Automated Pill Dispenser for Medication Management

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Motivation

Often times, an overlooked aspect of treating an illness occurs on the patient end in medication management. About 1 in 3 medication non-adherence cases are caused by forgetfulness, and the monetary effect of non-adherence reaches $100 billion per year in the US alone (Stawrz 2014). The term “stressed adherence” refers to emotional pressure resulting from the perceived danger of forgetting to take medication, and patients in one study have reported the difficulties in dealing with this pressure and lack of guidance or help from healthcare professionals (Hasbeck 2009). In order to address this issue, we have developed an automated device to match the individual’s medication regimen and eliminate medication non-adherence through a built-in notification system.

Design

Input

LCD Touchscreen: User interfaces with LCD capacitive touchscreen to input their pill regimen details (day, times, number of pills) and the pill compartment number. Users can also view their pill schedule or dispense pills immediately to take later.

Arduino Mega: LCD inputs are stored by Arduino Mega, and when pills should be dispensed, the Mega serially sends a two digit number to the Arduino Uno, designating the pill compartment and number of pills to dispense.

Mechanism

1. Compartment Calibration
   The pill compartments rotate until the infrared (IR) sensor module detects a block attached to the compartment. The signal stops the compartments such that the first compartment is aligned with the pill box.

2. Select Correct Compartment
   The pill compartments rotate the correct number of steps in either direction, as determined in the code through an optimizing function.

3. Insert Pill Box to Retrieve Pill
   The pill compartment and the pill box attachment is powered by a bipolar stepper motor. Extension speed and distance for pill retrieval are defined in the code.

4. Sense Pill Captured
   The IR sensor sends a CV signal to the Uno when a pill drops through its 15° cone of view into the outlet.

Final Product

Assembled pill dispenser with LCD display and lid removed to demonstrate wiring, pill box and rack-and-pinion, and slide

Pill dispenser with LCD display in place

Output

LED: Visual component of alarm system, beeps on and off to alert users that pills have been dispensed.

Auxiliary Components

Spring-loaded Compartment Block: Designed to prevent uncontrolled dispensing of pills. The block is compressed by the pill box and decompresses to block the opening in the capture zone.

Motor Driver: Establishes an electronic connection between Arduino Uno and each stepper motor.

USB Hub: Commercial 5 port USB power strip to provide 5V to LCD touchscreen, Arduino Mega, Arduino Uno, and both stepper motors.

Isolated Individual Pill Compartment View

Each compartment has sloped interior surfaces to funnel pills towards the opening. Controlled delivery of pills is controlled by a spring-loaded box.

Obstacles

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
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<tr>
<td>Pill box and pill compartment opening would often become misaligned during and after dispensing</td>
<td>Incorporate IR sensor to sense a block attached to bottom of pill compartments, allowing location calibration</td>
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<tr>
<td>Despite the pill compartment’s overall slope towards the capture zone, sometimes pills would not fall into the capture box</td>
<td>Implement function in code to quickly rotate pill compartments back and forth prior to dispensing to shake pills into capture zone</td>
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<tr>
<td>Even with pill compartment shaking before dispensing, sometimes pills would not fall into capture box</td>
<td>Incorporate IR sensor in pill slide to sense when a pill is successfully dispensed. Repeat dispensing if no pill is dispensed</td>
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<td>Motor driver H-bridge quickly heated and became too hot to touch</td>
<td>Affix aluminium heat sinks and add fan with inlet and outlet vents</td>
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Future Directions

Bluetooth App

We plan to implement a smartphone-based application as an added feature in the notification system. Because smartphone usage is becoming increasingly more common and widespread, including this functionality should help to further reduce medication non-adherence due to forgetfulness.

Patient Feedback System

One feature to improve healthcare by providing doctors with more information would be a system where patients are prompted for comments such as any noticeable side effects or irregularities associated with the medication. This feedback would be relayed back to healthcare professionals so that there can be a more direct line of patient-provider communication.

References


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