

A Research Paper on Enhancing medical data privacy and security in wireless network via smart card and QR code

Krushna Paygude¹, Vaishnavi Nikam², Soham Chile³, Tanishka Poman⁴, Prof. Ankita.B.

¹Member, Trinity Polytechnic Pune ²Member, Trinity Polytechnic Pune ³Member, Trinity Polytechnic Pune

Abstract- In recent years, hospitals have generated a lot of paperwork for patient records. Despite using the same personal information, there hasn't been an effective way to reduce this paperwork. The rise of mobile web technology offers new opportunities for the medical industry.

This paper introduces a QR code and RFID card - based e-health authentication system that allows for easy and secure access to patient health records in local hospitals while reducing unnecessary paperwork. One goal of this project is to use data and machine learning to predict diseases based on patient symptoms.

When a patient provides their symptoms, a QR code RFID card is created that includes their predicted disease and personal information, which is then sent to the doctor via email. After examining the patient, the doctor generates a prescription in the form of another QR code RFID card, which the patient can take to the pharmacy to be scanned. This integrated system is designed for healthcare personnel and works on all handheld devices. We believe that our proposed system will improve efficiency, save time and costs for patients, hospitals, and doctors, and protect patients' personal information

Index Term-Health care ,RFID card and QR code

I. INTRODUCTION

Medical data is constantly growing, with hospitals generating a lot of patient records in paper form. We aim to create a healthcare portal system that makes managing this information easier and more convenient by using QR codes and RFID card for patient details.

Our system will include features like clinical management, patient records, disease prediction, and the ability to generate a QR code and RFID card for each patient based on their updated health information. We will use the KNN algorithm to predict diseases and the Apriori algorithm to provide doctor recommendations.

Keeping track of all these records can be very error-prone, inefficient, and time-consuming for hospital staff. Relying on paper records is also unreliable and not cost-effective. Our main goal is to reduce paper

use by up to 90% and to automate the existing system in a low-cost and reliable way.

QR codes are becoming very common, and using them is a great way to connect patients to the internet through their mobile phones. The patient's personal health information and predicted disease will be automatically sent to the doctor as a QR and RFID cardcode. The doctor can then scan this QR code and RFID card with their smartphone to prescribe medication, which will be sent back to the patient as another QR code and RFID card .

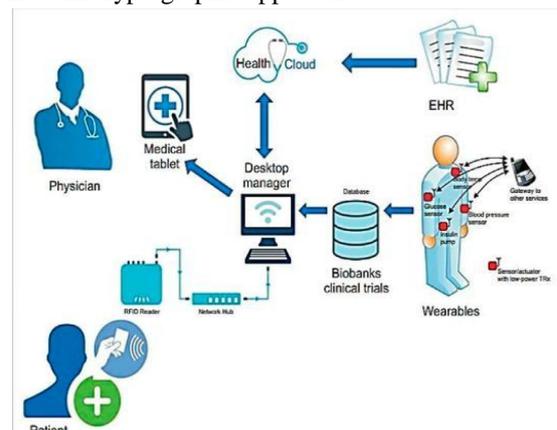
The pharmacist will then scan this code to dispense the medication.

II. APPROACHES FOR IMAGE STEGANOGRAPHY

Image steganography techniques can be broadly classified into two main categories: traditional methods and modern approaches.

Both aim to embed hidden information securely within digital images, but their methodologies, effectiveness, and robustness

Enhancing the privacy and security of medical data in wireless networks is critical due to the sensitive nature of health information. Various techniques can be employed, including the use of smart cards, QR codes, and RFID cards. These methods can be categorized into traditional security measures and modern cryptographic approaches.



Traditional Techniques: Traditional security methods often involve basic encryption and access control mechanisms to protect medical data during transmission and storage.

1.1 Encryption Techniques

Encryption is a fundamental method for securing medical data. It involves converting readable data into an encoded format that can only be accessed by authorized users. Common encryption algorithms include:

AES (Advanced Encryption Standard): A symmetric encryption algorithm widely used for securing sensitive data, including medical records.

RSA (Rivest-Shamir-Adleman): An asymmetric encryption algorithm that allows secure data transmission by using a pair of keys (public and private).

Strengths:

Provides a strong layer of security for data in transit and at rest.

Ensures that only authorized personnel can access sensitive information.

Limitations:

Requires proper key management to prevent unauthorized access.

Can introduce latency in data transmission due to encryption and decryption processes.

1.2 Access Control Mechanisms

Access control ensures that only authorized users can access medical data. This can be implemented through:

Role-Based Access Control (RBAC): Users are granted access based on their roles within the healthcare organization.

Multi-Factor Authentication (MFA): Requires users to provide multiple forms of verification before accessing sensitive data.

Strengths:

Reduces the risk of unauthorized access to medical data.

Enhances accountability by tracking user access.

Limitations:

Can be complex to implement and manage, especially

in large organizations.

May lead to user frustration if access is overly restricted.

2. Modern Cryptographic Approaches

Modern approaches leverage advanced technologies such as smart cards, QR codes, and RFID cards to enhance data privacy and security.

2.1 Smart Card Authentication

Smart cards are physical devices that store encrypted data and can be used for secure authentication. In healthcare, smart cards can be issued to patients and healthcare providers to:

Store personal health information securely.
Authenticate users accessing medical data in wireless networks.

Strengths:

Provides a secure and portable method for storing sensitive information.

Reduces the risk of data breaches by requiring physical possession of the card for access.

Limitations:

Requires infrastructure for smart card issuance and management.

Potential for loss or theft of the card, which could compromise security if not properly managed.

2.2 QR Code-Based Access Control

QR codes can be used to facilitate secure access to medical data. They can encode information such as patient IDs or access tokens, allowing for:

Quick and easy access to medical records by scanning the QR code with a mobile device.

Integration with smart card systems for enhanced security.

Strengths:

Easy to implement and use, providing a user-friendly experience.

Can be dynamically generated for temporary access, enhancing security.

Limitations:

QR codes can be easily copied or scanned by unauthorized users if not properly secured.

Requires a reliable method for verifying the authenticity of the QR code.

2.3 RFID Card Technology

RFID (Radio-Frequency Identification) cards can be used for secure identification and access control in healthcare settings. RFID technology allows for: Contactless access to medical records and facilities. Real-time tracking of medical equipment and patient information.

Strengths:

Enables quick and efficient access to medical data without physical contact.
Can enhance inventory management and patient tracking in healthcare facilities.

Limitations:

RFID systems can be vulnerable to eavesdropping and unauthorized scanning if not properly secured.
Requires infrastructure for RFID readers and management systems.

2.4 Secure Communication Protocols

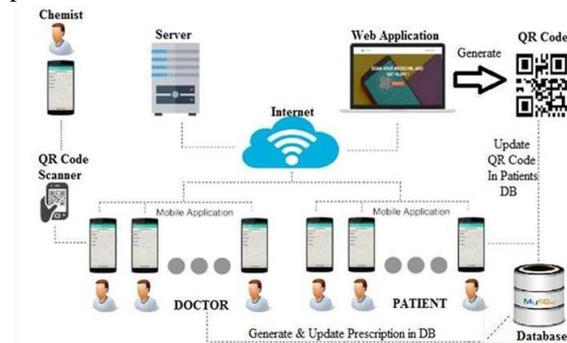
Implementing secure communication protocols, such as SSL/TLS, ensures that data transmitted over wireless networks is encrypted and secure. This is essential for protecting medical data during transmission.

Strengths:

Provides a robust layer of security for data in transit.
Helps prevent eavesdropping and man-in-the-middle attacks.

Limitations:

Requires proper configuration and management to be effective.
Can introduce overhead, affecting network performance.



III. LITERATURE SURVEY

1. Interaction with Medical Data Using QR Codes

Authors: Krzysztof Czuszynski, Jacek Ruminski
Highlights: This paper discusses the application of QR codes for exchanging laboratory results. It

proposes a secure method for data exchange between patients and laboratories, as well as between Electronic Health Records (EHR) and patients.
Limitations: The interaction between healthcare professionals and patients could be improved. Currently, physicians can receive a file containing a complete set of test results from the patient, but there is no mechanism for them to comment on these results in response.

2. Amplification of Hospital Healthcare and Data Management Using QR Codes

Authors: Paschou Mersini, Evangelos Sakkopoulos, Athanasios Tsakalidis

Highlights: This work describes an integrated system designed for healthcare personnel within medical facilities. The system is compatible with smartphones, tablets, and other handheld devices. Its primary goal is to assist doctors, nurses, and other staff, even in areas without network connectivity, using standard smartphones.

Limitations: The system does not currently implement features for disease prediction or medicine prescriptions by specific doctors..

3. Barcode Readers Using the Camera Device in Mobile Phones

Authors: Eisaku Ohbuchi, Hiroshi Hanaizumi, Lim Ah Hock

Highlights: This paper presents new algorithms and methods for recognizing EAN and QR barcodes using the camera on mobile phones.

Limitations: The method for deciding the threshold for barcode recognition will need to be developed based on a model of the camera device.

4. Design and Implementation of Doctor-Patient Interaction System Based on Android

Authors: Ran Wei, Zhimin Yang

Highlights: This paper discusses a doctor-patient interaction system designed for Android devices. It allows patients to access hospital servers to get advice about their symptoms and communicate with doctors using their mobile phones. Doctors can also monitor patients and make diagnoses based on data collected from mobile devices.

Limitations: The system has some issues, particularly in the monitoring module. If the objects in the camera view change significantly, the amount of data being processed increases quickly, which can reduce the system's efficiency

5. Secure Transmission of Medical Data for Pervasive Healthcare System Using Android

Authors: Sudha G. and Ganesan R.

Highlights: This paper discusses a system designed to access medical multimedia data for patients while they are on the move. Since mobile devices have limited memory, the system uses a MySQL database on a server to securely access larger amounts of data. The connection is established through a server program that ensures authentication and security when accessing the database. Limitations: The mobile application needs to be context-aware and adaptable, and efforts should be made to reduce delays in data access.

6. Planning and Development of an Electronic Health Record Client Based on the Android Platform

Authors: Dimitris Tychalas and Athanasios Kakarountas

Highlights: This work presents a client system that operates on Android devices and connects to a centralized database provided by hospitals or clinics to acquire electronic health record (EHR) data.

Limitations: A network manager is required; if any part of the network fails, it can cause significant disruptions in accessing the data.

7. Data Hiding Using LSB with QR Code Data Pattern Image

Authors: D. Antony Praveen Kumar, M. Baskaran, J. Jocin, Mr. G. Diju Daniel

Highlights: This paper focuses on improving steganography techniques by using QR code data pattern images and the Least Significant Bit (LSB) method. It includes advanced techniques for embedding and extracting message information through code pattern styles, block segmentation, and classification.

Limitations: The research could be expanded by analyzing the steganography processes of other tools. Additionally, it is important to identify the maximum amount of data that can be hidden in an image using a specific steganographic tool. challenge, limiting the practical application of deep learning-based steganography.

8. A Health Management Application with QR- Code Input and Rule Inference

Authors: Hui-Huang Hsu, Min-Ho Chang, Neil Y. Yen

Highlights: This paper proposes using QR codes as a way to record daily food intake. QR codes containing

calorie and nutrition information can be attached to food packages, restaurant menus, recipes, or dishes. Additionally, a dietary recommendation expert system is developed to analyze the recorded nutrition data.

Limitations: The system does not include features for doctor suggestions, medicine prescriptions, or feedback.

9. FASE: Fast Authentication System for E-health

Authors: Mungyu Bae, Suk Kyu Lee, Seungho Yoo, Hwangnam Kim

Highlights: This paper presents a QR code authentication scheme for e-health that helps patients avoid the redundant process of filling out paper forms when visiting a hospital for diagnosis. It also allows local hospitals to manage patient personal information more cost-effectively.

Limitations: The system does not predict diseases, so patients must inform doctors about their symptoms each time

10. Study of Machine Learning Algorithms for Special Disease Prediction Using Principal Component Analysis

Authors: Mr. Mahale Kishor M, Prof. Dhomse Kanchan B

Highlights: This paper explores the use of Support Vector Machine (SVM), Naive Bayes, and Decision Tree algorithms for predicting heart disease, applying Principal Component Analysis (PCA) to reduce the number of attributes in the dataset. The study finds that SVM outperforms the other algorithms after dataset reduction. The main goal is to predict diabetes using the WEKA data mining tool, with algorithm accuracy analyzed through WEKA.

Limitations: The disease prediction is limited to heart disease and diabetes, and the system does not provide doctor suggestions for treatment.

11. Research and Practice of Digital Fingerprinting Encryption Algorithm Based on QR Code

Authors: Xu Guo-Juan Zhang, SA1 Xu

Highlights: This paper introduces a new digital fingerprinting encryption algorithm based on QR codes. Experiments show that this algorithm is effective against conspiracy attacks and can trace users involved in such attacks.

Limitations: The algorithm does not include any disease prediction capabilities. architecture increases computational complexity, making it resource-intensive. Additionally, optimizing the model for

different steganographic algorithms remains a key challenge.

12. Robust and Fast Decoding of High-Capacity Color QR Codes for Mobile Applications

Authors: Zhibo Yang, Huanle Xu, Jianyuan Deng, Chen Change Loy, Wing Cheong Lau

Highlights: This paper proposes two methods that address different types of chromatic distortion, including cross-channel color interference and illumination variation, as well as a newly identified issue called cross-module color interference, specifically for high-density color QR codes.

Limitations: Future work will focus on developing a new mechanism for error correction that shares correction capacity across layers, rather than correcting them layer by layer, to enhance the robustness of the color QR code system.

13. Applying QR Code and Mobile Application to Improve Service Process in Thai Hospital

Authors: Chayakrit Charoensiriwath, Navaporn Surasvadi, Suporn Pongnumkul, Thunyasit Pholprasit

Highlights: A low-cost system was developed and tested in a public hospital with a limited budget. This system used QR codes and a smartphone application to capture current hospital processes and the time spent on various activities. Two algorithms were created to identify peak congestion times and bottleneck activities, and the results were implemented in the hospital.

Limitations: The study could infer user interface accessibility from usage statistics.

14. ScanMed: A Mobile Medicine Adherence Application With Intake Validation Using QR Code

Authors: Rizal Mohd Nor, Noor Azizah Mohamad Ali, Khairul Azmi, Ahmad Marzuki, Leilanie Mohd Nor, Mohar Yusof

Highlights: This paper proposes a mobile health medication adherence system called ScanMed, designed to help both government and private hospitals in Malaysia address medication adherence issues. The prototype is based on the Android platform and uses a camera to scan QR codes on medication labels.

Limitations: The system does not have the capability to store patients' previous medical histories.

15. Wireless Body Area Network and Healthcare Monitoring System

Authors: Lamia CHAARI FOURATI

This paper focuses on Wireless Body Area Networks (WBAN) and their applications in healthcare monitoring systems (HMS). It discusses emerging wireless technologies, supporting infrastructure, and design challenges related to WBAN, including physical (PHY), medium access control (MAC), routing layers, security, mobility, and patient localization.

Limitations: HMS faces several challenges, including the need for proactive monitoring, real-time feedback, and ensuring high levels of security, privacy, and confidentiality.

16. Efficient Heart Disease Prediction System Using Decision Tree

Authors: Purushottam, Prof. (Dr.) Kanak Saxena, Richa Sharma

Highlights: This paper presents a system designed to efficiently discover rules for predicting patients' risk levels based on their health parameters. The rules can be prioritized according to user requirements, and the system's performance is evaluated based on classification accuracy, showing good potential for accurately predicting heart disease risk levels.

Limitations: The study focuses on extracting risk levels from a heart disease database, which contains clinical screening data. The database is pre-processed to enhance the efficiency of the mining process.

17. An Improved Method for Disease Prediction Using Fuzzy Approach

Authors: Naganna Chetty, Kunwar Singh Vaisla, Nagamma Pati

Highlights: This paper describes a two-step approach for disease prediction. The first method uses a fuzzy c-means clustering algorithm for data clustering, followed by classification using K-Nearest Neighbors (KNN). The second method also employs fuzzy c-means clustering, but uses fuzzy KNN for classification. The methods are tested on PIMA diabetes and liver disorder datasets.

Limitations: Future work could focus on tuning the model to improve its robustness for use with other datasets.

18. Robust and Efficient Use of RFID Cards in Secure Applications

Authors: MA Baballe

Highlights: This paper discusses the implementation and advantages of Radio-Frequency Identification (RFID) cards in various secure applications, including healthcare, access control, and inventory management. RFID technology enables contactless

identification and data exchange, allowing for efficient tracking and management of assets and personnel. The paper highlights the benefits of RFID cards, such as their ability to enhance security, streamline processes, and improve data accuracy in real-time applications.

Limitations: The study notes potential vulnerabilities associated with RFID technology, including risks of eavesdropping and unauthorized scanning. Future work will focus on developing advanced encryption methods and security protocols to mitigate these risks and enhance the overall security of RFID systems.

19. Diabetes Disease Prediction Using Data Mining
 Authors: Deeraj Shetty, Kishor Rit, Sohail Shaikh, Nikita Patil

Highlights: This paper focuses on developing an Intelligent Diabetes Disease Prediction System that analyzes diabetes using a database of diabetes patients. The system proposes the use of algorithms such as Bayesian and K-Nearest Neighbors (KNN) to analyze various attributes related to diabetes for predicting the disease.

Limitations: The proposed system has several areas for potential improvement, including:

Increasing the accuracy of the algorithms. Enhancing the algorithms to improve the system's efficiency and performance.

Exploring additional attributes to better address diabetes. Developing the system into a comprehensive healthcare diagnosis tool for use in hospitals.

Handles the flow of data between the RFID module, Firebase, and LCD.

Authenticates with Firebase using API credentials and manages database operations.

Implements scrolling functionality for lengthy data fields.

Firestore Realtime Database:

Serves as the secure storage for user details. Processes database queries to retrieve and update user records.

3. Communication Layer

Wi-Fi (ESP32/ESP8266):

Establishes a wireless connection to enable real-time data exchange between the microcontroller and Firebase.

Firestore Token Management:

Ensures encrypted and secure communication with the Firestore Realtime Database.

4. Output Layer

Liquid Crystal Display (LCD):

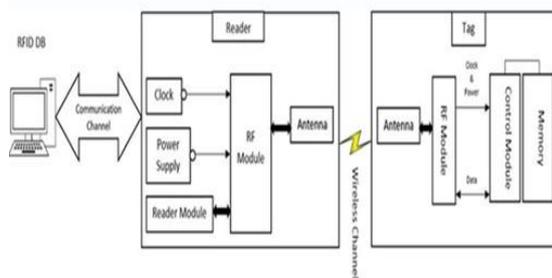
Displays user data, including UID, name, age, and description.

Implements a scrolling feature for displaying lengthy information.

5. Flutter App Interface:

Provides a remote view and management of medical data stored in Firestore.

IV. SYSTEM ARCHITECTURE



1. Input Layer

RFID Module (MFRC522): Scans and reads unique IDs from RFID cards to identify users.

Push Button: Provides a tactile interface for user actions like confirming or progressing through the displayed data.

2. Processing Layer

ESP32/ESP8266 Microcontroller:

V. END-TO-END PROCESS FLOW

1. Setup Phase

Wi-Fi Connection: Establishes connection to the Wi-Fi network and logs the IP address.

Firestore Initialization: Authenticates the system with Firestore and prepares for database operations.

LCD and RFID Setup: Initializes the LCD for data display and configures the RFID module for scanning cards.

2. Main Loop

Card Detection:

Continuously scans for RFID cards.

When a card is detected, its UID is displayed on the LCD and serial monitor.

Data Retrieval:

Constructs the database path using the detected UID. Fetches user information (e.g., name, age, and medical description) from Firestore.

Displays retrieved information on the LCD and logs it in the serial monitor.

3. User Interaction:

The push button allows the user to scroll through displayed data fields sequentially.

4. Error Handling:

Displays error messages if the UID is not found in Firebase.

5. Scrollable Data:

Implements a scrolling mechanism for lengthy data fields (e.g., medical descriptions)

VI. CONCLUSION

We have created a healthcare system for hospitals that uses two main techniques: the Apriori algorithm and KNN algorithm. Each patient gets a QR code generated using the LSB method. QR codes are a simple and effective way to share information, especially for people using mobile devices.

With our system, patients can avoid the hassle of filling out paper forms when visiting the hospital for check-ups, and doctors can manage patient information more efficiently.

We also developed user-friendly ways to improve the security of authentication processes. We created two protocols that enhance the user experience and protect against threats like keyloggers.

We believe our method can serve as a secure way for patients to communicate with the e-health system. In the future, we plan to further develop our security measures and test the e-health system in real-world settings.

VII. FUTURE SCOPE

Enhancements:

We plan to improve our system by adding blockchain technology for extra security. Future versions could also use encrypted QR codes and advanced biometric methods, like fingerprint or facial recognition, to make access even more secure.

Applications:

Our system can be used for safe online consultations between patients and doctors. It can also help verify identities in health insurance claims. Additionally, our solution can be applied in other fields that need strong data privacy, such as finance, education, and government.

VIII. REFERENCES

[1] Eisaku Ohbuchi eisaku.ohbuchi@necel.com
NEC "Barcode Readers using the Camera

Device in Mobile Phones" Proceedings of the 2004 International Conference on Cyberworlds (CW'04) 0-7695-2140-1/04 \$ 20.00 IEEE.

- [2] 2013 IEEE 17th International Symposium on Consumer Electronics (ISCE) "Design of Mobile Healthcare Service with Health Records Format Evaluation "Hung-Ming Chen, Yong-Zan Liou, Shih-Ying Chen, Jhuo-Syun Li.
- [3] 2012 International Symposium on Information Technology in Medicine And Education "Design and Implementation of Doctor-Patient Interaction System Based on Android," Ran Wei, Zhimin Yang.
- [4] 2016 15th IEEE International Conference on Machine Learning and Applications "A Big Data Analytics Framework for Supporting Multidimensional Mining over Big Healthcare Data", Mario Bochicchio Salento Lecce, Alfredo Cuzzocrea DIA.
- [5] QR Code 2015. <http://www.qrcode.com/en/>.
- [6] T.J. Soon, "QR code," Synthesis Journal, pp.59-78, 2008
- [7] Proceedings of the International Conference on Intelligent Sustainable Systems (ICISS 2017) IEEE Xplore "Analysis and Prediction of Breast cancer and Diabetes disease datasets using Data mining classification Techniques" Deepika Verma ,Dr. Nidhi Mishra (Author).
- [8] Denso, "QR code essentials," Denso Wave. International Journal of Advanced Computer Technology (IJACT) "Least Significant Bit algorithm for image steganography"
- [9] 2014 4th International Conference on Computer and Knowledge Engineering" Disease Detection in Medical Prescriptions Using Data Mining Tools" Mahsa Soudi Alamdari, Mehdi Teimouri , Amir Hashemi Meshkini
- [10] "Data mining for better healthcare: A path towards automated data analysis?", Tania Cerquitelli* , Elena Baralis* , Lia Morra† and Silvia Chiusano ,Control and Computer Engineering Dept., Politecnico di Torino, ITALY
- [11] 2015 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining " Importance of Data Mining in Healthcare: A Survey" Mohammad Hossein Tekieh, Bijan Raahemi
- [12] 2012 International Conference on Computer Science and Service System, " The Use of Data Mining in Pharmic Quality Analysis of Traditional Chinese Medicines* " ,Xia WU1

Shun LONG, Wei-heng ZHU ”

- [13] IEEE ICC 2013 - Selected Areas in Communications Symposium “NFC Based m-Healthcare Application Focusing on Security, Privacy and Performance” Weider D. Yu, Hargun Hansrao , Kirandeep Dhillon, Pradeep Desinguraj