The integration of smart features will: 1) allow only authorized patients access to their pills (only) at the right time and at the correct dosage; and 2) allow the prescriber and pharmacist to observe data generated by these sensors to remotely monitor product removal and help support pain management.

[0030] Bottle **21** of FIG. **1**A secures a bottle-cap **25** with fingerprint recognition technology using a single RGB camera **28** equipped with a standard CMOS sensor through which the colored images of persons and objects are acquired. A Frustrated Total Internal Reflection (FTIR) finger print image is captured by the user placing his or her finger on a right angle prism **29**. The fingerprint is illuminated using an array of white light LEDs **32**. Fingerprint recognition is performed using an on-board microprocessor **34**. A container body **35** of the bottle is secured against physical tampering by integrating a dual-walled layer including a water solution of aversive compound **36**. A compartment vial **38** of container body **35**, between the dual walls will release the aversive compound on pills **23** inside bottle **21** upon tampering with the bottle, which will render the pills unconsumable. Bottle-cap **25** is attached to the bottle body **35** using a hinge **37** and a biometric controlled locking mechanism **43**. The on-board microprocessor is powered using a non-rechargeable battery **49** in container body **35** on cap **25**.

[0031] A second embodiment bottle **121** of FIG. **1**B replaces the right-angle glass prism in FIG. **1**A with a thin glass sheet **123**. Bottle **121** of FIG. **1**B comes equipped with a dual camera **124** and **126** setup mounted back-to-back to each other. Camera **124** is pointing upwards to capture a direct view **126** is fingerprint image of the finger placed on thin glass sheet **123** mounted on a removable cap **125**. Camera **126** is pointing downward to image contents of a container **135** of bottle **121**, which is then processed to count the number of pills **23** in the bottle. A hinge **137** and locking mechanism **143** of the FIG. **1**B embodiment are also equipped with weight sensors **145** for measuring the weight in the bottle (discussed in greater detail hereinafter with regard to FIG. **6**), which augment the pill counting mechanism based on the image captured by camera **126**. The bottle comes equipped with Bluetooth and NFC technologies, which it uses to pair with any smartphone device **147** for utilizing its computing resources for analyzing the bottle's usage statistics.

[0032] Unlike the version of FIG. **1**A, the present exemplary FIG. **1**B bottle uses a wireless charging pad **110** for powering its on-board microprocessor **134**. The wireless charging pad can further draw power from a power supply **112**, such as a wall socket or a portable battery bank. A base or bottom **151** of the bottle is equipped with a compatible wireless charging coil **111** as shown in FIG. **2**B.

[0033] The sensing and computation procedure requires DC power, which is usually obtained from batteries. However, use of a battery would make the pill bottle bulky in size and impose a recurring cost. Hence, an RF power harvesting mechanism, such as coil **111**, is implemented at the bottom part of the pill bottle, preferably as a high-density coil. A detailed block diagram is shown in FIG. **3** for the wireless charging and the energy harvesting. Bottom coil **111** receives the AC signal with mutual coupling of the coil. The signal is rectified in the diode rectifier bank to convert AC into DC power. However, the generated DC is unregulated and needs a voltage regulator for a regulated supply. Once the regulated power is generated, it can power up the processing unit, the MCU and other sensors.

[0034] Referring to FIG. **1**C, a software-enabled bottle **221** contains multiple sensors namely: an RFID sensor **261** (see FIG. **4**B), an optical sensor using a camera **224** and a weight measurement sensor **245**. The model of FIG. **1**C has all the features of the model of FIGS. **1** and **9**B. The FIG. **1**C bottles **221**, however, are additionally equipped with Wi-Fi technology, including a transmitter and receiver **263** mounted to the bottle, and can connect to the internet. Therefore, the bottles can be remotely monitored and controlled by healthcare professionals or caregivers **264** via a monitor station **267**. Also, this bottle **221** comes equipped with a circular array of far-field microphones and a speaker unit **215** mounted on top of the bottle cap **225**. Microphone-speaker unit **215** is used to operate a voice based digital assistant on the bottle itself. The digital assistant can assist a user **226** with correct usage of the bottle and can provide an additional layer of biometric security using voice recognition technology.

[0035] RFID sensors **261** are mounted to cap **225**. Furthermore, an electrical circuit **265** of a lockout mechanism **243** with a processing unit **234** is shown in FIG. **5**. The processing unit is responsible for obtaining necessary information from the sensors and activates lock **243** upon authorization. The lock out is an electromagnetic lock mechanism **243** having a small size and an electronic control.

[0036] The basic block diagram of the RFID sensor is shown in FIG. **5**. The sensing unit consists of two parts: 1) an RFID reader **265**; and 2) an RFID card **267**. The RFID card has the ID, which is read by the reader. Reader **265** is installed on top of cap **225** of the pill bottle along with a processing unit **234**. The bottle verifies each user with a valid RFID **267** card and provides acknowledgement signal to processing unit **234** for opening a push-pull lock **343** (see FIG. **4**B) which is operably received in a hole **269** (see FIG. **4**C) in an outer wall of container **235** at an optional reduced diameter neck. The reader has a RF oscillator **271**, which generates the RFID frequency. The low power RF signal is amplified by a power amplifier **273** and transmitting coil **261** is excited. To miniaturize the system, the transmitting coil is designed around cap **225**. If an RFID card is present within the electromagnetic field, a perturbation is observed, which is compared at a comparator **275** with a reference voltage **277**. The sequence of ID is read and sent to microcontroller unit (MCU) **234**.

[0037] Also a weight sensor **145** is implemented as shown in FIG. **6** to estimate how many pills **23** are dispensed and/or to prevent drug abuse. For this, a piezo resistive based thin film is inserted in between pill container **235** and a pill bottle bottom **251**. The piezo film changes the RFID sensor circuit architecture based on its resistance according to pressure applied on it. From the resistance of piezo film **145**, an estimate of the number of pills **23** is obtained. The resistance is measured by processing unit **234**.

[0038] Reference should now be made to FIGS. **7**, **8**A-F and **9** to understand the anti-tampering features of the present bottle **321**. The present embodiment of this bottle device **121** combines RFID sensor, biometric authentication sensors, and a lockout mechanism that secures prescribed drugs **23** and prevents unauthorized individuals **301** from accessing them. This smart pill device prevents young children and adolescents from accessing pills found at home. To make it able to divert force—induced package-tamper-