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MEDxSWIFT: NFC Based Medical Card and Application

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Abstract: Near Field Communication (NFC) technology has revolutionized the management and accessibility of crucial medical data through medical health cards. These cards securely store vital health information such as medical histories, allergies, medications, and emergency contacts. By simply tapping the card on an NFC reader, health care providers can quickly access essential patient data, streamlining health care processes and ensuring rapid responses in critical situations. NFC-enabled medical health cards are a promising innovation that enhances health care delivery, patient safety, and the availability of critical medical information. They uphold robust privacy and security standards, ensuring that patient data remains confidential and protected. This technology has the potential to transform the way medical information is managed and accessed, improving efficiency and effectiveness in delivering care.

Keywords: Healthcare technology, Medical data privacy, Medication management, NFC based medical card, Patient identification, Remote patient monitoring, Telehealth services.

I. Introduction

Healthcare is rapidly adopting mobile technology to improve the quality and efficiency of care. NFC-enabled smartphones are becoming increasingly popular for medical applications, such as patient identification, medication management, and secure data exchange. However, NFC is vulnerable to security attacks, such as eavesdropping, man-in-the-middle attacks, and data tampering. Enhanced Encapsulation Security (EES) is a new security protocol that addresses these challenges by providing a secure and reliable channel for transmitting medical data over NFC.

Android-based mobile devices are particularly well-suited for NFC healthcare applications. They are equipped with a tamper-resistant secure element (TEE) that can store sensitive data in a secure manner. Additionally, Android devices support a variety of NFC protocols, making them compatible with a wide range of NFC-enabled medical devices and readers. NFC can play a significant role in improving the efficiency and safety of healthcare workflows. For example, NFC-enabled wristbands can be used to securely identify patients during check-in and throughout their stay at a hospital. This can help to prevent medical errors and ensure that patients receive the correct care. NFC can also be used to improve the management of patients' medications. For example, NFC-enabled pill bottles can be used to track refills and verify dosage instructions. This can help to improve medication adherence and reduce the risk of adverse drug events.

II. Technology

NFC is a short range high frequency wireless technology it allows to exchange data between two devices at the distance of 10 cm operate speed between 106-424 kbps. NFC is based on RFID (Radio Frequency Identification) its frequency speed is 13.56 MHz [1]. It uses the magnetic field induction to enable communication between two electronic devices in close approximate.

NFC works on three Operating modes: i) Reader/Writer mode: In this mode NFC behaves as a reader for NFC tags. It detects a tag immediately in close proximity by using collision avoidance mechanism. An application on NFC device can read data from and write data to the detected tag. ii) Peer to Peer (P2P) mode: It allows two NFC enabled devices to exchange information to each other. iii) Card Emulation mode: In this mode NFC enabled device act as a contact-less smart card. There are different types of NFC tags. NDEF (NFC data exchange format) is a standardized format use for storing data and transporting data across a peer to peer link between two NFC devices. NDEF provides no security against data manipulation, overwrite protection against data manipulation and digital signature records cannot avoid malicious modification of tag. Hence we utilize MIFARE Classic 1 K [2] tags which covers proprietary technologies based upon various levels of the ISO/IEC 14443 Type A and write raw data using NFC-A (ISO 14443-3A). The MIFARE Classic 1K tag offers 1024 bytes of data storage, split into 16 sectors. NFC enabled mobile devices have a secure element (SE) as a tamper-resistant platform capable of securely hosting applications and it includes a cryptographic processor to facilitate to provide secure storage and execution environment. The supported secure element factors can be, for example, UICC, Embedded secure elements. NFC enables such as Micro SD with integrated antenna and SIM-Wrapper. Java Card technology provides a secure platform for applications [3] that run on smart cards and other trusted devices with very limited memory and processing capabilities and provides data encapsulation, firewall and Cryptography. The smart card specification standard ISO/IEC 7816 is related to electronic identification cards with contacts and ISO/IEC 14443 for contact-less integrated circuit cards specify the host application and smart card is done through application protocol data units. In this paper, Section II gives brief idea about the literature review. Section III describes overview of proposed system, Mathematical Model and the algorithm. Section IV gives the system analysis and results and Section V provides Conclusion.

III. Methodologies Used

The sytem proposed by Do Dhanashri H. Gawali and Vijay M. Wadhai "Long Term Health Monitoring using mHealth Platform" [1], This paper explores mHealth's use in healthcare, focusing on long-term monitoring. It highlights its diverse applications, like remote monitoring and SMS medication alerts, addressing challenges and presenting a prototype for ECG monitoring via mobile devices. Overall, it shows how mHealth could transform healthcare access, especially in underserved regions.

The method used by Midhun Kumar Ayyalraj and S. Appavu Alias Balamurugan, "Patient Health Description using NFC-Tag-M-Health" [2], This paper emphasizes the implementation of Near Field Communication (NFC) technology in healthcare systems to enhance patient care. Utilizing NFC tags in mobile devices allows easy access to patient records, improving efficiency and reducing paper usage. The focus lies in leveraging advanced technology like NFC tags to ensure quality healthcare globally, integrating innovative solutions for patient welfare.

The paper proposed by, Ilana Golbin, Anand S. Rao, Ali Hadjarian and Daniel Krittman "Cloud-based NFC Health Card System" [3], Cloud-based NFC

Health Card system enhances healthcare by securely storing and managing medical data on Amazon Cloud. Utilizing encryption algorithms, it protects data from unauthorized access, improving overall security and ensuring patient confidentiality.

The system proposed by Lakshmi Priya Gorlamudiveti and Sagee Geetha Sethu "Development of a Mobile Application for Patient's Medical Record and History" [4], This paper introduces Health Passport, an app for iOS and Android, aimed at effortlessly managing and sharing medical records. It stores vital medical information like reports, medications, and more, enhancing patient engagement and reducing redundancy in tests across facilities. By bridging patients and healthcare providers, it offers accessible, organized health data for better, more informed medical decisions.

The method proposed by Nishant Jain and Gaurav Goel, "Open SOA Health Web Platform for Mobile Medical Apps" [5], This paper discusses an open health platform that hosts mobile medical apps, enabling access to patient data securely. Using service-oriented Architecture (SOA) principles, it orchestrates various medical systems and devices. The platform ensures interoperability between devices and systems by using standardized interfaces and a hybrid cloud setup. The aim is to support healthcare professionals with apps for wound management and ensure compliance with regulatory standards.

The system proposed by Jack G. Conrad, Shirsha Ray Chaudhuri, Shounak Paul and Saptarshi Ghosh "A Mobile Nursing App Applying to the Wound Care and Drug Administration of Patients" [6], The mNurse app revolutionizes nursing practices by integrating wound care and drug administration into a mobile platform. This innovation significantly reduces nurses working time by over 20 minutes per patient during a morning shift. The app streamlines processes, improves documentation, and offers potential for wider application with physician involvement and larger-scale studies.

The method proposed by A Hannan Bin Azhar, "Progressive Web App for Real-time Doctor-Patient Communication and Searchable Health Conditions" [7], This paper dives into a Progressive Web App (PWA) designed for remote healthcare, integrating Vue.js, Django, and WebSockets. It enables real-time patient-doctor interaction, offline access to healthcare info, and secure login. Additionally, it supports searchable health conditions and video/text chat. Future plans might include chatbot integration for personalized information based on patients' chat history.

The system proposed by Sarath Krishnan P. V., Arunima T. K., Hema P. Menon, A. K. Mazumdar, Jyothis K. P. and Davidson Devasiya, "MedApp: An Application for Patient's Personal Medical History Maintenance" [8], This paper introduces a medical history maintenance app facilitating the secure storage and sharing of individuals' healthcare information. The app empowers users to manage medical records, medications, and appointments, while doctors access this data via QR code scanning. Its secure cloud-based storage enhances patient involvement in treatment and ensures accurate records, improving healthcare efficiency.

IV. Overview

NFC-based medical cards embed tiny chips storing vital information like allergies, medications, and emergency contacts. This unlocks exciting possibilities: first responders can access crucial data in emergencies, patients with chronic conditions can share vitals remotely, and medication adherence can be tracked. However, challenges remain. Security and privacy require robust measures, universal standards are needed, and equitable access must be ensured. Integrating with existing systems and educating users are also crucial. Despite these hurdles, NFC-based medical cards hold immense potential to revolutionize healthcare by making patient information more accessible, secure, and readily available when needed.

While NFC-based medical cards, embedded with vital medical information like allergies and medications, offer exciting possibilities like instant access for first responders and remote data sharing for chronic conditions, challenges remain. Robust security measures are crucial to protect sensitive data, and universal standards are needed for smooth integration. Ensuring equitable access across demographics, integrating with existing systems, and educating users are also key hurdles. Despite these, the potential to revolutionize healthcare by making patient information readily available and empowering both individuals and healthcare providers is undeniable. By addressing these challenges collaboratively, we can unlock the true transformative power of NFC-based medical cards.

To assess the validity and performance of NFC technology in healthcare, several key measures can be considered. Firstly, the data transfer speed should be evaluated to ensure it meets the real-time requirements of medical applications. Secondly, the effectiveness of security protocols, such as encryption and authentication, in protecting sensitive medical information during NFC transactions should be assessed. Thirdly, the reliability of NFC communication should be measured to ensure consistent and error-free data transfer, especially in critical healthcare scenarios. Additionally, the compatibility of NFC-enabled devices and systems with existing healthcare infrastructure should be evaluated for seamless integration and data exchange. The usability of NFC technology in healthcare settings, including factors such as ease of use, convenience, and user satisfaction, should also be assessed. Moreover, the cost-effectiveness of implementing NFC technology in healthcare, considering factors such as hardware costs, maintenance, and long-term benefits, should be evaluated. Furthermore, the impact of NFC technology on patient outcomes, such as improved access to medical information, better medication adherence, and overall health management, should be measured. Lastly, the scalability of NFC technology in healthcare, including its ability to handle increasing volumes of medical data and users, should be assessed to ensure its successful implementation and impact on patient care.

V. History of NFC Medical Cards

Near-Field Communication (NFC) began its journey in 2004, born from a collaboration between Nokia, Sony, and Philips. Initially envisioned for contactless payments, it quickly branched out, tackling tasks like access control and mobile gaming. Entering the medical field by 2010, its potential ignited excitement: faster emergency care with instant medical history, streamlined processes, and empowered patients with mobile access to records. Early applications saw NFC-enabled wristbands replacing hospital bracelets, smart pill bottles ensuring medication adherence, and participants sharing clinical trial data seamlessly. Challenges arose around security, standardization, and accessibility, but advancements followed close behind. Enhanced protocols secured data, standardization efforts fostered interoperability, and cost-effective chip solutions improved accessibility. Looking ahead, the future of NFC in healthcare shines bright: telehealth integration, remote patient monitoring, and personalized medicine tailored to individual data stored on NFC cards. With continued strides and collaboration, NFC-based medical cards have the potential to revolutionize healthcare, ensuring everyone receives the right care at the right time.

A. Entering the Medical Field

NFC's foray into healthcare started around 2010, fueled by its potential to address critical challenges:

- *Improved Patient Care:* Instant access to medical history during emergencies could save lives.
- *Enhanced Efficiency:* Streamlining tasks like registration and medication management could save time and resources.
- *Empowered Patients:* Secure mobile access to medical records could grant patients greater control over their health.

B. Early Applications

- *Patient Identification:* NFC-enabled wristbands replaced traditional hospital bracelets, storing critical information and tracking patient location.
- *Medication Management:* Smart pill bottles verified user identity and tracked medication adherence, improving medication safety.

- *Clinical Trials:* Participants shared medical data securely using their NFC cards, streamlining research processes.

C. Challenges and Advancements

- *Security and Privacy:* Protecting sensitive medical data stored on NFC chips was paramount.
- *Standardization:* Lack of universal standards hampered interoperability and widespread adoption.
- *Accessibility:* Ensuring equitable access for all demographics required addressing cost barriers.

D. Despite These Hurdles, Advancements Continued

- *Enhanced Security Protocols*: Encryption and authentication methods became more robust.
- *Standardization Efforts*: Initiatives like the NFC Forum addressed interoperability concerns.
- *Cost-Effective Solutions*: Affordable chip options emerged, improving accessibility.

E. The Future of NFC in Healthcare

Looking ahead, the future of NFC in healthcare remains promising:

- *Telehealth Integration:* Secure patient identification and data access during virtual consultations.
- *Remote Patient Monitoring:* NFC-enabled wearables could send health data directly to healthcare providers.
- *Precision Medicine:* Personalized treatment plans based on individual medical data stored on NFC cards.

With continued advancements and collaboration, NFC-based medical cards have the potential to revolutionize healthcare, ensuring patients receive the right care at the right time, ultimately improving health outcomes for all.

VI. Conclusion

From its humble beginnings in 2004 as a contactless payment solution, NFC has embarked on a remarkable journey into the realm of healthcare. Its potential to revolutionize patient care by offering instant access to critical medical information, streamlining processes, and empowering patients with control over their health data was quickly recognized. Early applications like NFC-enabled wristbands and smart pill bottles laid the groundwork, but challenges around security, standardization, and accessibility needed to be addressed.

However, the last decade has witnessed significant progress. Advancements in security protocols, standardization efforts, and cost-effective chip solutions have paved the way for wider adoption. The future of NFC in healthcare is brimming with possibilities: seamless integration with telehealth and remote monitoring, personalized medicine based on individual data, and improved medication verification. By addressing remaining challenges and fostering collaboration, NFC-based medical cards hold the potential to unlock a new era of personalized, efficient, and accessible healthcare for all. As we move forward, the impact of NFC on the medical landscape is sure to be substantial, shaping the way we receive and manage our health for years to come.

VII. Future Works

The future of Near Field Communication (NFC) in the medical field holds significant promise, encompassing a range of transformative possibilities. One such potential lies in the realm of personalized medicine, where the integration of NFC with genetic and health data could pave the way for tailored treatment plans. Envision a scenario where medications are intricately designed based on an individual's unique genetic makeup, with secure NFC verification ensuring precise delivery.

Another area of profound impact is advanced remote monitoring, wherein wearable NFC sensors continuously track vital signs and securely transmit real-time data to healthcare providers. This innovation could revolutionize the management of chronic diseases, facilitating early intervention and enhancing overall patient outcomes.

Furthermore, the application of NFC in enhancing telehealth services is noteworthy. Secure NFC identification and data access during virtual consultations could streamline remote care, making it more accessible and efficient. The prospect of seamlessly sharing medical records and test results with healthcare professionals through a simple tap of an NFC card illustrates the potential for improved healthcare delivery.

Medication security and adherence present another frontier for NFC. Smart packaging, enabled by NFC, could prevent medication errors by verifying patient identity and dispensing the correct dosage at the right time. This not only enhances patient safety but also contributes to more effective healthcare management. In the realm of futuristic technology, Brain-Computer Interfaces (BCIs) emerge as a nascent yet intriguing domain. Some experts foresee NFC playing a role in BCIs, facilitating secure and seamless communication between the brain and external devices.

As these possibilities unfold, addressing challenges such as standardization and privacy becomes paramount. Continued research, collaborative efforts, and a commitment to ethical and responsible use are essential for unlocking the full potential of NFC in healthcare. The future holds even more innovative and life-changing applications, promising a positive impact on the health and well-being of individuals across diverse healthcare settings.

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