INTERNET OF THINGS LIDAR PILL CAP SENSOR

BACKGROUND OF INVENTION

[0001] LIDAR sensing has been applied to gross mapping of 3D surfaces on Unmanned Aircraft Vehicles and other large macroscale problems. Existing solutions function using two distinct methods: The first is a mechanical counting mechanism that requires medication to be fed into an apparatus that dispenses the drugs with a hopper-style device that tracks the number of dispensing actions.

[0002] The second involves a piezoelectric/incapacitance mass measurement. These systems utilize piezoelectric materials or implanted electrodes to sense alterations to enclosed mass dielectric constants within a controlled pill container volume. These methods require (1) physical contact with medication or (2) measurements from sensor that are substantially altered by even slight alterations to environmental conditions. These existing solutions thus impart potential risk for medication contamination through physical device-medication interactions. Furthermore, piezoelectric/incapacitance based systems rely on a consistent pill container orientation for reliable measurements and are thus severely limited by real world use.

SUMMARY OF INVENTION

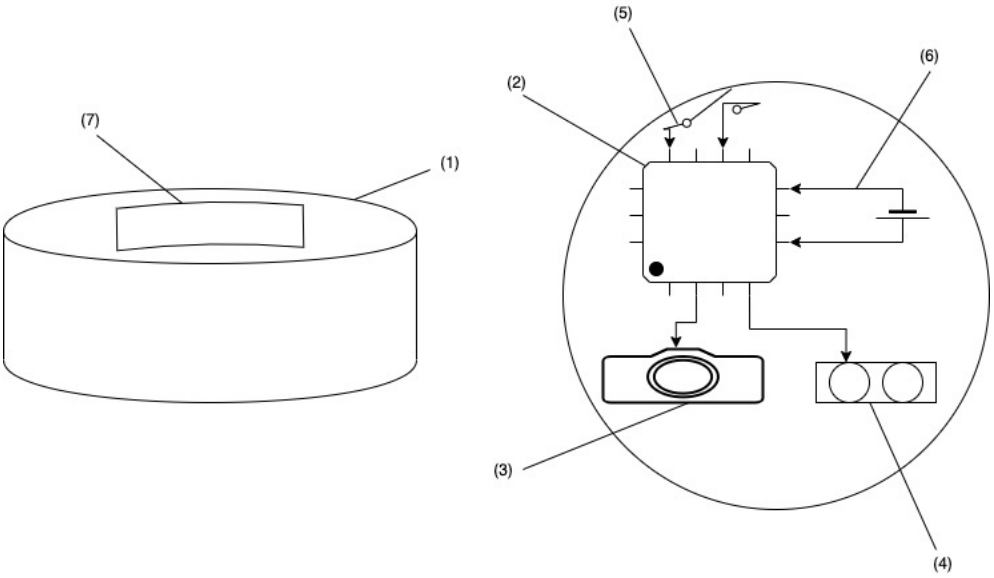
[0003] The solution described herein is designed to integrate LIDAR technology to accurately count the amount of medication in a container and uses a cloud-based application to monitor patient medication adherence. More particularly, the present invention uses a LIDAR approach for small length-scale topology sensing within medication bottles. Furthermore, this sensing device is Internet of Things (IoT) enabled and interfaces with a phone calling application programming interface (API) to encourage medication adherence.

[0004] The proposed invention does not require direct contact with enclosed medication for proper function. Instead, the invention works through counting medication quantities using the LIDAR sensing array and uses differences in measured pill quantity to determine the medication being taken. This allows the device to take up less space than existing solutions and does not require a dispenser to count pill quantities. This allows for greater portability, and the Internet of Things (IoT) electronics eliminate the need for frequent recharging or an external power source.

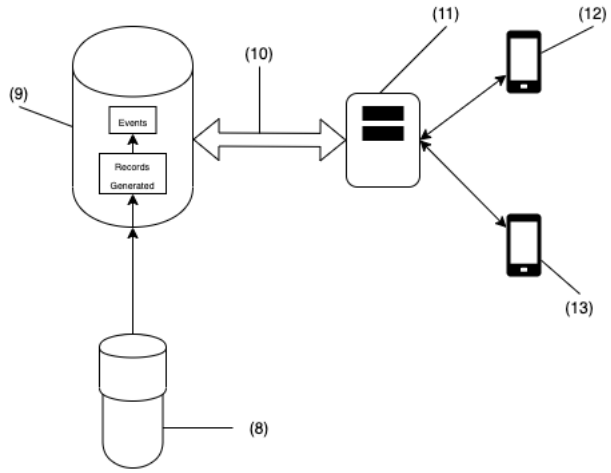
[0005] The device uses a Time-of-Flight sensor and a 3D infra-red dot projector/sensor to sense the depth and surface topology of pelleted medications. Based on established capsule volume standards utilized in the pharmaceutical industry and a scaling factor output of a machine learning model the described device detects approximate pill quantity in a contactless manner. The described devices is a one-piece unit, all required components are housed in the standard sized “pill cap”. The pill cap is IoT enabled, such that the consumer can select dosage and administration frequency parameters. The IoT device creates an event calendar which is triggered at the user-defined interval. The device has a contact/pressure dependent trigger which activates upon pill cap opening. During the medication dosage window, the IoT device scans the interior volume to detect alterations in bottle contents/cap opening every 5 minutes for 7-14 times depending on the dosage window. The device will push an incident claim of noncompliance to the IoT server if no change is detected in either interior medication topology or the open trigger. The server will follow-up on the noncompliance claim using a phonecalling/texting API to message a phone number (designated contact) linked to the IoT’s device key.

DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0006] In the accompanying drawings, which form a part of the specification and are to be read in conjunction therewith in which like reference numerals are used to indicate like or similar parts in the various views:



[0007] Fig. 1 and 2 illustrate a design for the pill cap sensor featuring a cellular-band IoT microcontroller chip (2), passive LCD display (7), a 3D infra-red dot projector (3), time-of-flight Sensor (4), and a mechanical pressure sensor (5). The entire apparatus receives a voltage supply from a standard battery (6) inside the sensor. The functions of each component are detailed in further sections.



[0008] Fig. 3 illustrates a designed server implementation built around the device (8) that upon triggering from the device, adds a record to a storage server (9), which triggers an event that causes a serverless function (10) to trigger based on the event that sends data to a phonecalling server (11) that separately call the target phone (12) and recipient phone (13) and routes the separate calls through the server that simulates conferencing to merge the calls.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Fig. 1 and 2 illustrate a sketch of an integrated LIDAR sensor arranged to detect the location of millimeter sized pelleted pharmaceuticals. The LIDAR systems works to approximate the quantity of items within a container using information obtained from the 3D infra-red dot projector & infra-red sensor to determine the internal topology of the container; this data is married with ranging information acquired from the Time-of-Flight sensor to determine the plane at which the defined topology resides with respect to the pill cap. Given these data, established capsule volume standards, and a scaling factor output of a machine learning model the described device detects approximate pill quantity in a contactless manner with minimal error.

[0010] Fig 3. Illustrates a model for the server-side implementation of an IoT LIDAR sensor that uses a HIPAA-compliant storage server to store events and keep history of incident claims, and

uses an event-driven application to trigger an event on another phonecalling server system to call the phone number specified in the emergency contact linked to the ID in the storage server. In this implementation, records are tied and hashed through the button's ID, but specifics of storage and access will depend upon need. If the phonecalling server is able to connect the emergency contact to the patient's phone, it pushes a resolved claim back to the storage server to mark the incident as resolved; if it fails to contact the emergency contact, it will attempt a second call, and if there is an additional failure, it will continue to try connecting the patient to other emergency contacts. If enough failures happen, it will cease in attempting to connect the patient to a contact and close the incident claim with a special "resolved-expired" property to note in the app that the medication wasn't taken.

[0011] From the foregoing, it will be seen that with a well-trained algorithm, the LIDAR pill cap sensor possess the distinct advantage of being able to estimate the number of pills in a bottle while expending minimal resources do so, whereas other methods such as a camera-based machine learning algorithm require powerful processors and are impractical, while other alternatives such as a custom apparatus that can individually hold and dispense pills similar to an ammo clip are too bulky and have difficulty working with a wide array of pill sizes. It will be understood that certain features and sub combinations are of utility and may be employed without reference to other features and sub combinations. This is contemplated by and is within the scope of the claims. Since many possible embodiments of the invention may be made without departing from the scope thereof, it is also to be understood that all matters herein set forth or shown in the accompanying drawings are to be interpreted as illustrative and not limiting.

[0012] The constructions described above and illustrated in the drawings are presented by way of example only and are not intended to limit the concepts and principles of the present invention.

Thus, there has been shown and described several embodiments of a novel invention. As is evident from the foregoing description, certain aspects of the present invention are not limited by the particular details of the examples illustrated herein, and it is therefore contemplated that other modifications and applications, or equivalents thereof, will occur to those skilled in the art. The terms “having” and “including” and similar terms as used in the foregoing specification are used in the sense of “optional” or “may include” and not as “required”. Many changes, modifications, variations and other uses and applications of the present construction will, however, become apparent to those skilled in the art after considering the specification and the accompanying drawings. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow.

ABSTRACT

The IoT LIDAR Pill-Cap sensor is a low-cost method to detect the quantity of pills in a bottle and track medication compliance. It is able to trigger server-side events in an attempt to make sure the patient is compliant, as well as notify caretakers/emergency contacts of noncompliance.