Mock Design Review
Top Level Block Diagram:

Legend:
- Power Line
- Control Signals
- Electrical - Mechanical Interactions
- Pill Movement
- Pills Dispensing into External Pill Case
- Pill Box Placed on Rotation Plate
- Wireless / Internet Communications
Mechanical Design Diagram:

Front Cross-Section View:
Single Pill Dispenser System:
Rotation Plate:

- Placement Aids
- Direction of Rotation
- Pill Box
- Reflective surface
- Rotation Plate
- Dispensing Funnel
- Pill Compartments
- Force Sensors
Wireless Communication Part:

Block Diagram:

The Arduino Yun has the ability to act as an Access Point, and it can also connect to an existing network. The Arduino Yun has two processors on board. On the left is ATmega 32U4, and on the right is Linino AR 9331. These two processors communicate by Bridge Library in both directions. ATmega 32U4 is in Arduino Environment; Linino AR 9331 is in Linux Environment, which runs Linux and the OpenWRT wireless stack, enabling the board to connect WiFi, IEEE 802.11b/g/n, and Ethernet networks, 802.3 10/100Mbit/s. If it works perfectly, ATmega 32U4 is able to receive/transmit data by/to data path, and through the Bridge, Linino AR 9331 and ATmega 32U4 can simply communicate in both directions. If Wi-Fi is ready, Arduino Yun is able to interact with Cloud, obtaining and sending data from Cloud, which will be also connected to the App.
Power Supply:

Block Diagram:
Power Supply Transformer and AC/DC Converter Calculations:

Input Ratings: 120V AC
Output Ratings: 5.25V DC, 1.35A, Change is output voltage less that +/-1%

\[
\begin{align*}
\text{Power} & = I \times V = 1.35A \times 5.25V = 7.09 \text{ Watts} \\
\text{Resistive Load} & = \frac{V^2}{P} = 3.89 \text{ Ohms} \\
\text{ Turns Ratio} & = \frac{V_{1,\text{max}}}{V_{2,\text{max}}} = \frac{N_1}{N_2} = \frac{120\sqrt{2}}{5.25} = \frac{N \text{ Turns}}{1} \\
N \text{ Turns} & = 32.38 \approx 33 \text{ Turns} \\
\Delta V_{\text{out}} & = \frac{V_{1,\text{max}}}{2(\text{Freq.})(\text{Resistive Load})(\text{Cap.})} \\
\Delta V_{\text{out}} & = 0.1V = \frac{5.25V}{2(60\text{Hz})(3.89\Omega)(0.1\text{V})} \\
C & = \frac{5.25V}{2(60\text{Hz})(3.89\Omega)(0.1\text{V})} = 0.1042 \text{ Farads}
\end{align*}
\]

Circuit Schematic:
Preliminary Simulations Results:

**Figure 1.** Simulated waveforms from primary and secondary sides of the transformer. The green waveform displays the primary voltage with an amplitude of 170V. The blue waveform displays the secondary voltage with an amplitude of 5.36V.

**Figure 2.** Simulation results displaying the output voltage of the rectifier circuit. The amplitude of this waveform is 5.28V.
Figure 3. Simulation results displaying the output voltage of the rectifier circuit (Green), 3.3V Regulator (Red), and 1.8V Regulator (Blue).

Requirement and Verifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
<th>Points</th>
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| 1. Power Supply  
a. Provide 5V +/- 0.25V DC, with minimum current of 100mA +/-25mA  
b. Provide -5V +/- 0.25V DC, with minimum current of 2mA +/-0.25mA  
c. Provide 3V +/- 0.25V DC, with minimum current of 1.8A +/-0.1A  
d. Provide -1V +/- 0.25V DC, with minimum current of 2mA +/- 0.25mA  
e. Convert 120V AC to 5 +/- 0.25V DC, with minimum current of 1.18A +/-0.1A | 1. Power Supply  
a. Measure each output voltage (5V, -5V, 3V, and -1V) by placing multimeter probes in parallel with each respective source. The voltages should be within the requirements.  
b. Measure each output current by placing multimeter probes in series with each respective source. The current should be within the requirements. | 20 |
| 2. Barcode Reader  
a. Read UPC standard barcode and transmit data to MCU as an integer set. | 2. Barcode Reader  
a. Connect reader to MCU and scan any UPC standard barcode with the reader. The | 5 |
<table>
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<tr>
<th>2. Barcode</th>
<th>returned input data should be a set of integer as encoded in the UPC barcode. b. Place barcode 5 cm away from the scanner to see if results can be obtained from the MCU.</th>
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| **3. Wireless / Internet Communication Module** | **3. Wireless / Internet Communication Module**
| a. Set up the Arduino Yun connect to Wi-Fi b. Enable Arduino Yun communicate with the Cloud | a. When Wi-Fi is ready, Arduino is able to be programmed wirelessly. Specifically, when connected it with a LED on PIN 13, we should be able to control the LED remotely. b. Arduino is able to work with other online platforms, specifically be connected to internet services with Temboo, which Arduino has partnered with. If it works perfectly, Arduino should be able to mix and match data from multiple platforms, such as Twitter and Facebook. |
| **4. MCU (Arduino)** | **4. MCU (Arduino)**
| a. MCU must have enough analog and digital inputs and digital and pwm outputs to support barcode reader, wireless module, sensors, and motor control outputs. b. Must be able to run from 5 to 10 volts. c. Processor must have clock of at least 16MHz. | a. Check that there is enough analog and digital input and output ports of the needed type. b. Power up MCU with voltage between 5 to 10 volts to see if it has proper function. c. Run simple program to check running time. |
| **5. Servo Motor** | **5. Servo Motor**
| a. The servo must have a rotational freedom of 180 degrees +/- 5 degrees and must be able to rotate clockwise and counterclockwise. b. Must be able to accomplish a 90 degree rotation in 15 seconds with tolerance of +/- 5s. | a. Provide power to servos to check rotational freedom in both directions. b. Time the time needed to do a 90 degree rotation. Repeat 5 times and take the average for requirement check. |
| a. Motor must rotate 360 Degrees b. Must be able to accomplish a 90 degree rotation in 10 seconds with tolerance of +/- 1s | a. Provide power to motors to check rotational freedom in both directions. b. Time the time needed to do a 90 degree rotation. Repeat 5 times and take the average for requirement check. |
| 7. Force Sensors  
a. Force sensor must have at least a difference in resistance of 0.05 +/- 0.02 ohm for every 325mg. | 7. Force Sensors  
a. Rest the force sensor flat on the table and measure its resistance. Then place a ~325mg aspirin pill on the sensor and see if the new resistance is at least 0.05 ohms or within the tolerance from the resting resistance. | 5 |
|---|---|---|
| 8. IR Sensors Network  
a. Sensors must be able to provide a difference of 1V (+/- 0.2V) when it sees reflective surface on pillbox and when it is not or when a pill is blocking the emitted IR wave from its corresponding detector.  
b. Must be able to provide said accuracy from 8cm (+/- 2cm) away from the pillbox for reflective IR sensors. The desired accuracy must be obtained when the emitter and detector are apart by 1cm (+/- 0.2cm).  
c. Must run on 5V +/- 1V.  
d. Fall time of IR detector must be 5.54 +/- 0.24 ms or significantly lower. | 8. IR Sensors Network  
a+b. Measure output when reflective surface is placed 8cm away from sensor and when it is not to see if 1V difference is observed. Place a pill in between the 1cm spacing of the emitter and detector to see if a 1V difference can be observed with the pill and without the pill in between.  
c. See if sensor responds when 5V is applied.  
d. Set up oscilloscope trigger to run when voltage from detector start to decrease and see how long it takes for the detector voltage to drop to a low voltage value. | 10 |
| 9. App  
a. App must be able to operate on an Android smartphone or iPhone.  
b. Must be able to provide correct medicine intake time notification to user with accuracy of +/- 5min.  
c. Must contain database of common prescription drug for input of prescription.  
d. Must upload correct amount of pills to dispense to the backend server with 100% accuracy. Fail upload rate must be limited to 0.01%. | 9. App  
a. Open app on Android or iPhone to see it is able to start.  
b. Set notification time and wait to see if notification pops up at the stated time. Do this 20 times to see if notification time is within the tolerance.  
c. Check database with list of common prescription drug list.  
d. Upload prescription to server and check if the correct pill and its amount are uploaded. Do this 20 times to ensure no error occur. | 10 |
Safety

The pill dispenser will be drawing its power from the a standard 120V AC wall outlet. Precaution must be taken to avoid malfunctioning of power supply.
- Only plug into 120V AC outlets.
- Do not short the power supply.
- Do not leave Dispenser, especially the power cord, in a humid environment
- Before use, always check for damage to the power cord.
- Do not use device in high temperature environment.

The dispenser will rely on motors for the majority of its functions. The following rules should be followed whenever working on these motors.
- Do not touch the motors while power is provided to it.
- Do not short the motor.
- Do not provide power above the motor’s power rating (Add number later)

Infrared and Barcode Scanner usage should follow the rules below.
- Not not directly look into an IR emitter.
- Do not point IR at someone’s eye.