

Design of automated medicine vending machine using mechatronics techniques

A Brolin^{1*}, R Mithun², V Gokulnath³ and M Harivishanth⁴

^{1,2,3,4} UG scholar, Department of mechanical engineering, A.C. Govt College of Engineering and Technology, Karaikudi, Tamilnadu, India.

*corresponding author: abrolin65@gmail.com

Abstract. An automatic medicine vending machine with a self-contained on-site pill dispensing mechanism and a storage facility for the plurality of pills that can be dispensed based on the user requirement. Major components of the machine are, a scanner to take the input from user, a system that includes servo motors for dispensing the medication, large storage space to store the pills, sensors to detect the motion of pills, an inventory monitoring system to keep track of the storage, an industrial standard vertical foam fill machine to pack the medication separately and a non-contact laser inkjet printer to print the description which includes the time at which the medicine must be taken. The inventory monitoring system also keeps track of the expiry date of each batch of medicine and sends alert to refill the storage when the pills run out. It also holds an inbuilt system to receive money from the user for the drugs that are dispensed. All these systems are monitored by a central microprocessor, which is programmed to receive input from the user via the scanner and to actuate and control all the necessary components required to dispense the medication requested by the user. The machine can be viewed as an automated pharmacy placed on a commercial scale so that infinite number of user will be able to access it anytime.

1. Introduction:

1.1 Field of invention:

The present invention relates to automatic medicine vending machine, in particular to a machine that has the capability to dynamically receive input for the user and then dispense the required type of medicine. The input, here means, the prescription by the physician to the user. The system features a machine that is capable of handling a complete range of prescription.

1.2 Background of invention:

The growing modern age has also brought with it the dawn of the age of numerous types of diseases. The use of medicine to maintain and regain physical and mental health has been growing at a rapid pace. The doctors prescribe different type of medicine for one particular type of illness. Today it has



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

become common for a person to take at least one type of pill at regular interval each day ^[1]. A statistical survey shows that about 21% patients never follow their prescription and 6% patients is not capable of identifying their own medicines. In extreme cases, between 12 and 20% take medicines of other patients ^[2]. But in case of the elderly people the scenario is awful. They take numerous number of pills at one particular time of the day to maintain their health. Therefore, confusion can arise both concerning the schedule and whether or not the medication has been taken.

This problem has been addressed by a number of personal pill dispensing machine in related art. Wherein the dispenser is preloaded with the medicine to be taken and is programmed to dispense the medication at a particular time of the day and alert the user to take the pills. Sometime, improper loading of the medication can cause some dosage issues. Improper medication is reported to be the most common reason why some patients do not respond properly to medical treatment. Patients sometimes forget to take the pill at a particular time and then try to ‘catch up’ by taking more than prescribed dosage ^[3]. It becomes difficult to remember when to take the medication when different types of pills are required to be taken at different times. Elderly people frequently do not have sufficient mental alertness to keep track of the frequencies and dosages of their various medicines over a sustained period of time ^[3].

Not only elderly people but also the people who go to work have this problem due to external factor like work pressure. It is not possible for them to carry a medicine dispenser with them. Even if they carry all the medicine strips with them, there is good chance that they might forget which pill to take at the particular time.

2. Design of the machine

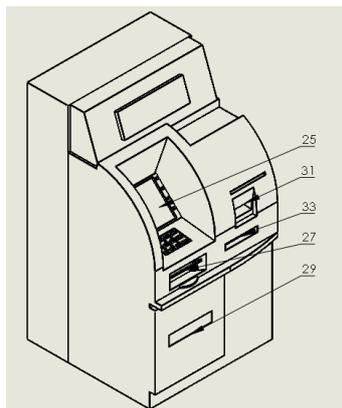


Figure 1. User side of the machine

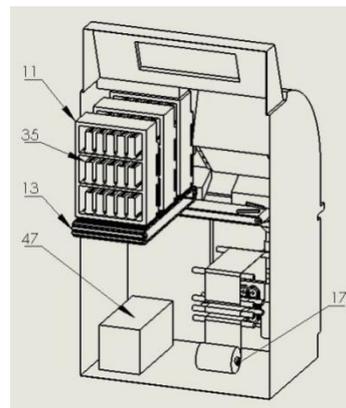


Figure 2. Inside the machine

The design is based on simplicity and the utilizations of low cost materials and components that can be easily available ^[4]. Figure 1 and 2 shows the major components of the preferred embodiment which includes a major housing that hold within it the central micro controller, a scanner that takes the input from the user; storage space that houses small containers where all the different type of drugs are stored; a conveyor series that takes the pill form storage to packing region; a small size industrial standard vertical foam fill packing machine; a dispatch area for the user to receive the packed medicine.

2.1 Design of the user interface:

Referring now to figure 1, the user interface is ergonomically designed so that even the least of the untaught people will be able to easily access the facility on their own. The user has to put the printed prescription in the small slot like space provided. The slot contains an inbuilt barcode scanner that can read the prescription. The prescription mentioned here is different from the customary practice of written prescription. The prescription is in printed format containing the relevant barcodes of the medicine and the dosage being recommended. The prescription is prepared using a special computer application that is specifically designed to get the name of the medicine from the physician and then the barcode is automatically put in the respective space in the prescription with the help of an offline database that contains all the barcodes of the medicines available in the market.

The user need to manually input the time of the day in which the medicine is being prescribed. For example, a particular pill may be prescribed to be taken in the morning and afternoon and another may be prescribed to be taken only at night. After these information are given, the user can view the total amount of the medication for a single day. Then the user is prompted to enter the number of days he desires to buy the medication. At last the grand total for the entire medication is displayed.

A money transfer system is provided to receive money from the user for the medicine via a debit or a credit card. The user is prompted to enter in the details and accepts the terms of the payment to be made. Once the payment process is complete, the user receives a printed description of the detail of the money transfer made. Then the controller signals the packing mechanism to start the packing of the required pill(s).

2.2 Design of storage space:

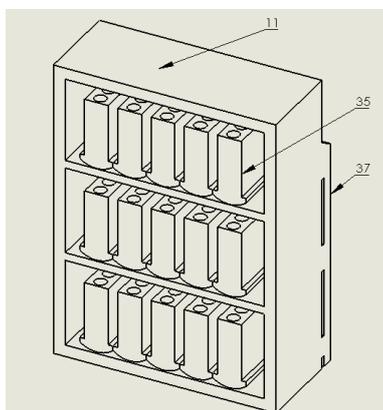


Figure 3. Isometric view of storage rack

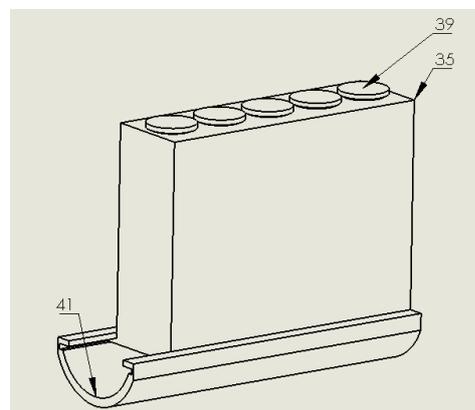


Figure 4. Design of a receptacle

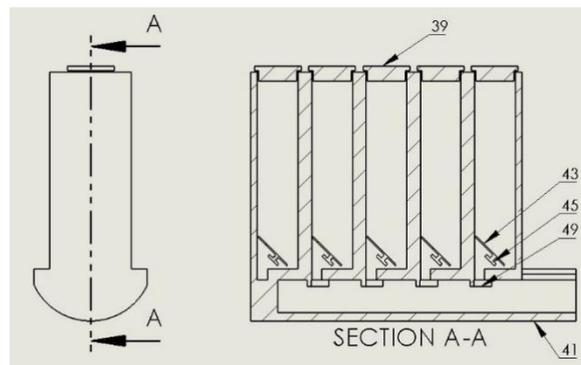


Figure 5. Cross sectional view of the receptacle

Referring now to figure 3 and 4, the storage space contains a number of receptacles. Each receptacle is divided into ten individual compartments to contain different type of pills. The divisions are cylindrical with an oblique bottom. All these container are made air tight to avoid the reaction of pills with the moist air or being contaminated by dust. Figure 5 shows that each division is provide with a unique servo attached to a carousel at the bottom. An infrared slot sensor is placed beside the servo to detect dispensing of pill. The carousel is used to pick an individual pill ^[5] to be packed with other pill that is to be taken at the particular time as per the prescription.

When the receptacles are loaded with new batch of pills, the inventory is updated manually by the person who is refilling. Also the expiry date of the particular batch is updated. The main controller keeps track of the inventory with the help of signals from the infrared slot sensor.

Medicines that are more frequently used by people are stored in more than one division to ensure that the pill doesn't run out of inventory very soon. The feed chute that take the pills from receptacle to the packing section are sealed tightly to avoid being contaminated by the atmosphere and to maintain the purity of pills while moving out of the storage.

2.3 Design of pill singulation system:

The pills are put into the receptacle as a whole bunch. So there is need to isolate one pill from the plurality of pills in the container. The servo motor placed at the bottom of each division of receptacle does the work.

Each division of the receptacle is angled upward from the upper mouth, so that the pill dispensing end is positioned above the input end. In this fashion, the pills that are fed through the chute move upward against gravity ^[6]. This oblique bottom wall helps to centralize the pill. The pill dispensing mechanism is rotationally controlled using the servo motor by the main controller.

The carousel at the bottom has two small slots that are 180° apart at the periphery of the circular disc that is attached to the servo motor. This slot in the disc helps in singulation of the pill. When the servo motor is signaled to rotate, the slot picks up only one pill and rotates along with the carousel. A small hole is placed at the bottom of the division just a little below the carousel. When the slot and the hole match, the pill is dropped to the feed chute which eventually leads to the packing section. The number of slot can be increased to reduce the operating time and increase efficiency.

The infrared slot sensor placed adjacent to the servo motor makes sure that one pill is dropped per half rotation of the carousel disc. The signal from the sensor is used to activate the packing mechanism, track the flow of pill and is also used to maintain inventory of medicines.

Dust builds up in the sensor over a long working period. Thus maintenance and cleaning of the storage is necessary to assure accurate pill count and equipment life is an economically important consideration [6].

2.4 Description of packing system:

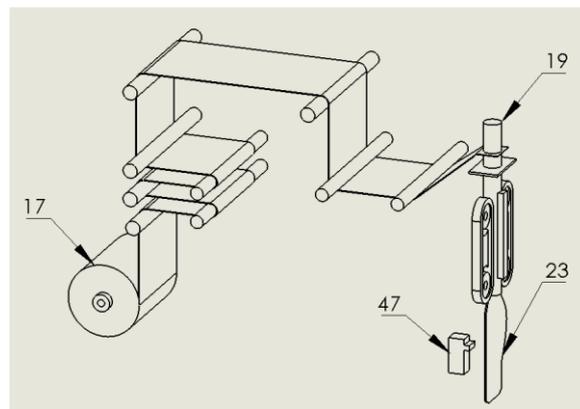


Figure 6. Vertical foam fill machine with non contact laser printer

Referring now to figure 5 and 6, the pill is taken from the receptacle to the packing area through the feed chute. The medication is packed in an aluminum foil bag using an inbuilt smaller version of an industrial standard vertical foam fill machine. The machine is loaded with aluminum foil roll which is used for blister packing in pharmaceutical industry. Aluminum foil's keep out moisture, microorganisms, light, oxygen and other gases. Thus making it a primary material in the protective packaging of pharmaceuticals. The pills are made to fall through the opening into the bag for packing.

The foil is fed into the packing machine and the pills are packed one batch at a time. Batch, here refers to the set of tablets that are to be taken at a particular time of the day. As the packing process continues, a non-contact laser inkjet printer prints all the necessary descriptions like the expiry date of each pill in the bag and the time at which the medication is to be taken by the user.

3. Brief of the entire operation of the machine:

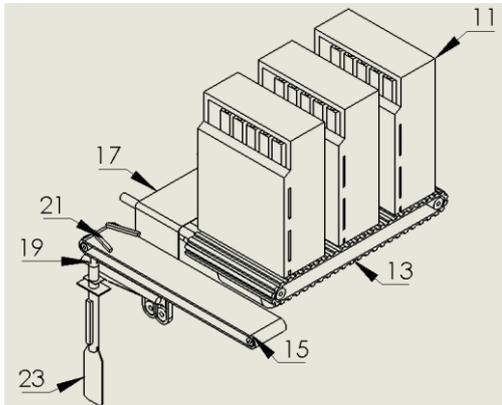


Figure 7. Total assembly of the machine

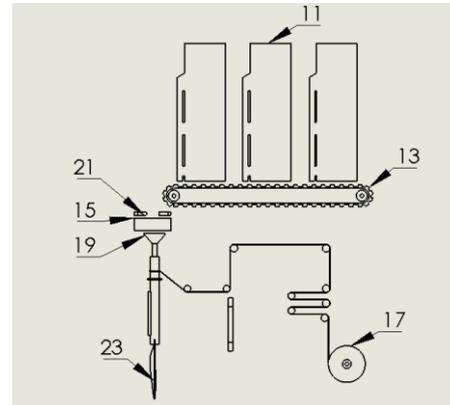


Figure 8. Side view of the assembly

Referring now to figure 7 and 8, the user is requested to insert the printed prescription provided by the physician into the slot provided. Some of the sensitive medicines are not to be legally provided to the user without a doctor's prescription. Another option can be included in the user interface to allow for the user to take some of the commonly and 'not very sensitive' medicines from the vending machine without a doctor's prescription in emergency cases. The scanner which is inbuilt in the slot scans the printed prescription for the barcode corresponding to the medicines. The medicine details are then displayed on the screen.

The user need to manually input the time of the day in which the medicine is being prescribed. After these information are given, the user can view the total amount of the medication for a single day. Then the user is prompted to enter the number of days he desires to buy the medication. At last the grand total for the entire medication is displayed. After this the user is requested to pay the money for the medication. Only then the dispensing function will begin.

The micro controller is programmed to group all the pills in timely basis i.e. all the pills that are to be taken in the morning is grouped. Then the specific pill is picked by the carousel as per the request. The pills fall on the feed chute and then to the conveyor via a slot provided in the storage rack. The guide placed in the conveyor guides the pills to fall into the funnel that puts the pills inside the aluminum foil bag. Then these pills are packed in an individual aluminum foil bag. This type of packing aids in neglecting confusion to the user. Also a brief description of the medication in the bag is printed by the non-contact inkjet printer. This process is carried out till all the necessary pills have been packed.

Once the process is over, the dispatching door is signaled by the micro controller to open through which the user can take the medicine that is packed as per the request.

4. Future developments and scope of invention:

The working scope of afore described vending machine can be further improved by expanding the database adding more functionality. The controller's capacity can be increased and it can be programmed to work like a doctor. That is, the machine will be able to take all the vitals like the body

temperature, blood pressure and other necessary details from the patient through the sensors interfaced with the machine.

Then the patient is prompted to input the symptoms that he is experiencing through multiple choices displayed on the screen. The program must be capable of computing and inter relating the various symptoms to one illness. Then based on the age of the patient that was received earlier, the dosage for the person will be recommended.

5.References:

- [1] James Lim 2014, Programmable automatic pill dispenser, United States Patent ,1(12).
- [2] Boquete L, Rodriguez Ascariz J M, Artacho I, Cantos Frontela J, Peixoto N 2010 Dynamically programmable electronic pill dispenser system,*Journal of Medical Systems*.34,357–366
- [3] Lewis et al 2007, Automatic pill dispenser and method of administering medical pills, United States Patent.
- [4] Ahadani M A, De Silva L C, Petra I, Hameed M F A, & Wong T S, Low cost robotic medicine dispenser. *Procedia Engineering*.41, 202–209.
- [5] Topliffe et al 1992, Bulk medication dispenser and monitoring device (12) United States Patent.
- [6] Balasubramanian et al 2012 , Apparatus for counting and dispensing pills using multi-stage pill singulation, united States Patent.