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Medi-Cliq (A Drug Dispenser) - A Survey Paper

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Abstract

In this paper, the concept of automated drug dispensing is summarized, and its significance in the healthcare sector is illustrated. MediCliq is designed to efficiently dispense prescribed medication, is researched in detail, focusing on the integration of mechanical design with IT-based control systems. Key technologies, including prescription scanning, prescription validation, and user interaction interfaces, are explored to enable seamless dispensing and user authentication. This paper also conducts a formal review of interdisciplinary methodologies, combining mechanical engineering with IT for developing an effective, secure, and user-friendly automated drug dispensing solution.

Keywords: Automated drug dispensing, Prescription scanning, Secure dispensing solution, Prescription validation

1. Introduction

Automated medicine dispensing systems are increasingly recognized for their role in enhancing healthcare efficiency, accuracy, and accessibility. Systems like Instymeds[1] and MedAvail[2] have already made strides in reducing wait times for patients by providing prescribed medications without direct human intervention.

However, these existing models often lack advanced prescription validation features, such as digital signature verification, OCR capabilities, image matching, and drug interaction detection—all critical for reducing errors and preventing misuse in clinical settings.

This paper surveys current models and technologies in automated medicine dispensing, focusing on their strengths and limitations. It also highlights the gaps that our interdisciplinary system, designed to function as a vending machine for medicines, aims to address by integrating enhanced IT components for prescription verification and safety in hospital environments.

2. Existing Systems in Automated Medicine Dispensing

Several automated dispensing machines are in use today, focusing on patient convenience and error reduction. Systems like InstyMeds[1] and ScriptPro[9] allow patients to receive their prescribed medications without requiring pharmacy staff. These systems are typically used in pharmacies or clinics, enabling easy access to medicines through patient-friendly interfaces.

• InstyMeds[1]: An automated prescription medication dispenser that primarily focuses on reducing the waiting time for patients. It uses basic prescription validation methods but does not handle digital signature verification or sophisticated fraud detection.

• MedAvail[2]: Similar to InstyMeds, MedAvail operates as a remote pharmacy kiosk. It focuses on easy dispensing of medicines but has no integrated mechanism for detecting harmful drug interactions or verifying printed digital signatures.

While these systems offer considerable improvements in efficiency, they come with limitations:

• Prescription Validation: Current systems rely on basic or manual methods for validating prescriptions, which may not be sufficient to handle fraudulent prescriptions.

• Digital Signature Authentication: Most systems lack the ability to verify digital signatures on printed prescriptions, which can lead to unauthorized dispensing.

• Real-time Inventory Management: While real-time tracking exists, it is often cloud-based and not localized to each machine, which could introduce latency or accessibility issues in certain hospital settings.

• No Integration for Drug Interaction Detection: Few systems focus on preventing harmful drug combinations, leaving room for errors in high-risk patients taking multiple medications

3. Proposed System

The proposed system is a fully-automated drug dispenser that needs no human intervention in the entire transaction process. Medi-Cliq offers a no contact performance with customization available for quantities of prescribed medicines with maximum security and contact-less payment. This machine introduces the unique method of scanning the printed prescriptions with the help of OCR, aiming for maximum precision and accuracy. Unlike the systems that already exist Medi-Cliq uses a new approach to eliminate strain on pharmacy staff by reducing queues for medicines, and a quicker way for customers, users to get their desired drugs with ease.

3.1. Methodologies and Techniques chosen for Medi-Cliq

- Image-Based Prescription Validation

Digital Signature Verification: Utilizes digital signatures printed on prescriptions for authentication. The challenge lies in employing Optical Character Recognition (OCR) and image matching for signature validation.
Image Matching Techniques:

1. SIFT (Scale-Invariant Feature Transform): A technique that detects key features in images, robust to changes in scale and rotation, but computationally expensive.
2. ORB (Oriented FAST and Rotated BRIEF): A more efficient alternative to SIFT, suitable for real-time applications in medicine dispensing systems.

Mitigating False Positives: Combines image matching with secondary authentication methods (e.g., password or OTP) to reduce false positive rates in signature verification.

- Mechanical Medicine Dispensing Mechanisms

Spring-Based Dispensing Mechanisms: Employs springs of varying sizes for dispensing different medication packages, focusing on reliability and minimal failure rates.
Error Detection: Incorporates feedback loops and real-time monitoring to detect dispensing failures, aiming for improved reliability beyond current fail-safe mechanisms like weight sensors.

- Drug Interaction Detection Systems

Pre-defined Drug Interaction Databases: Utilizes open-source databases (e.g., DrugBank, Medscape) for known drug interactions, which can be integrated with machine learning algorithms.
Machine Learning Models: Implements machine learning techniques, such as neural networks and decision trees, for real-time identification of drug interactions based on historical prescription data.

- Real-time Medicine Inventory Management

Localized Inventory Management: Focuses on a localized system with data stored on the dispensing machine, addressing complexities of ensuring data consistency and avoiding stock discrepancies.
These methodologies reflect a comprehensive approach combining technology, mechanical engineering, and data science to enhance the functionality and reliability of automated medicine dispensing systems.

3.2. Key Features of Medi-Cliq

1. Image-Based Prescription Validation with Digital Signature Matching
2. Localized, Secure Prescription Validation System
3. Customizable Real-Time Inventory Management
4. Spring-Based Mechanical Dispensing Mechanism
5. Future Drug Interaction Detection
6. User Interface with Customizable Medicine Selection
7. Feedback Mechanism for Dispensing Failures

3.3. Design and Functioning of Medi-Cliq

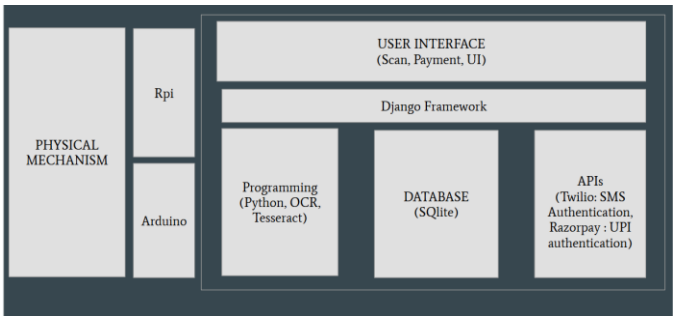

Figure 1: Architecture Diagram

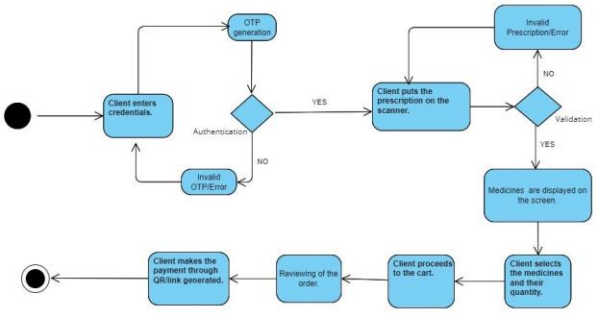

Figure 2: Activity Diagram

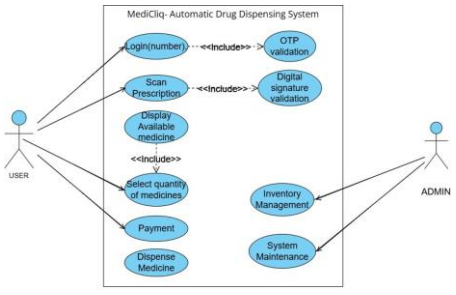

Figure 3: Use Case Diagram

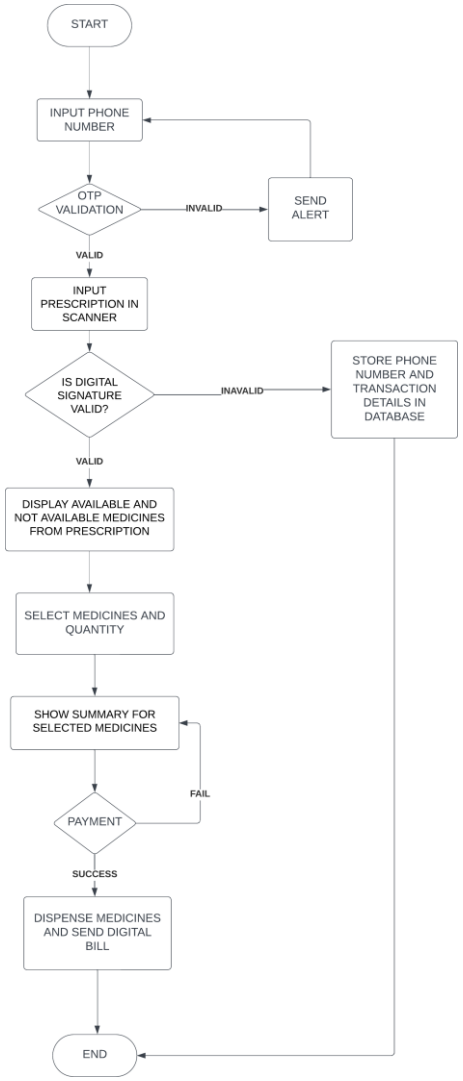

Figure 4: Block Diagram

4. Differences in approach and methodologies

1. OCR for Prescription Validation: Existing systems like InstyMeds and MedAvail rely on manual validation or barcode scanning, lacking advanced OCR-based text extraction. In contrast, the proposed system integrates OCR technologies, such as Tesseract, Google Cloud Vision, and AWS Textract, enabling effective reading of both typed and printed prescriptions.
2. Digital Signature Verification: Current systems do not have mechanisms to verify digital signatures on printed prescriptions, which poses a risk of fraud. The proposed system addresses this issue by implementing image-based digital signature matching using pre-configured doctor signatures, enhancing security and trust in the prescription process.
3. Prescription Fraud Detection: The existing systems employ basic validation methods, making them susceptible to misuse and fraud. The proposed system introduces secure signature verification, localized to the hospital and machine configuration, which aims to prevent fraudulent activities effectively.
4. Real-Time Inventory Management: Inventory management in existing systems is typically cloud-based, introducing potential latency and dependency on internet connectivity. In contrast, the proposed system offers localized real-time tracking with immediate updates and customizable refill thresholds, significantly improving efficiency and reliability.
5. Drug Interaction Detection: Current systems lack built-in mechanisms to detect harmful drug combinations, which can lead to safety issues. The proposed system envisions future enhancements that could include predefined drug interaction detection using open-source databases and machine learning models, providing proactive safety measures for patients.
6. User Interface: Existing systems feature basic touch screens or interaction interfaces that may not be user-friendly. The proposed system aims to improve this by offering a redesigned interface with a small touch screen that allows users to adjust medicine quantities (decrease only), enhancing usability and user experience.
7. Medicine Dispensing Mechanism: Standardized dispensing methods in existing systems provide limited customization for different medicine sizes. The proposed system introduces a spring-based dispensing mechanism that allows for options based on different spring sizes, depending on the medicine packaging, thereby enhancing versatility in dispensing.
8. Handling of Dispensing Errors: Current systems do not provide any feedback or help systems for mechanical dispensing errors, which can lead to user frustration. The proposed system suggests implementing a feedback or help section to assist users in handling malfunctions during dispensing, thereby improving overall reliability and user satisfaction.

Conclusion

Ultimately, our investigation of existing automated dispensing systems has revealed their shortcomings and guided the creation of Medicliq. We have thoroughly examined different systems and discovered distinct features that make our solution stand out. Medicliq incorporates advanced functionalities like OCR to confirm prescriptions, verify digital signatures, and manage inventory locally, filling important gaps seen in existing options. Additionally, our system has been developed with future improvements in consideration, such as the capability to identify drug interactions, to offer a complete solution specifically suited for multi-specialty hospitals.

The special blend of these traits makes Medicliq a strong and trustworthy tool for improving medication dispensing procedures. As we progress, we will concentrate on adjusting these elements to guarantee that the system functions smoothly in practical situations. Our goal is to enhance patient safety and care quality, as well as improve operational efficiency, resulting in a better healthcare experience for providers and patients alike. The progress made by Medicliq marks a significant advancement in transforming automated dispensing systems in the healthcare industry.

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