Smart Pill Tray for Medical Adherence

Introduction

Medication adherence refers to whether patients take their medications as prescribed. In last two decades, it invokes a growing concern to clinicians as people, especially among elderly patients, forget to take their pills [1]. With the demand on market, pill trays with pre-programed multi-functions become a possible solution to the problem. This paper reviews current on-market pillboxes that utilize embedded system and send data to user devices.

Commercial applications for wireless connected pillboxes

Bottle caps

Vitality develops cellular-connected caps that fit on regular pill bottles [2]. The caps connect through cellular network with a data base station to constantly update and synchronize. Each bottle cap has multiple functions including: voice speaker to remind patients, text reminder on mobile devices like cellphones, and external refill request button [3].

Bottle (as a whole)

AdhereTech builds a “smart” bottle that senses the amount of medication inside the bottle and updates the value to the cloud server [2]. Furthermore, the OS software API offered by the company leads to an integration of hardware, mobile software and medication platforms. The retail fee is about two dollars each. Another type of pillbox, called uBox, is owned by Abiogenix [2]. It connects to schedules and calendars stored on user mobile devices. At the beginning of dosing time, it unlocks itself and automatically supplies desired medicine. This feature prevents accidently overdosing. The product does not retail; instead, the company cooperates with insurance company, clinical center and pharmacy to supply a complete solution that covers from the beginning of prescription to the end of recovery.

Calendar-bottle

Medminder comes up with an integrated solution that targets patients who take more than three or four pulls a day [4]. The box appears like a physical calendar with speaker, LED and cellular connections built in. It reminds patients by text message, lightening, phone call, and voice. The data collected such as miss-dose and over-dose is transferred to a family member or caretaker directly.

Underlying technology for pillboxes

Wireless connection

In order to send real time data to user devices or cloud base, pillboxes have internal cellular integrated circuit chip that periodically uploads data to the cloud. Other types of pill trays use Bluetooth low power connection for short distance coverage. Typical microcontroller such as nrf52 has on board BLE capability that realizes this connection [5].

On-bottle sensor

Various types of sensors are implemented in pillboxes and each depends on design topology. Weight sensors detect the mass of pills inside and send out a digital signal to indicate if the bottle is filled. Distance sensors detect if the bottle cap is removed. Sonar sensors detect if an object passes through the bottle cap and thus assumed a pill is removed.

Indicator

LEDs emit visible light signaled as a reminder for users. Speakers play various tones and volume satisfying custom demands [6]. On box screen functions as a human interface to display current status of the bottle.

Building blocks for implementation

The first phase involves circuit assembling and testing. The prototype circuit is wired on breadboard with microcontroller and corresponding sensors. The second phase includes a phone application development as well as wireless connection between the phone and microcontroller. The third phase needs pill tray physical design and 3D printing. Then the final prototype pill tray can be tested and evaluated.

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