

***Pharmacy Automation and Robotics:
Enhancing Efficiency and Ensuring Patient Safety***

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Abstract

As the time passes human inventions also evolve in the field of automation and technology which resulted in the implication of these technology's, automations, robotics and AI in the field of health care and Pharmacy sector. This research helps us to explore the types of methodologies, its benefits and risks involved in Pharmacy and how efficient are they in ensuring the patient safety.

This paper also mainly focuses on Automated medicine dispensing devices, its significance in storing medicine's, reduction of human errors and interactions, components utilised, its working methodology, its advantages and disadvantages and how accurate it is to ensure patient safety.

Acknowledgement

Agrawal, Kunal, et al. "Design and functioning of automated medicine dispensing module." *International Journal of Engineering and Advanced Technology* 10.4 (2021): 120-123.

Introduction

"In today's fast-paced healthcare industry, even a few seconds can make a life-or-death difference."

As all knows, health plays a major role in each and every people life. Health is the state of one's

mind, body, and spirit, the idea of being freedom from illness, injury, pain, and distress. In recent years, the health care sectors and health industries are drastically preferring technological advancements to offer the best services to the patient in terms of efficiency and safety. By engaging these technological systems, reduces human errors and optimise time consumption and workflow.

As the population increases and hospitals gets crowded with each of them facing verities of problems, it is big deal for the doctors and the staff to suggest relevant prescriptions and collect the right medicine.

Problem Statement

It is human nature to make mistakes but sometimes it may lead to serious issues, especially while treating someone sick in case of hospital and health related matters. So, it's always safer to have a less human interaction environment to avoid making mistake and save lot of time in preparing prescriptions and storage of certain drugs that requires certain temperature. Later the staff can spend max time by communicating with patient and other operational related works.

Scope

This project highlights the real-life issues faced by patients and staff members regularly in hospitals. This project helps to build a real automated model that helps both staff and patient. Can improve further to store and dispense injections, auto persecution generating, barcode or QR scanner to dispense without mobile phone.

Outcomes/Objectives

1. Broad understanding on automated dispensing devices, its design, functions, and other types of ADDs used.
2. The efficiency and accurate it is to use automated dispensing devices and its storage capacity.
3. Impact on prescription reading and reduces the incorrect dosage levels and wrong medicine suggestions.
4. Helps in identify the barriers to adopt ADDs, cost, training requirements, limitations for infrastructure and impact of change in technology.
5. Recommendations and reviews on ADD's help as resources who are willing to adopt this technology.

Methodology

1. Listing down the requirements: The Machine includes loading/unloading mechanism & hopper mechanism for dispensing of medicines which includes sensors, servo motors, motor drivers, & Raspberry Pi 3 which help in keeping track of medicines being dispensed.
2. Data collection: The details of the of the shapes and quantity of the tablets are required to build the storing drawers. After analysing, the standard shapes were cube, oval, cylindrical and round medicines.
3. Design: The module contains three main parts, the body, slider-spring and hight adjustment parts. From the top of the lid the medicine is stored in storage chamber. Based on the hight of the medicine the hight is adjusted and gets locked. The bottom most medicine in the slot is displaced at the opening at the bottom by the slider spring mechanism done by motor.

4. Functioning:

- i) Storage Chamber Opening: Takes input in the form of medicines.
- ii) Stored medicine chambers.
- iii) Storage Chamber: Space to store medicines under suitable storage conditions and providing isolation around the chamber.
- iv) Medicine Slot: Slot where medicines will fall under gravity and be placed for further dispensing.
- v) Motor Attachment Slot: Space for adding extension slit which will provide sliding motion to the slider.
- vi) Slider: Part which moves sideways to shift medicine from Medicine slot to exit slot.
- vii) Exit Slot: Slot through which medicine will be dispensed out of the module.
- viii) Spring: Spring adds a balancing part for smooth movement of slider and after dispensing, the slider will be pushed to keep prepare for next dispensing.
- ix) Hight Adjustment Part: Part used for adjusting size of module as per the height of medicine. (Agrawal, 2021)

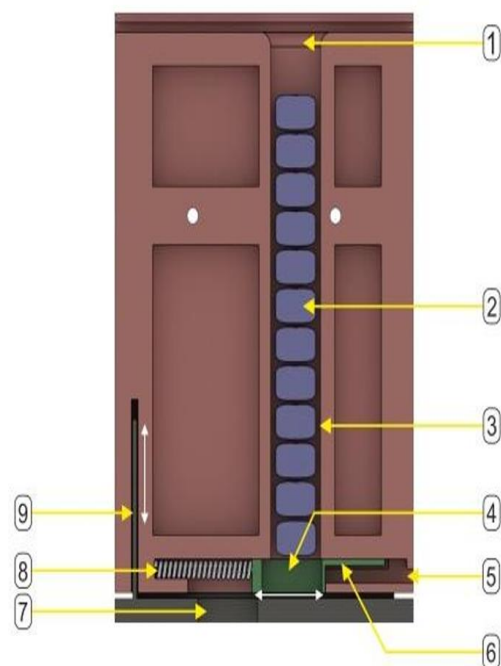


FIG: parts of design

Literature Review

Other than dispensing, these are other more commonly available Pharmaceutical in case of time efficiency, easy access and to ensure patient safety systems are;

- 1-AI-driven prescription verification,
- 2-Inventory management in pharmacies,
- 3-Barcode scanning & medication safety,
- 4-Automated compounding machines (for custom meds),
- 5-Pharmacy workflow optimization

The methodology used till present are,

- 1.Compounding workflow software solution (BD Cato): Focus on oncology pharmacy, Solution to manage both preparation and documentation was initiated. The suite had initial pharmacist verification of the order, gravimetric checks, and on-screen instructions displayed on the monitor inside the work area for the technician. (Meren, Ü. H., & Waterson, J. 2021)
- 2.The RxSafe System: securely stores and automates an entire pharmacy's inventory. By uniquely identifying pharmacy staff to the system, the RxSafe increases accountability for every pill in inventory.
- 3.Pharmacy Automation Solutions: Automated storage and retrieval systems, robotic dispensing units, and workflow management software. (Piercy, C. W., & Gist-Mackey, A. N. 2021).
- 4.Automated Storage and Retrieval Systems such as Automated Dispensing Systems, Automated Packaging and Labelling Systems, Automated Table-top Counters, Automated Storage and Retrieval Systems.

In addition to the mentioned systems, there are various other automation solutions tailored to specific pharmacy needs. These may include medication compounding robots, prescription verification systems, prescription filling robots, and medication management software.

Flow of Operations and Analysis:

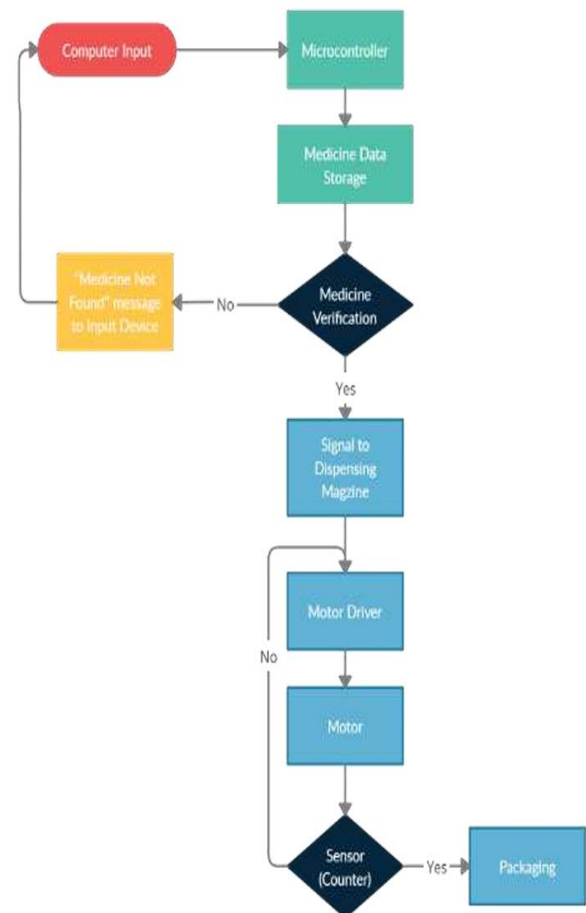


Fig: Flow of the operation

Analysis

The input, prescription suggest by the doctor is given to the machine by the computer. The microcontroller receives the signal and checks the availability of the medicines in the machine. After medicine is verified, a signal is sent to the motor driver connected to the motors which are attached to the dispensing module for dispensing medicines as per the prescription. While being dispensed, the medicines are counted using sensors and upon reaching the counter as per the prescription, the motor stops movement and dispensing of medicines is halted. Post dispensing of medicines, they are packaged in cylindrical vials placed at the exit end of the machine and the vials are later collected by the user. (Agrawal,2021)

Flow of Operations:

1. User inputs data through computer
2. Input is sent to the Microcontroller where it is verified with Medicine Data in dispenser
3. Post verification, signal is sent to Dispensing Module for initiating the process.
4. The signal is further sent to Motor Driver which actuates the motor which in turn moves the slider to dispense medicine.
5. The medicines keep dispensing until the counter reaches its limit.
6. Lastly the medicine is packaged and received by the user. (Agrawal,2021)

Hardware components used in short run

Servo Motors used in providing motion to Slider-Spring Mechanism. These are attached with a slit which is connected to the slider. Motor

Drivers Motor Drivers to receive signal from microcontroller to dispense medicines by movement of the motor which in turn moves the slider.

Object Detection Sensor used for counting medicines coming out of exit slot.

Medicine Dispensing Module for storing and dispensing medicines. Raspberry Pi 3 used for handling operation of entire machine.

So, the tech stack used for this small scale is Python as front end and SQL as backend. The module would look like the below fig.

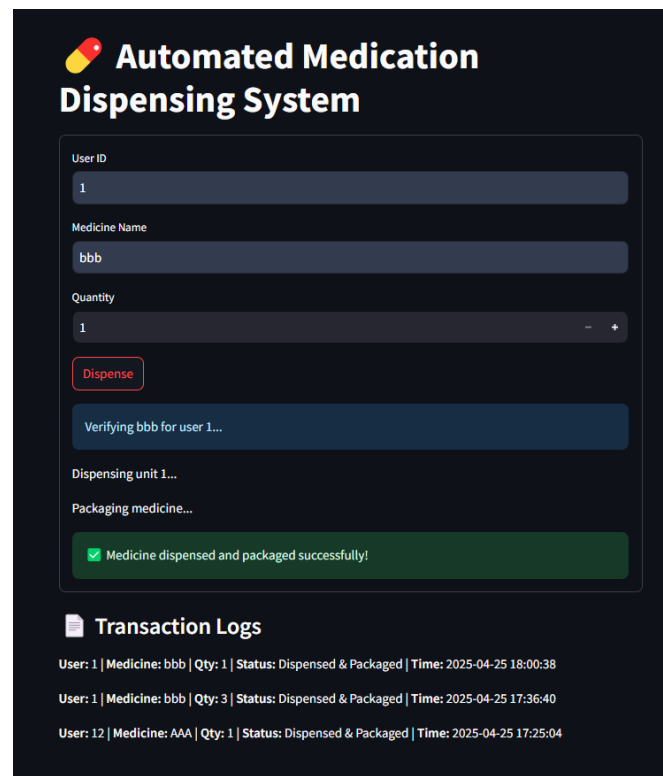


Fig: AMDS model

This working is just for the idea, it can be further improved such that it can take payments, scan bar code, QR codes, auto generating prescriptions based on sickness of patient and storing capacities.

Safety measures

The machines or devices can be installed in hospitals, medical stores, nursing homes and in the houses (for personal use which is made like a disk board and works with batteries). The installer should make sure that the place is secure and power availabilities. The staff members should be well trained to use the device completely. Mainly children should be kept away from the devices.

Outcome and results

This machine would reduce human interactions, saves time, stores medicine in required temperature, dispense correct quantity, helps in labelling and maintaining record.

The system will offer an easy-to-use interface, through which the user could make an interaction, select medicine, enter quantity, make payments and see the logs, all-in real-time display.

It also provides safety and security by incorporating authentication and role-based access to guarantee that only right individuals can access and modify the system.

Future goal and innovations

By using AI in forecasting medication requirements through data history. Can extend the system to be switched to mobile apps in order to be more accessible and easier to control.

We can set an automatic alarm system, where we can set timer to on time medicine dispensing without missing. Also expired date checker can also be implemented.

Conclusion

Healthcare organizations can improve patient care outcomes through proper handling of automated dispensing device challenges combined with pharmacist expertise. Methods of automation in medication management are expected to grow in healthcare. So, organizations must create complete tactics for deploying these systems and their continuous operation.

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