ERCIYES UNIVERSITY FACULTY OF ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING

BIOMEDICAL DESIGN AND APPLICATION

AUTOMATED MEDICATION DISPENSER

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1. PURPOSE OF THE PROJECT

Medication error is one of the most common patient safety incidents reported in hospitals. In England and Wales, almost 80,000 medication errors were reported to the National Reporting and Learning System (NRLS) by National Health Service organizations between October 1, 2013 and March 31, 2014. A small but not negligible portion of these errors is dispensing wrong medication. Moreover, many elderly people with dementia or Alzheimer's disease may not remember when to take their medication or what medication to take. In addition, elderly people often face some problems in taking their medication because the pills are small and the boxes may not open easily. We design this project as a solution to this problem.

2. MARKET RESEARCH

Even though there are many products on the market under the name “medication dispenser”, we found majority of them either too advanced hence expensive, or not automated enough to meet the needs of elderly. In the table below, we compared 3 different products.

Product Name	**Image**	**PRO**	**CON**
MedTime		- Timer with alarm - Portable - $232.95	- Difficult loading - No cutting device - No security feature

MD2		- Timer with alarm - Gives medication instructions - Calls caretaker if medication not dispensed or refill is needed	- Dispenses in small container - No cutting device - No security feature - $919.95 plus $38.95 per month
CompuMed		- Timer with alarm - Gives medication instructions - Minimal security - Tracks number of missed doses	- Pills deposited into drawer - Only dispenses up to 4 times per day - Medicine cassette needs to be changed weekly - No cutting device - $1045.00

3. DESIGN

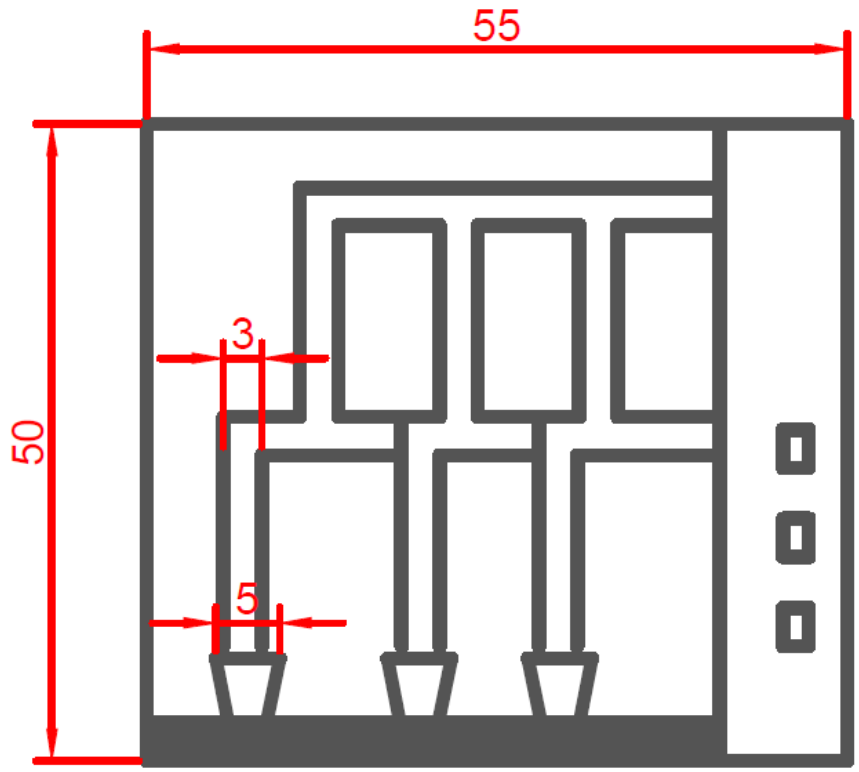
During the semester we were discussing a couple of designs to meet the purpose of this project. After some drafts we settled on two possible options for the design described below, respectively.

3.1. Design 1

The first design is very simple and its front projection can be seen in the picture 1. It consists of 3 separate vertical and very slim containers in which pills would be placed. On the bottom of every container there is a horizontal “canal” in which a solenoid would be placed. Incoming power would trigger solenoid to push and pull, and with every pushing it will cause 1 on the bottom of the container to move horizontally and eventually downwards when it encounters the exit of the container.

This project will use one kind of user interface connected with Arduino board to input the timer for all three medications. When the time is elapsed, the computer will send an input signal to the controller. 5v output will be sent to the relay switches and the LED will go on as well as the alarm (buzzer). This power will then be fed to the solenoid whose force will push the medication out of the dispenser. A small container will be put under this mechanism to collect the dispensed medication.

Additional feature of this dispenser is sending a text message to the user’s phone some minutes before the time scheduled for taking the medication is elapsed. A GSM module will be used to achieve that.



Picture 1. Front projection of the dispenser

3.1.1. Electronics components

a) Microcontroller that is going to be used in this project is Arduino Uno.
   It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The 3 digital input/output pins will be used in this project for the dispenser.
   The board is going to be connected to the computer by an USB cable.

b) A relay is an electromechanical device having electrical, magnetic and mechanical components. The relays control the electric circuit by opening or closing the contacts of that circuit. An electromechanical relay consists of three terminals namely common (COM), normally closed (NC) and normally opened (NO) contacts. These can either get opened or closed when the relay is in operation. Relays involve two circuits: the energizing circuit and the contact circuit. The coil is on the energizing side; and the relays contacts are on the contact side. When a relays coil is energized, current flow through the coil creates a magnetic field. Whether in a DC unit where the polarity is fixed, or in an AC unit where the polarity changes 120 times per second, the basic function remains the same: the magnetic coil attracts a ferrous plate, which is part of the armature. One end of the armature is attached to the metal frame, which is formed so that the armature can pivot, while the other end opens and closes the contacts. Contacts come in a number of different configurations, depending on the number of breaks, poles and throws that make up the relay.
   In the system, if a signal is fed from the microcontroller to the relay, it will supply 12V to the magnetic solenoid that will function as push and pull.
   Magnetic solenoid is the key device for dispensing. It is a coil of wire that acts as a magnet when a flow of current passes through it. The magnetic solenoid used is a 12V supplied solenoid that is used in an amplifier circuit. This magnetic solenoid has enough power to push the medicine out of the container without breaking or damaging the medicine.
   In order to feed the 5V output signal of the microcontroller to the magnetic solenoid, which needs 12V to be triggered, the researchers used a 5V relay module which amplifies

the voltage into 12V. Amplified voltage is then fed into the relay. The output of this relay is connected to the magnetic solenoid.

c) LED or light-emitting diode is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength. The output from an LED can range from red (at a wavelength of approximately 700 nanometers) to blue-violet (about 400 nanometers). Some LEDs emit infrared (IR) energy (830 nanometers or longer); such a device is known as an infrared-emitting diode (IRED).

d) Buzzer. The buzzer is provided to notify the patient that a medicine has been dispensed.

e) A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

f) Additional DC power.

3.2.Design 2.

Although the design number 1 is very easy to make and use, we were concerned about exposing the medications to air since the design did not include any physical protection from the outside conditions. This design, on the other hand, will consist of separate rectangle boxes for each pill. In place of dispensing one pill at a time we decided that storage of pills is more important, so we focus on that in this design. Also, each compartment will be electronically locked using a solenoid, and it will be opened only when the time is up.

After the medication is taken, the compartment needs to be closed manually and a button needs to be pressed. This will signal the controller to push the solenoid back, locking the compartment untill the next use.

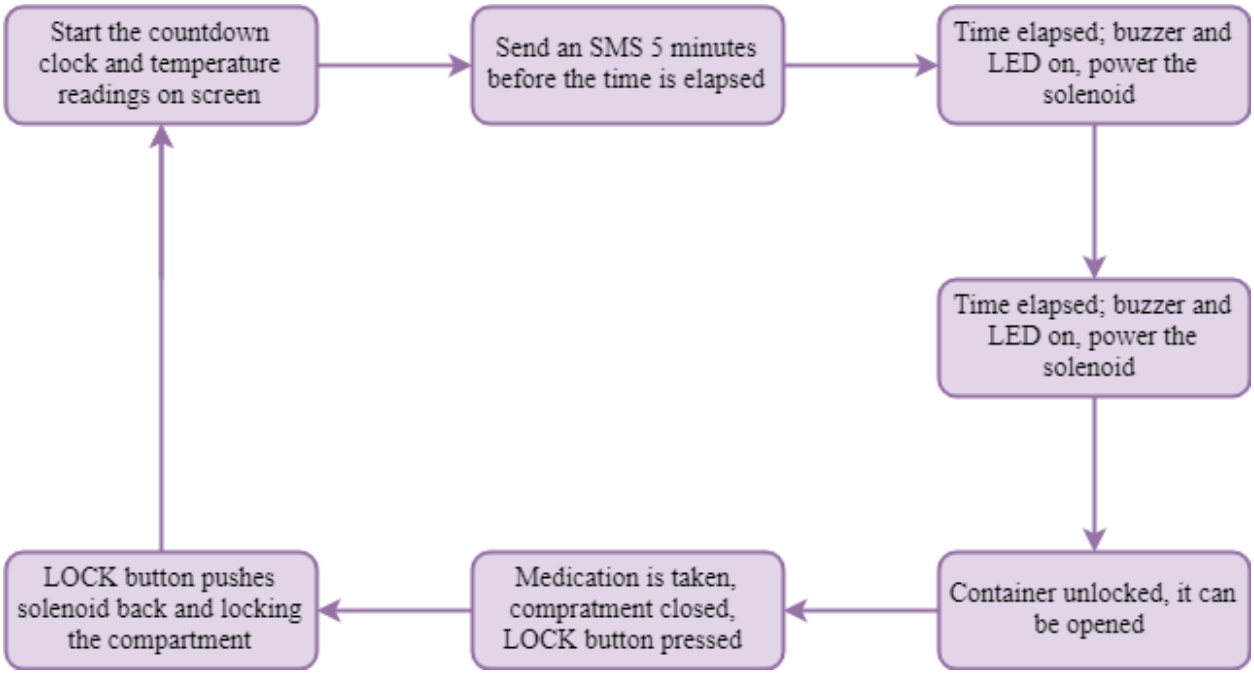


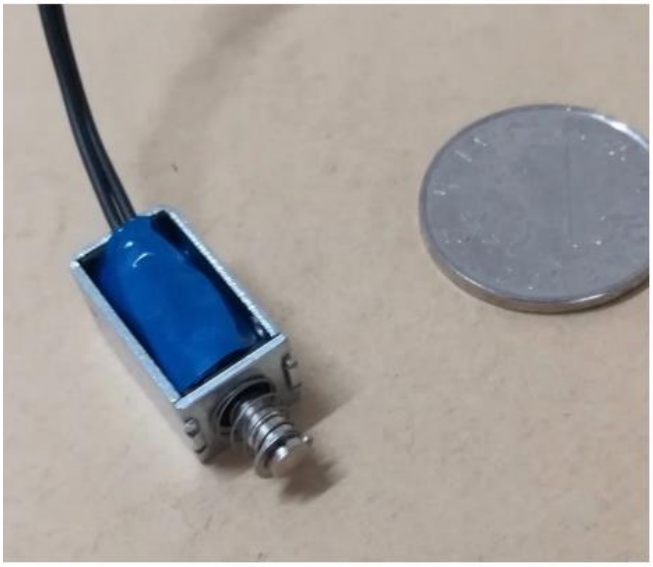
Diagram 1. Working of the dispenser

In the picture below we can see a product similar to the aim of this project. The Jon pill dispenser has a locking feature that allows users access to only the correct compartment at the correct dosage time; all other compartments will remain locked. The medication dispenser is electronic and can be controlled remotely using the MedMinder website.

Picture 2. A similar design, produced by MEDMINDER

3.2.1. Electronic components

a) Solenoid It is important to find a solenoid small enough not to encrease the size of compartments. W e find this particular one with dimensions of 9.8x11.3x21 mm to be the most suitable for this project.



Picture 3. Electromechanical solenoid

b) Arduino microcontroller
c) DC power
d) Buzzer
e) LED
f) LCD screen
g) GSM module

All of the components and their usage has been explained in section 3.1.1.

4. REFERENCES

1) http://www.euro.who.int/en/home
2) https://www.medminder.com/
3) University of Connecticut, Accessible medical device competition 2005-2006