EEL 4914 – Senior Design 1 Divide and Conquer
Senior Design Project Group 6 Fall 2017
In Home Pill Dispensary

1. Members:

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Sponsors:

Private Investor

2. Narrative

In the United States, the abuse and illegal distribution of prescription drugs is a large scale problem. Without measures in place to stop such actions the problem will never be ended. So, the question becomes what actions can be taken to make steps toward a solution, in comes the MEDLOCK (Patent Pending). In hospitals, there are machines that manage the distribution of medicine so that the nurses or patients cannot steal medication. This idea has yet to be extended to a personal home system, this is our proposed idea. A portable system that regulates the use and dosages of prescription drugs in an effort to reduce abuse as well as the selling of such drugs. Although this device is more aimed towards trying to help stop opioid addiction, it can also serve a purpose for those who often forget to take their medication. In the end, this device is designed to help regulate and monitor the prescription drug industry.

This project is sponsored by an outside party and many of their specifications are built into the schematic of the device. This product is to be similar to receiving a prescription from the pharmacy with many additional safety measures. There will be a casing that encloses the pills along with electrical components and a disbursal mechanism. There will be an LCD display that acts like the label on an ordinary pill bottle that shows the patient's name, dosage, medicine type, etc. The mechanism will allow a pill to be distributed every time the patient is required to take their dosage of medication. There will be a notification system to remind the patient when the pill is ready as well as a software mechanism to update the time of the disbursal of the next pill based on when the previous is taken. On top of this is, a lock, tape on the casing, and well as a magnetic sensor will be used to determined if the case has been broken into and if so the case will no longer be eligible for refills.

The main goal for this project is to develop a light weight, portable, and easy to use device that will help stop addiction as well as illegal sales of prescription drugs. We feel that this is an accomplishable project that could create a real impact in many people's lives today. Overall the idea of Senior Design is to get some hands on experience with real world applications and apply the knowledge that we have obtained in our college career to develop, test, and present a working device. We figured if we could do this while also creating a product that can truly help the world then the experience would become even more meaningful.

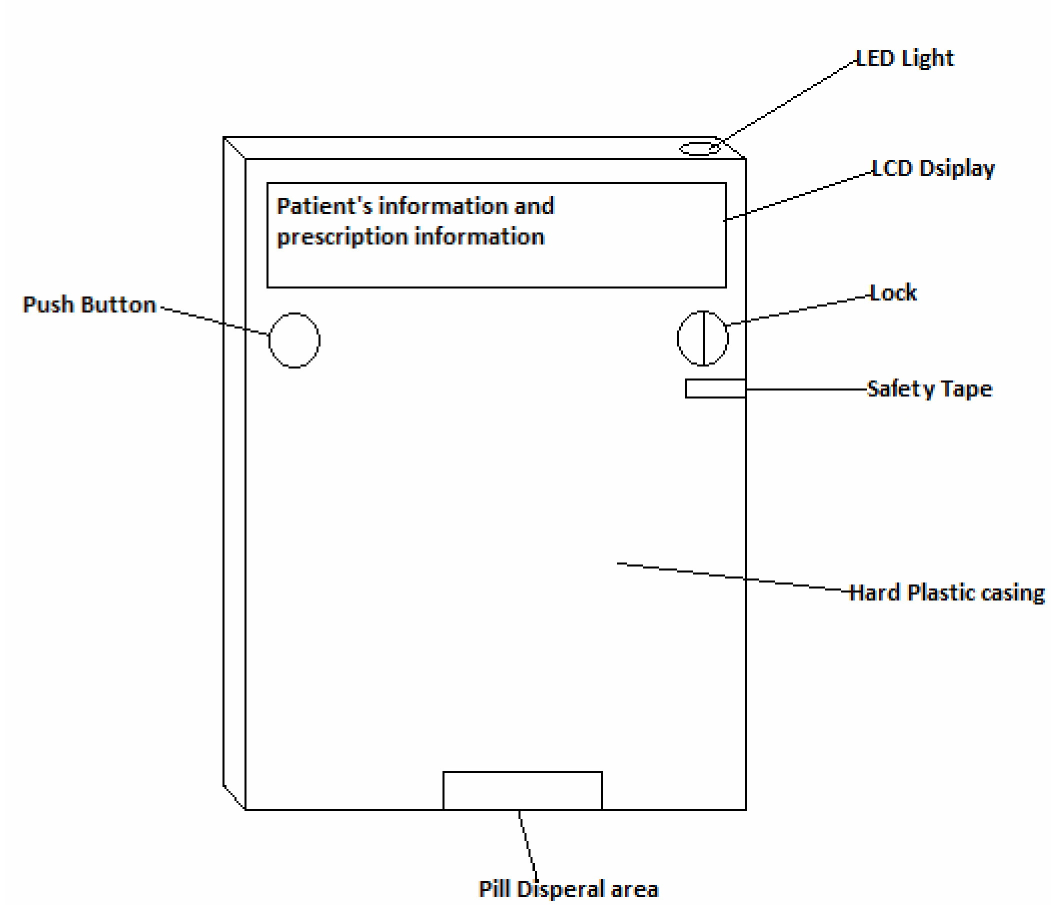


Fig. 1 This figure is a simple sketch of the outside of the device, showing what components will be visible from the outside.

3. Design Specs:

Specifications:

Size of device: Goal, 6 by 3 by 2 inches, realistic size 12 by 6 by 4 inches.

LED display: Shows patient's name, type of medicine, dosage, how often medication must be taken.

Database: Unsure on this aspect of device. Device would be able to connect to a database of patients for quick access.

Bluetooth connection: Phone will be able to connect to the device via Bluetooth so messages can be sent from the device to the patient's phone.

Piezo buzzer: Releases an audible sound if the patient has not taken their medication in a specific time frame.

Pill release mechanism: Small mechanism to ensure that the proper amount of pills have released at the proper time.

Notification system: Device would have audible, visual, and mobile alerts as to when the patient needs to take their medication.

Pill not taken system: Software that updates the time if the patient has not taken pill in specified range of time. This is to avoid over dosage and selling of pills.

Button to release pill: Physical button that patient presses to release pill once alerted.

Seal on container: Physical lock on device door, authorized colored tape to determine if device has been tampered with, as well as sensors that record when device has been opened.

Software to determine if refill is needed: When device is filled, the amount of pills in device is recorded as an input, every time a pill is dispensed; one is subtracted from that number.

Light Sensor: On the inside of the case to determine if the case has been opened.

Magnetic Sensor: Logs every time the device has been opened.

Sensor for proper pill amount: A mechanism will be designed that ensures the proper amount of pills has been release, unsure at this point.

Microprocessor: This will be used to keep track of time, date, and amount of pills. Will also be used for notifications of when patient needs to take medication.

PCB: Holds electronic components for communication between sensors, displays, and the CPU.

Power source: Battery source that can be charged.

Constraints:

Some known constraints at this point include the following:

The device is only going to be able to contain one type of pill at a time.

The device must be charged daily in order for patient to receive medication on time.

The size of the device is aimed to be small, but in a realistic term the device is most likely going to be a little bulkier than was originally thought.

The material used in the prototype is going to differ from the final product. The prototype material will be cost efficient for us, so it will not be the ideal material for this device.

4. House of Quality

When it comes to meeting expectations/specifications, perfection cannot be entirely achieved, especially when creating the first prototype of a device or invention. There needs to be certain compromises to ensure that what is being made meets what the customer is looking for as well as fulfilling credible requirements for the engineer in terms of quality and reliability. To represent this concept in a quantitative fashion, the use of the house of quality within a method of quality function deployment (QFD) would be useful.

The first step to creating this house of quality is to gather as much of the customer concerns and wants as possible. This should be considered the most crucial step to create and pay attention to since this is the reason the product is developed to begin with. Simply put, it is the selling point for the product to make it as desirable as possible. So far, it's known that the customers want:

- Compact
- Cost
- Security
- Ease of use
- Safety
- Attractive

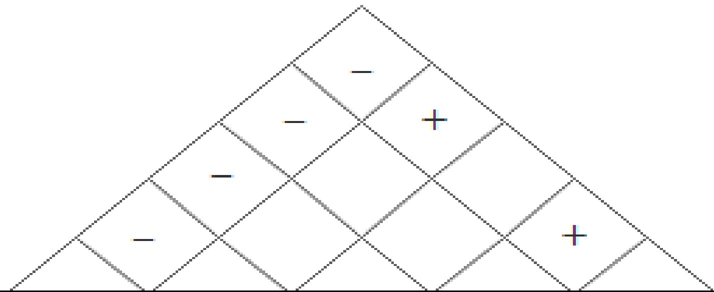
Normally, a planning matrix would be created next which would categorize the importance the customer had with each of the keywords above via a survey weighing each task on a scale. However, for the sake of simplicity, the priority list is represented by pluses and minuses.

The following part of the house creates the technical requirements to be carried out. These factors not only show what they are confident in accomplishing but it provides the customer with a contract to let them know that these items are what the engineer is accountable for. This can be, but are not limited to:

- Cost
- Power consumption
- Weight
- Reliability
- Sensitivity

Next, connecting the customer requirements with the technical requirements gives an overview of which items are to be considered more important to work on in relation to each other by the development team which is represented in the diagram below. Through this matrix, it should be understood which aspects create a strong relationship and if improving one would benefit the other in any way. Anywhere there is no symbol in the matrix; there is no foreseen positive or negative relationship when comparing the two items.

Moving on to the roof of the house shows which items from the technical list will either hinder or improve up the quality of other attributes of the technical requirements. This is shown by the pluses and minuses in his triangle of the root matrix. For example, increasing the sensitivity of the product could mean more precise and accurate materials to buy, meaning that the cost would increase as well, which isn’t something that is wanted hence the minus in the top tile.



		Cost	Power Consumption	Weight	Reliability	Sensitivity
		-	-	-	+	+
Compact	+	↑↑		↑↑		
Cost	-	↑↑	↓	↑	↓	↓
Security	+	↑			↑↑	
Ease of Use	+			↑↑		
Safety	+		↑	↑		
Attractive	+	↓↓				
		$100 min	< 5 W	< 2 lbs	3 Years, pill drops on time	<1% clock error

Legend	
↑↑	Strong Positive Relationship
↑	Positive Relationship
↓	Negative Relationship
↓↓	Strong Negative Relationship
+	Needs to Maximize
-	Needs to Minimize

5. Block Diagram

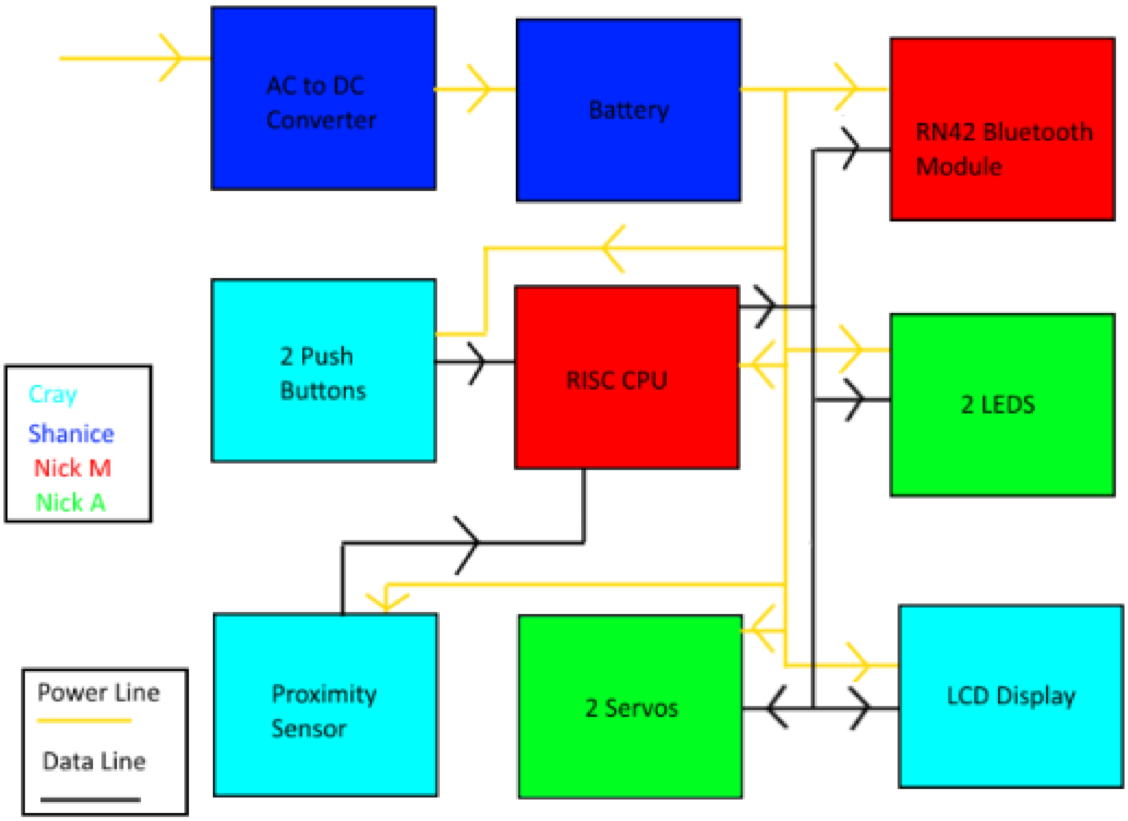


Fig. 2 This is a block diagram that shows the data flow and power flow of the device. It is also color coded, showing which members are responsible for which tasks.

6. Expenses

Parts	Estimated Cost
6 UART ports	
16-bit RISC CPU	$10: Comes with 1 KB RAM, 48 GPIO pins http://www.ti.com/product/MSP430F1471/description
8 KB flash memory	$2
512 Byte RAM	
Two ACLK clocks	

RN42 Bluetooth module	$19: https://www.sparkfun.com/products/12574
Micro piezo buzzer	$2: https://www.sparkfun.com/products/7950
Two 9-gram remote control servos	$6: https://hobbyking.com/en_us/hxt900-micro-servo-1-6kg-0-12sec-9g.html
Two push buttons	$1: https://www.sparkfun.com/products/9190
16x2 LCD display	$25: https://www.sparkfun.com/products/9067 3.3V
Two LED lights	$1-3: https://www.sparkfun.com/products/11453
24 GPIO	$2: https://www.sparkfun.com/products/14017
Rechargeable battery pack (unknown which on at this point)	
Plastic casing	

7. Project Milestones

First Semester:

- September
  - - Divide and Conquer completion
  - -Meeting with Senior Design Coordinator
  - -Review of Divide and Conquer
- October
  - -Assignment on Standards
  - -Prototype Design Creation (Drawing)
  - -60 Page Draft
- November
  - -100 Page Draft
  - -Final Paper

Second Semester:

- January
  - -SolidWorks Design to 3D print casing
- February
  - -Creation of PCB and Software
  - -Testing of PCB and Software
  - -Write software for microprocessor
  - -Test software for microprocessor
  - -Creation of disbursal mechanisms
  - -Testing of disbursal mechanisms
- March
  - -Combining the component to make one unit

April	-Test all components as one unit -Testing of overall system and make final adjustments -Demonstration and presentation of finished product