Design and Functioning of Automated Medicine Dispensing Module

Kunal Agrawal, Jil Jain, Vrutant Shah, Gargi Chauhan, Piyush Surani

Abstract: In a world where technology has bridged the gap between people communicating to reducing human efforts and improving efficiency, the problem that major hospitals & pharmacies face is i.e. lack of staff & resources. As per the survey conducted by LANCET[1], India faces a significant shortage in medical staff which leads to patients being unattended for several hours. This problem can be solved if the tasks per staff member is reduced and one such way is by reducing their repetitive movement from the patient's room to the pharmacy for giving the medicines to the patient. This effort can be reduced by creating a remotely located machine which can be placed at the right place to dispense medicines automatically. This reduces the extra movements and hence provides them the time to do tasks that are of more importance. Although the concept of an automated medicine dispensing unit is not new, it is something that if built and implemented, can provide aid to patients in developing countries.

Keywords: Height Adjustment Part, Hopper mechanism, Medicinal Data Analysis, Medicine Dispensing Module, Spring Slider Mechanism.

I. INTRODUCTION

This project was aimed to build a machine which provides medicinal aid to patients in a hospital. Upon observing and understanding the current progress in the field of pharmacy automation and going through past researches, the objectives were set to create a user friendly, compact & ease-to-use automated dispensing unit for medicines. 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. The entire operation of this machine will be done automatically once the medicines are loaded and after being dispensed, the medicines will be packaged in a sanitized way which will help in reducing the unnecessary crowd around pharmacy store and also help in maintaining sanitary standards.

II. RESEARCH AND DATA COLLECTED

For starting the project, medicinal data of 109 commonly used medicines was collected and analyzed as shown in the Table 1. The medicines were chosen as per the suggestion of doctors and pharmacists. The various shapes of medicines helped in building the dispensing module for universal height based medicines. Upon drawing inferences from the data collected, the project was initiated by analyzing past research papers and identified that focus was kept on the electronics part of the machine and not on the mechanical aspect. The medicinal data was bifurcated in terms of different standards shapes as follows: Cube, Oval (With height present & absent- This indicates the pills which are spherical or have minimal height), Cylindrical & Round.

Table -1: Medicinal Data

CUBE							
Max Length	21.2mm	Min Length	11.2mm	Common Range Length	17-18mm	Remark	Every size of medicine is present between common length, breath and height.
Max Breath	10mm	Min Breath	6.6mm	Common Range Breath	8-10mm		
Max height	9mm	Min Height	4.9mm	Common Range Height	5-6mm		
Average Length	17.48mm	Average Breath	8.43mm	Average Height	7.61mm		
Total Number of Medicine				**39 (35.77%)**			
OVAL(HEIGHT PRESENT)							
Max Length	14.6mm	Min Length	11.3mm	Common Range Length	14.3-14.6 mm	Remark	3 medicine are present in common Range Length. All four medicine are of
Max Breath	11.6mm	Min Breath	7mm	Common Range Breath	N/A		
Max height	7mm	Min Height	3.8mm	Common Range Height	5-5.2mm		

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Average Length	13.65mm	Average Breath	31.02mm	Average Height	5.25mm	different Breath. 2 medicine are present in Common Range Height.
Total Number of Medicine				**5 (4.58%)**		
OVAL(HEIGHT ABSENT)						
Max Diameter	10.4mm	Min Diameter	7mm	Common Range Diameter	N/A	All 5 medicine are of different Diameter and Length.
Max Length	22mm	Min Length	12.6mm	Common Range Length	N/A	**Remark**
Average Diameter	9.86mm	Average Height	13.96mm	N/A		
Total Number of Medicine				**5 (4.58%)**		
CYLINDRICAL						
Max Diameter	7.4mm	Min Diameter	5.9mm	Common Range Diameter	6mm	6mm Diameter medicine is most common as 4 medicine are present out of 9.
Max Height	21mm	Min Height	17mm	Common Range Height	17-17.5mm	**Remark**
Average Diameter	6.2mm	Average Height	17.87mm	N/A		
Total Number of Medicine				**9 (8.25%)**		
ROUND						
Max Diameter	14.9mm	Min Diameter	5mm	Common Range Diameter	12-12.9mm 7-7.7mm 9.2-9.8mm	Most of the medicine are present in Common Range Diameter as well as in Common Range Height.
Max Height	6.3mm	Min Height	2.2mm	Common Range Height	3-4.8mm	**Remark**
Average Diameter	7.52mm	Average Height	1.86mm	N/A		
Total Number of Medicine				**51 (46.78%)**		

III. DESIGN AND FUNCTIONING OF MEDICINE DISPENSING MODULE

The key to this project is the development of the Dispensing Module. The Module has 3 major components: The body, slider-spring mechanism and height adjustment part. The medicines are inputted manually into the storage chamber from the top lid. Based on the height of the medicine, the height is adjusted and the adjustment part is

locked. Once the medicines are stored, the medicine that is placed in the slot at the bottom of the module is displaced towards the opening at the bottom by the slider spring mechanism which is controlled by a motor. The built prototype is shown in figures 1 & 2 along with detailed cross sectional modules shown in figure 3. A detailed part description of figure 3 is explained as follows:

1-Storage Chamber Opening: Opening to input medicines into the module.

2-Medicine

3-Storage Chamber: Space to store medicines under suitable storage conditions and providing isolation around the chamber.

4-Medicine Slot: Slot where medicines will fall under gravity and be placed for further dispensing.

5-Motor Attachment Slot: Space for adding extension slit which will provide sliding motion to the slider.

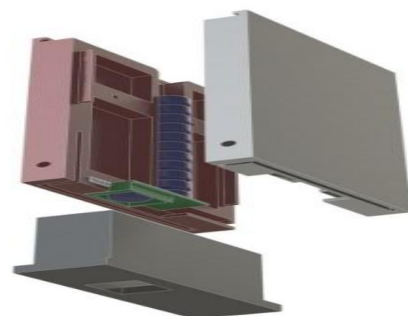6-Slider: Part which moves sideways to shift medicine from Medicine slot to exit slot.

7-Exit Slot: Slot through which medicine will be dispensed out of the module.

8-Spring: Spring adds a balancing part for smooth movement of slider.

9-Hight Adjustment Part: Part used for adjusting size of module as per the height of medicine.

Fig.1: Images of Prototype

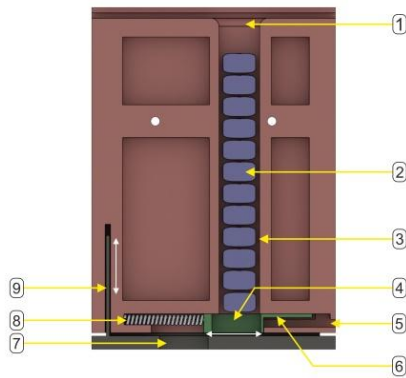**Fig. 2: Exploded view of Design**

121

Fig. 3: Cross-section of Design

IV. FLOW OF OPERATIONS

The Machine is given input of prescribed medicines by a doctor via a computer interface and the signal is sent to a microcontroller which verifies the availability of medicines in the Dispensing module and upon verification, 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. The flow of operations is explained using Flowchart 1.

Flow of Operations:

Step 1: User inputs data through computer

Step 2: Input is sent to the Microcontroller where it is verified with Medicine Data in dispenser

Step 3: Post verification, signal is sent to Dispensing Module for initiating the process.

Step 4: The signal is further sent to Motor Driver which actuates the motor which in turn moves the slider to dispense medicine.

Step 5: The medicines keep dispensing until the counter reaches its limit.

Step 6: Lastly the medicine is packaged and received by the user
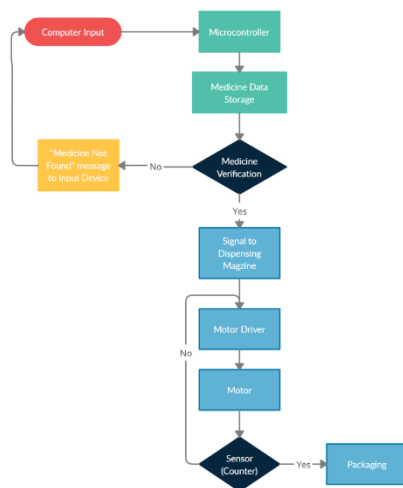
Flowchart 1: Flow of Operations

V. HARDWARE COMPONENTS

Component	Use
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 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	Module for storing and dispensing medicines.
Raspberry Pi 3	Used for handling operation of entire machine.

VI. RESULT AND DISCUSSION

The design of module was completed and prototypes prepared were well functioning. The Machine successfully dispenses medicines of varying height using a similar module. the slider-spring mechanism provided a good alternative to drop mechanism and helped in keeping a count of medicines being dispensed, also ensuring that medicines flow without getting stuck in storage space. Overall the machine worked as expected and provided insights for improvement.

VII. CONCLUSION

The project design and implementation lead to find solution for automating processes in pharmacies and providing prescribed medicines to patients automatically. The medicine dispensing module solves the problem of storing and dispensing of medicines of different heights and on implementing, the machine will provide aid to patients and medical staff in a hospital.

Future Scope:

The machine can be modified to become storage and dispensing unit for injections and can improve pharmacy automation.

REFERENCES

1. Lancet Article India: Towards Universal Health Coverage| Volume 377, Issue 9765, P587-598, Februray 12, 2011
2. M Sangeetha, T V Janardhanarao, Ch S Rama Gowri, AUTOMATIC MEDICINE VENDING SYSTEM-MEDICAL ATM ISSN: 2455-2631© October 2016 IJSDR | Volume 1, Issue 10 IJSDR1610031 International Journal of Scientific Development and Research (IJSDR)
3. Sarika Oundhakar, Automatic Medicine Vending Machine, India International Journal of Engineering Technology Science and Research IJETSR ISSN 2394 – 3386 Volume 4, Issue 12 December 2017
4. Abhishek Singh, TOUCH SCREEN BASED AUTOMATIC MEDICAL VENDING MACHINE, IJIRST –International Journal for Innovative Research in Science & Technology| Volume 1 | Issue 11 | April 2015 ISSN (online): 2349-6010.
5. Shrikant Bhange, Kaveri Niphade, Tejshri Pachorkar, Akshay Pansare, Automated Vending Machine, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 3, March 2015 .

6. Shraddha Kadam, Aishwarya Kale, Punam Nimase, Sheela Padwal, Shobhit Khandare, AUTOMATED MEDICINE DISPENSING MACHINE, International Journal of Technical Research and Applications e-ISSN: 2320-8163, www.ijtra.com Volume 4, Issue 3 (May-June, 2016), PP. 73-76

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