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Designing A Prototype of Implantable Digital Pill using Internet of Things(Iot)

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Abstract: *The Radio pill is the most innovative technology in telemedicine system, which transmits the data of the inner body to the outside world. With the advent of IoT (Internet of Things), this technology has now become the solution to monitor the internal gastro-intestinal mechanisms. Since our today's food plays an important role in the body's poor metabolism rate which leads to the several disease such as ulcers, cancers, etc. Hence the prototype of digital pill based on the IoT has been developed to monitor the gastro-intestinal part of the body and to monitor the body's parameters using IoT.*
Keywords: *Digital pill, Gastro-intestinal, Metabolism, Parameters, Telemedicine*

I. Introduction

A radio pill is a capsule containing a miniature radio transmitter that can be swallowed by a patient. During its passage through the digestive tract it transmits information about internal conditions (acidity, etc.) that can be monitored by means of a radio receiver near the patient. Such capsules can contain video cameras and light sources to examine the bowel. Whereas a **digital pill** is a dosage that contains an ingestible sensor inside of a pill. The sensor begins transmitting medical data after it is consumed. The technology that makes up the pill, as well as the data transmitted by the pill's sensor, are considered to be part of digital medicine. The purpose of the sensor is to determine whether the person is taking their medication or not (called "adherence").

Digital pills are ingestible miniaturized electromechanical devices representing a point of convergence between biomedical technology, medicine and the pharma industry. Electronics, sensors and miniature robotic technology can give access, analyze and manipulate the body from the inside. In particular, smart pills for drug delivery are an emerging technology; many different approaches to local drug delivery have been proposed, including transcutaneous and implantable means. Anyhow, swallowable smart pills for drug delivery are receiving increasing attention as the oral one is still the preferred route for drug administration, due to its high patient acceptance and low cost . In previous system, radiopill find only the alcohol in our body due to some changes in the normal pH level. In proposed system radiopills find whether the food will be digest or not digest. Here we using machine learning to identifying what kind of food. Then people can easily know this information through the pc by IOT.

II. Literature Survey

Jose Luis Merino proposed that a glass pill for digestive motility tracking with wireless communication is presented. It is to determine its position inside the digestive tract has been implemented by an integrated CMOS solution for low-power consumption and integration in a smaller encapsulation. The building blocks of the system have been presented where trimming of design parameters are highlighted for satisfying the system requirements on accuracy[1]. The main limitations of this proposal was
(i) It can analyse only the digestive tract.
(ii) Magnetic coil inside the digestive may cause severe digestive problem.

Rosa Goffredo approached a smart pill includes a drug delivery system feasible for oral administration with its small dimensions, low power consumption (electrolytic pump, CTPE sensor) and biocompatibility, assured by a proper selection of materials (e.g. PDMS membrane in contact with drug; saline electrolytic solution, Pt electrodes). It is used to achieve the local therapy on gastrointestinal tissue but not as a solution for the problem.

The data acquired with the increasing viscosity of the solutions, showed that measurements performed synchronous with the ingestion of food could be affected by the increased response time. In context, considering the slow passage speed in the gut, signals could still be detected within an accuracy of 30 mm in the small intestine. Thus, the potential of radio telemetric chemical imaging would allow screening of disease conditions without the requirement of visual aids [3]. The main limitations of this proposal is given by

i. It can sense only for 42 hours
ii. It cannot screen the internal condition of the tissue.

E.Guglielmelli states the actuation principle of the micropump used for drug delivery relies on the electrolysis of a water-based solution, which is separated from a drug reservoir by an elastic membrane. The electrolytically produced gases pressurize the electrolytic solution reservoir, causing the deflection of the elastic membrane. Such deflection, in turn, forces the drug out of its reservoir through a nozzle. The proposed system is integrated in a swallowable capsule, equipped with an impedance sensor useful to acquire information on the physiological conditions of the tissue. Such information can be used to control pump activation. It creates acid reflux in the internal tissues.

Guobing Pan and LitongWang explained the concept prototype integrates the micro-optical images module, the physiological parameter sensors, the micromechanical arm and pump for biopsy, drug delivery and microsurgery, and the locomotion parts. It has the ability of advancing forward and backward, orientating, stopping, and anchoring itself onto the GI tract wall under the control outside. It is equipped with a micromanipulator arm that is able to perform therapeutic procedures like taking biopsy, microsurgery, and injection.The main limitation is,

i. It requires receiving box and workstation separately
ii. It allows only 6hrs of continuos working.

L. Gonzalez-Guillaumin developed an innovative multi sensor esophageal capsule design has been presented and tested in stationary laboratory conditions for the purpose of simultaneous detection of acidic and nonacidic gastro-esophageal reflux. The obtained results suggest that if appropriate shielding of the external permanent magnets is provided, and the latter are of appropriate weight and size . This technique could offer a minimally invasive and reliable testing of all aspects of GERD. A capsule suitable for clinical testing needs to be developed so that the proposed method is dynamically tested in real-life conditions. Its limitations is given by,

i. It monitors the state of the esophagus by the magnetic coil.
ii. It senses by the pH sensor towards the circuit and several maintenance for the circuit is required.

In order to measure and monitor the membrane displacement, and therefore the volume of drug ejected, a strain gauge sensor has been prepared using a conductive thermoplastic nano composite elastomer (CTPE). The sensor has been fixed on the deformable membrane. The conductive thermoplastic elastomer is a good candidate for this application because of its high sensitivity. Furthermore, the CTPE allows to customize the resistance of the device in order to obtain low power consumption.[7] It has some limitations like,

i. It is not used for a continued period.
ii. It does not support any automation.
iii. It is not implantable

III. Existing System

In existing method, alcohol content in the blood can be detected by using IoT technology. It consists of two threshold value of blood samples. The first threshold reaches when our body consume alcohol content. This information send to others end using IoT. When it reach second threshold value “STOP” message send to device. Then all data’s are collected and store in frame format. So, it predict and desired the outputs send to device.

Their exist an Miniaturized electronic pill device that can be swallowable or implantable in human body in order to detect biological signals or capture images that could eventually be used for diagnostic and therapeutic purposes. Electronic pills, smart capsules or miniaturized microsystems swallowed by human beings or animals for various biomedical and diagnostic applications are growing rapidly in the last years.

Limitations:

1. There is no implantable device which can monitor the body’s condition for a continued period.
2. Need for IoT based connectivity to monitor the body’s condition.
3. Swallowable pill leads to acid reflux and leads to several digestive problems.
4. There is no update continuosly

IV. Proposed System

In this work, a prototype of implantable digital pill is going to be designed. It can be used for the real-time measurement parameters such as concentration, pH, conductivity and dissolved oxygen of the consumed food. It is going to be automated and we can get an update instantly through message at the time of consuming food.These all informations are stored in cloud. The pills continuously monitor our stomach pH level, blood pH. It sends message about the body pH levels. Machine learning is a mechanism using to predict and analyze the data’s about on food ingredients. These all informations are send through ZigBee which has been connected with microcontroller. So, all the details are stored and displayed. The prototype of digital pill based on internet of things(IoT) has been developed to monitor the gastro intestinal part of the body and to monitor the body's parameters using IoT.

1.1 Block Diagram:

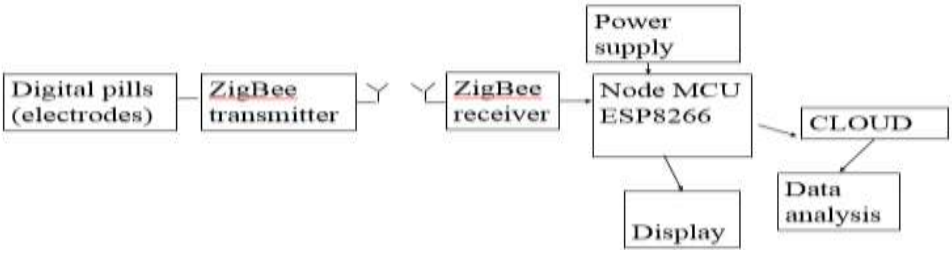


Figure 1. Block diagram of ZigBee transmitter.

The main blocks of the circuit is
Pill transmitter , ZigBee receiver, Node MCU, Display, Cloud

1.2 Pill transmitter:

Figure 2. Block diagram of pill transmitter.

It consists of two electrodes with ZigBee transmitter that transmits the signal to the receiver through ZigBee. It is a pill prototype with changeable lithium battery of 3V. The electrodes X ,Y conducts and measures the pH and send the signal to the receiver. It is provided with on and off switch for the working.

1.3 ZigBee transmitter:

ZigBee is the ideal choice of protocol for automation and smart energy, because different ZigBee devices can be connected. As more ZigBee devices are linked, communication paths between devices multiply, eliminating the risk of single-point signal failure. ZigBee is an open, global standard for wireless communication between IoT devices. With ZigBee, IoT devices can easily be connected to other IoT devices. The ZigBee protocol is secure and stable, which is one of the reasons why it has become one of the world's most widely adopted protocols.

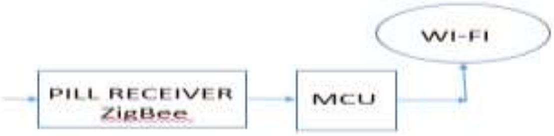
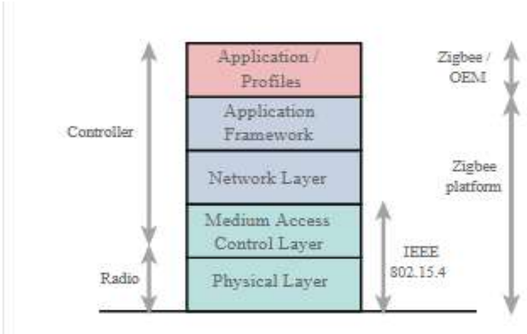


Figure 3. Block diagram of Receiver.

4.4 . ZigBee Receiver:

The ZigBee standard is a standard built on top of IEEE 802.15.4 which provides the upper layers for control and sensor applications. It has been designed to be very robust so that it can operate reliably in harsh radio environments, providing security and flexibility. The distances that can be achieved transmitting from one station to the next extend up to about 70 metres, although very much greater distances may be reached by relaying data from one node to the next in a network.



The differnet ISO layers in a Zigbee protocol stack

The standard supports 64 bit IEEE addresses as well as 16 bit short addresses. The 64 bit addresses uniquely identify every device in the same way that devices have a unique IP address. Once a network is set up, the short addresses can be used and this enables over 65000 nodes to be supported.

4.5. Node MCU:

The All new Node MCU ESP8266 V3 Lua CH340 Wi fi Dev. Board is a fast leading edge low-cost Wi Fi technology. Modern high-level mature LUA based technology. It is an integrated unit with all available resources on board. It is super simple to complement your existing Arduino projects or any development board that has I/O pins available .Modern Internet development tools such as Node.js can take advantage the Node MCU with the built-in API to put your idea on the fast track immediately.

Figure 4. Node MCU

Node MCU is built based on the mature ESP8266 technology to take advantage of the abundant resources available on the web**.** Node MCU has ESP-12 based serial Wi Fi integrated on board to provide GPIO, PWM, ADC, I2C and 1-WIRE resources at your fingertips, built-in USB-TTL serial with super reliable industrial strength CH340 for superior stability on all supported platforms. This module is one of the cheapest available wi Fi-modules in the market. V3 or Version3 is the latest version of this module and it is a 32bit microcontroller.

4.6. Display:

Here the mobile phone screen is used as a display screen to view the output of the system.The output is received from the cloud storage. The pH value is viewed on the display screen.

4.7. Cloud:

Figure 5. Storage model.

Information and data is stored on physical or virtual servers, which are maintained and controlled by a cloud computing provider, such as Amazon and their AWS product. As a personal or business cloud computing user, you access your stored information on the 'cloud', via an Internet connection.

4.8. Software used:

Here arduino 1.8.6 software is used to program the microcontroller. Embedded C is used to code the hardware kit.

V. Results And Discussion

The digital pills used to predict and the food quality. When you eat after or before the quality of food can be predicate by digital pills. The information are transmit to micro controller through wireless by ZigBee transmitter and receiver. The ZigBee can be used only in range between, 70 meters. In case we want long distance communication IOT can be used. The microcontroller coding with embedded C and the electrodes used to the information. That means, it can predict pH levels in body

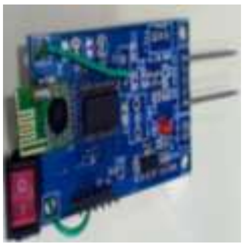


Figure 6. Designed prototype

Figure 7. Hardware kit.

5.1. Output:

The output can be taken from set of samples and viewed using the serial monitor and also using the Thingspeak account. This information is stored in cloud for further reference.

Figure 9. Serial monitor screenshot.

5.2. Ph LEVEL IN HUMAN BODY :

pH values is varies from 1 to 14.In here 7is neutral, Below 7 is acid and above 7 is alkaline, With alkaline-7.35 to 7.45, Stomach acidic- below 3.5, Saliva-6.5 to 7.5pH, Upper stomach- 4.0 to 6.5, Lower stomach-1.5 to 4.5pH, Dusdenum-7 to 8.5pH, Small intestine-4.0 to 7pH, Large intestine 4 to 7pH

5.3. Graph:

Figure 10. Concentration Vs time.

Here the graph is plotted by the data received from the pill electrodes. It gives the variation in concentration with respect to the time. The graph is plotted by thingspeak account in which the data is fed and stored in the cloud.Using this thingspeak, We can update of the operating digital pill at real time with the help of twitter account,etc.

5.4. Advantages:

i. It can be easily removed when it not required.
ii. Since the data is stored in cloud we can access at anytime when we needed.

iii. Affordable cost when we compared to the swallowable digital pill.
iv. Blooming technology in future.
v. Side effects can be reduced.

VI. Conclusion

Hence, the prototype of digital pill is designed and tested with the test samples. The size of digital pill will be reduced in future under several conditions with respect to the nanotechnology. Therefore the designed prototype of digital pill to monitor the gastro-intestinal part of the body and to monitor the body's parameters using IoT has been designed and implemented successfully.

VII. Future Work

In future the size should be minimized as possible using nano and MEMS technology. Here, Node MCU can be replaced with ARM processor for advance features.

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