequency.	RFID
[6]	The paper proposed a system which uses NFC to pair devices and bluetooth to transfer data from health care to patient's smart phone and vice versa. The system consisted of 4 modules viz Data Encryption, Authentication, Device Pairing, Data Decryption. The Authors also created an android application using AES/Advanced Encryption Standard algorithm for encryption and decryption of data.	NFC and Bluetooth
[7]	A system is proposed for five right medication administration. Each patient and medication is tagged with NFC chip. Nurse scans these NFC chips to check all five tests.	NFC
[8]	Passive RFID tags can be used in trauma resuscitation. In this system patient, doctors, all objects in the room are tagged with RFID chips. Floor-facing and ceiling-mounted antennas are used for task analysis, movement detection and content analysis.	RFID
[9]	RFID wristbands can be used to identify patient and tag equipped plastic cards can be used to locate equipments. GUI application allows updation and easy lookup of patient's data. Wireless APs are used all over the hospital for easy access of internet. Security is achieved in this system through encryption. Tablet which is carried by hospital staff must have USB interfacing capability for scanning RFID tags.	RFID
[10]	A system is implemented with 3 NFC modes. NFC tags, NFC P2P mode, NFC card emulation mode. MIFARE NFC tags are used in this system which have 1024 bytes of on-chip storage. Large records are transferred with bluetooth because NFC could be slow while transferring large records. Hybrid cloud is used for storage of all records. Public Key Infrastructure (PKI) is used as security framework.	NFC and Bluetooth
[11]	A architecture is proposed for NFC based system for health monitoring. It consists of NFC read/write device, PC/laptop, database server and home care unit. All patient details, consulting doctor, medical history, real time sensor data are stored in database. Data from Wireless sensors will update the database which can be viewed by doctor. NFC tag is used as unique identification for patient. This system for health monitoring will help to ease patients admission in hospital, prescriptions and comments from doctor and health details of patient monitored using different sensors.	NFC and different sensors for monitoring the health
[12]	This system proposed the use of NFC based card which will store patient's name, contact no, family doctor information, blood group, allergies, surgeries done and link to online database.	NFC
[13]	A System composed of wrist band and mifare card. Prescription and patients info will be stored in wrist band while Card will store CT scan and X ray reports.	NFC
[14]	This system will help to understand patients medical condition in critical cases if patient will be at remote location. Available doctor can contact and can use database from previous doctor.	NFC
[15]	This system uses NFC tags, database and Server. For security purpose it uses two step authentication and access control protocols. In two step authentication it uses pin code and pattern matching.	NFC
[16]	This paper contain three systems-Object identification system using NFC tag, e-healthcare for patients and ehealth card based system for peer to peer communication.	NFC

Operating Modes of NFC-

In NFC standard there are three separate modes of operation which depends on the type of information.

Peer to peer mode: In this mode, two NFC devices can communicate in both directions, for instance exchange of data between two smartphones using NFC. During transmission, the device that sends acts as active device while device that receives data act as passive device.

Read/write mode: This mode allows to read and write the data on the tag. Tag consists of labels. It is widely used.

Card emulation mode: In this mode, NFC is used as smart contactless card which can be used for making payments at stores and railway stations.

Advantages of NFC over other (Bluetooth, RFID)-

NFC does not require pairing like Bluetooth to initiate data transfer. This reduces significant amount of overhead. [17]

NFC transfers data at low data speeds (106 kbps - 424 kbps). Hence, consumes less power.

Both connected devices can communicate in bidirectional manner i.e. both devices can send and receive data simultaneously.

Easy to use, Small - NFC tags are compact and small.

NFC is used for short range communication, hence there is no interferences of more than one chip. [17]

As, the chip can only be accessed within short range, there is no risk of information stealing from unauthorized person.

NFC is comparatively secure. The security of NFC is implemented at the hardware chip layer and protocol layer whereas in Bluetooth the security is implemented only in the protocol level.

Gap Analysis-

The major concern in usage of RFID is its security. RFID tags have a range up to 12 metres, so it poses a security threat. Data stored in RFID tags may be sensitive. As RFID tag has long range of transmission, information stored can be easily accessed and modified by unauthorized person. Security of tags must be maintained. Patient needs to carry RFID and NFC cards/tags along with them while visiting hospital but many times it becomes tedious to carry these tags along. RFID and NFC tags can get affected because of external environment which may result to corruption of data in the NFC tag. Many times, two or more tags are read together which results in gambled data. During emergent medical conditions, it becomes difficult to get patient's past medical record for further treatment. Carrying medical files along all the time is not feasible solution. Person may be unconscious and alone sometimes, so getting the personal details becomes difficult. RFID cards or tags can store up to 2KB of information on them. Many times, it becomes difficult to write data of large size. Here, less memory storage is the main challenge while using RFID in system. Systems based on RFID requires special RFID reader to read/scan the information on the tag. Hence it becomes necessary to have expensive RFID reader.

After the survey, we came to conclusion that there should be an efficient system for medical history/data retrieval.

In this paper we have tried to cover this gap of earlier system by proposing an efficient NFC implanted system.

3 Proposed model

System overview

Our proposed system consists of implanted NFC chip which will be implanted in patients body, Smartphone Application which is used to write data on cloud and NFC tag. Patients Data will be classified into 2 types: 1) Primary data, 2) Secondary data. This data is classified based on the emergency requirement. Primary data includes data which is most important for medical staff in emergency situations to treat the patient. This data is stored on the chip for quick access. Secondary data can be considered as petty but can be used by doctors for detailed reports. Later, this data is stored on the cloud and can be retrieved by the doctor as and when it is needed. Primary data will contain one attribute called Link. Using this attribute doctor will be redirected to the page where all the data which consists of primary and secondary data from cloud is displayed. Primary data includes patients name, blood group, medical records, allergies, operations and a cloud link which will provide doctors with other secondary details like Address, emergency contacts, patients doctor details, medical history in plain text format.

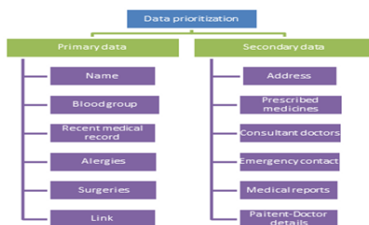


Fig 1: NFC implanted chip- Data Prioritization

When Patient is admitted to a hospital, doctor can simply scan the NFC implanted chip present in patients body and get his/her medical details instantly. Thus, it reduces the time taken by doctor to begin the treatment. Also, various issues with the traditional file system such as misinformation, misinterpretation of prescribed medicines can be reduced.

To prevent the radiations of human body from damaging the implanted NFC chip, the chip will be encapsulated in a glass capsule before implanting. Glass capsule will allow the sensor information to pass through it but will block the radiations from body and thereby increasing the reliability of the chip.



Fig 2 - Our Proposed System

This system is proposed as an android application to enable the doctors to manage patients medical record using smartphones. The model consists of 3 main parts:

- 1)NFC readers - A smartphone to read information from NFC tag.
- 2)NFC implanted chip - NFC chip will be implanted in patient which will store medical details.
- 3)Database - It will contain the patients entire details.

Mathematical model

According to the proposed model , data are represented in a key-value pair as

$$(K_1, V_1), (K_2, V_2), (K_3, V_3), \dots, (K_n, V_n)$$

After certain check-ups and tests conducted from the doctor , this data will be expanded as $(K_1, \{V_{11}, V_{12}, V_{13}, \dots, V_{1m}\})$

$$(K_2, \{V_{21}, V_{22}, V_{23}, \dots, V_{2m}\})$$

⋮

$$(K_n, \{V_{n1}, V_{n2}, V_{n3}, \dots, V_{nm}\})$$

The problem is to select only those data items which have abruptly changed over time.

To solve this problem , lets only consider 1st key and value set.

$$(K_1, \{V_{11}, V_{12}, V_{13}, \dots, V_{1m}\})$$

$$V_1 = \{V_{11}, V_{12}, V_{13}, \dots, V_{1m}\}$$

Find out the mean of values as

$$\bar{V}_1 = \sum_{i=1}^m V_{1i}$$

Calculate standard deviation as

$$\sigma = \sqrt{\frac{\sum_{i=1}^m (V_{1i} - \bar{V}_1)^2}{m}}$$

Find out Coefficient of Variance (CV) as

$$CV = \frac{\sigma}{\bar{V}_1}$$

Considering the medical attributes , slight change in value may also mean huge change in patients overall health , the boundary value is selected as 0.05.

There are 2 cases for CV:-

1. If $CV < 0.05$ then only recent 3 values can be selected.
2. If $CV > 0.05$ then we need to decide which values should be selected.

Find out absolute differences

$$d(i) = abs(V_{i+1} - V_i)$$

where,

i varies from 1 to m-1

Let D be set of differences such that

$$D = \{d_1, d_2, d_3, \dots, d_{m-1}\}$$

Divide each item in the set D by Dmax and let this set be D

Find out the position of items with values greater than 0.5 from

D

If i is the position of value greater than 0.5 from set D then select data items which are at position i and i+1 from set V_1 .

Advantages and applications

The application will include adding, deleting and looking up of an asset with security features (integrity check and secure login).

Features in the application will include: Add record, delete record, look-up history, check-in and check-out details, tampering detection, secure login, use of digital signature to detect any modification of tag data with the help of encryption & decryption techniques.



Fig 3Application Overview

Doctor can use system for two-major purpose

1. Fill and Update data of the patient onto the chip:
Doctor can update the information of the Patient onto implanted chip using phone app.
2. Scan the NFC implanted chip to get patients medical records:
Doctor gets access to primary data as well as a link which gets directed to the cloud on which the whole data is stored. The doctor can then update the medical information of the patient which will get reflected automatically onto the chip.

Advantages of our System-

1. Doctor can easily get patients details by scanning NFC implanted chip in patients hand.
2. Secure data transmission.
3. Due to data prioritization, necessary data can be availed within no time.
4. A smartphone enabled with NFC can be used to scan NFC chip. So, no need to carry special readers.
5. Secondary Data will be stored on cloud.
6. Faster treatment process during emergencies: During emergency, doctors can obtain information by scanning chip which results in fast treatment process.
7. Easy to maintain and use.
8. No Prior connections are required like Bluetooth.

4 FUTURE SCOPE

Despite this system solves many problems, there are still some issues yet to be resolved.

Security is a major concern as someone can try to change the data on the chip with malicious intent. So, a data encryption algorithm can be used to make the data in the chip more secure.

Further NFC chips can be designed with more data storage so that all the data can be stored in the chip itself and the use of cloud can be eliminated. There must be some security measure which allows only authorized person to access the data after the patient is dead. This must be done to avoid misuse of the patients data.

5 CONCLUSION

In this paper, we proposed a system containing a NFC chip implanted in human body which can be used to obtain patients medical record. It contains primary data (stored on the chip) and secondary data (stored on cloud). The main benefit of the system is usage of NFC chip instead of RFID which makes the data more secure as NFC has less range when compared to RFID. Major drawback of doing the tedious tasks of paperwork is eliminated because of the portable nature of the system. Implanted NFC chip is a glass capsule which protects the data from getting corrupted due to different elements inside human body and other external threats. Thus, NFC implanted chip in human body proves to be more reliable and efficient as compared to existing systems. Using this chip, treatment process can be carried out briskly without wastage of time. The system suppresses the possibility of fatal damage due to delay in treatment. Also, the factors such as data accuracy can be preserved. The system saves doctors valuable and patients arduous savings.

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