A REVIEW ON MICRO ELECTRONIC PILL

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***Abstract*— The purpose of this paper is to provide the information about the innovation of new device called Micro Electronic Pill in the field of Bio-Medical Measurement, this is mainly used for diagnosis of internal part mainly gastrointestinal system which cannot be easily done with the help of normal endoscope. It is modern wireless type of endoscopic monitoring system.**

This tiny capsule can pass through our body, without causing any harm. It takes pictures of our intestine and transmits the same to the receiver of the Computer analysis of our digestive system. This process can help in tracking any kind of disease related to digestive system. Also we have discussed the drawbacks of PILL CAMERA and how these drawbacks can be overcome using Grain sized motor and bi-directional wireless telemetry capsule Besides this we have reviewed the process of manufacturing products using nanotechnology.

Keywords— NANOTECHNOLOGY, PILL

INTRODUCTION

The microelectronic pill is a small capsule shaped electronic pill that can be comfortably swallowed by any normal patient. It consists of lens, antenna, transmitters, camera or sensors and battery. It can reach regions such as small intestine and provides the video wirelessly to the receiving device connected to the monitoring system outside the human body and kept at distance of 1 meter. The transmission of data takes place through the radio communication between electronic pill transmitter and external receiver. Parameters such as temperature, pH and pressure of gastrointestinal tract can be measured, for the detection of diseases and disturbance in gastro intestinal system which prevents the entry of conventional endoscopic tube, a micro pill with single channel radio telemetric function is preferred. The invention of semiconductors provides ease in development of concise electronic pill capable to carry and transmit huge amount of data at a time without affecting the human body. The diagram below represents the wireless video transmission between transmitter and receiver.

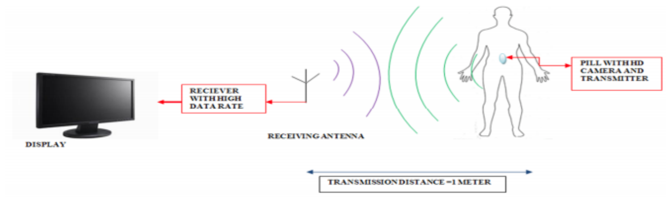


Fig 1:- Wireless Endoscope through Micro Electronic Pill

Recent development in electronic pill technology requires the integration of more complex systems on the same platform when compared to conventional implantable systems. A small miniaturized electronic pill can reach areas such as small intestine and deliver real time video images wirelessly to an external console. Fig. 1 shows a wireless endoscope (i.e. electronic pill) for a medical monitoring system. The device travels through the digestive system to collect image data and transfers them to a nearby computer for display with a distance 1 meter or more. A high resolution video based capsule endoscope produces a large amount of data, which should be delivered over a high capacity wireless link.

CONSTRUCTION

A Microelectronic pill construction requires narrow band transmission and has limited camera pixels. One of the commercially available endoscopic devices designed by the company “Given Imaging” uses Radio Frequency chip for wireless communication for real time video transmission based on the Medical Implant Communication Service band. The channel bandwidth allowable for this band is limited to 300 kHz; the low frequency application provides high transmission efficiency through layers of skin. It is very much difficult to carry enough data rate for high definition real time video data during real time monitoring process. So, for better real time diagnosis there is requirement of higher bandwidth data transmission. The fabrication of sensors of electronic pill are done on two silicon chips which is generally kept at the top of the capsule and the first chip encompasses diode, the pH ISFET sensor,temperature sensor and conductivity sensor with two sensor. The another chip has thermometer and oxygen sensor.The method which provides the baud rate of 100Mbps is Wide band Technology. This technology is currently used in radar, Image processing and In-door entertainment. But, the major problem in high frequency is the major loss in body tissue. The schematic diagram of pill is represented by the figure below:-

DESCRIPTION

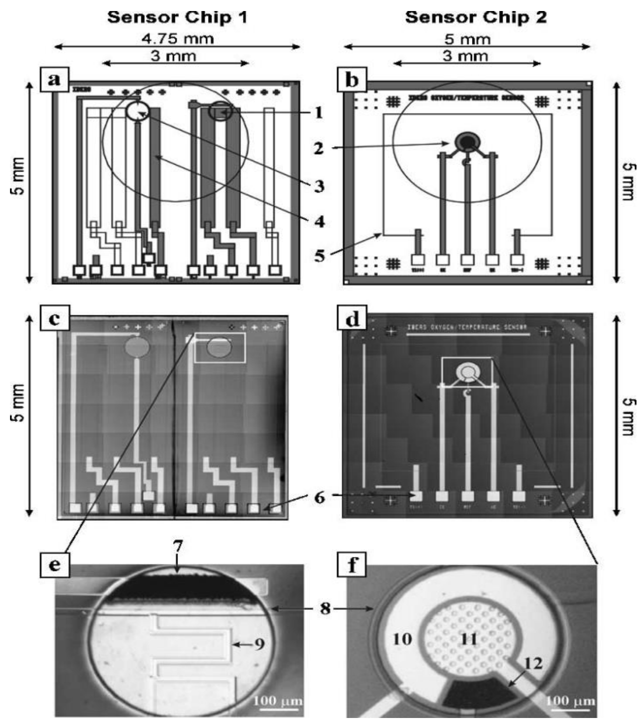
All Microelectronic pill is powered by a battery, in order to utilize the device in internal remote locations. There is scanning receiver which captures the wireless radio signal from pill through a coil antenna. A computer system is required for the control of data acquisition unit which acquires data in analog form from the scanning receiver. It provides recording of data on the computer. Stable
transmission frequency must be constantly maintained. The transmission frequency is measured with the help of change in temperature. The change in frequency is measured with the help of scanning receiver, and the result obtained is used to evaluate the advantage of crystal stabilized unit.
The power consumption of microelectronic including transmitter and sensors connected is calculated to 12.1 watermill with current
rating 3.9mill Ampere at 3.1 volt voltage supply, where as free running radio transmitter consumes 6.8milliwatt.Two silver oxide batteries SR44 are used to provide operating time of more than 40 hours. The pH measurement ranges from 1 to13 can be carried out. The dissolved oxygen is up to 8.2 mg per liter. The temperature measurement is done from 0ºC to 70ºC. The pH ISFET sensor operated in constant current mode, with the drain voltage connected to the positive supply and the source voltage changes as per gate potential and gate potential is grounded. In control chip, the noise from application specific integrated circuit provides a constant level of 3Mega volt peak to peak, which provides single Least Significant Bit of Analog to Digital Convertor; the second Least Significant Bit is used to provide an adequate noise margin, and here to have an effective resolution of 8 bits the 10 –bit Analog to Digital Convertor is used. The components of capsule must be capable to protect itself from corrosive environment in gastro intestinal tract and it must be nontoxic to the human being but as the battery electrodes are toxic in nature, so care must be taken to prevent leakage of toxic fluids into the digestive system.

MICROELECTRONIC PILL DESIGN AND FABRICATION

The key characteristics of a smart card are:

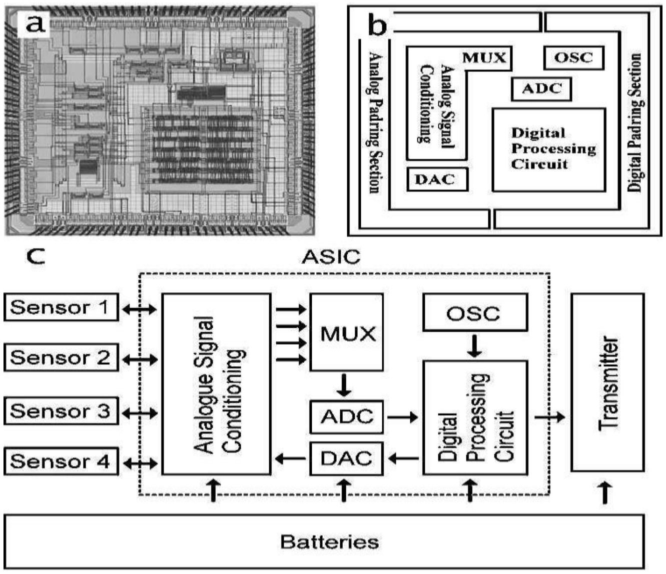
A. *Sensors:*

The sensors were fabricated on two silicon chips located at the front end of the capsule. Chip 1 [Fig. 1(a), (c), (e)] comprises the silicon diode temperature sensor, the pH ISFET sensor and a two electrode conductivity sensor. Chip 2 [Fig. 1(b), (d), (f)] comprises the oxygen sensor and an optional nickel-chromium (NiCr) resistance thermometer. The silicon platform of Chip 1 was based on a research product from Ecole Superieure D'Ingenieurs en Electrotechnique et Electronique (ESIEE, France) with predefined n-channels in the p-type bulk silicon forming the basis for the diode and the ISFET. A total of 542 of such devices were batch fabricated onto a single 4-in wafer. In contrast, Chip 2 was batch fabricated as a 9X9 array on a 380- m-thick single crystalline 3n silicon wafer with<100> lattice orientation, precoated with 300 nm Si3N4, silicon nitride.



B. Control chip:

The ASIC was a control unit that connected together the external components of the micro system (Fig. 2). It was fabricated as a 22.5 mm2 silicon die using a 3-V, 2-poly, 3-metal 0.6- µm.CMOS process by Austria Micro systems (AMS) via the Chiropractic initiative.



It is a novel mixed signal design that contains an analog signal conditioning module operating the sensors, a 10-bit analog-to-digital (ADC) and digital-to-analog (DAC) converters, and a digital data processing module. An RC relaxation oscillator (OSC) provides the clock signal. The digital data processing module conditioned the digitized signals through the use of a serial bitstream data compression algorithm, which decided when transmission was required by comparing the most recent sample with the previous sampled data. This technique minimizes the transmission length, and is particularly effective when the measuring environment is at quiescent, a condition encountered in many applications [10]. The entire design was constructed with a focus on low power consumption and immunity from noise interference. The digital module was deliberately clocked at 32 kHz and employed a sleep mode to conserve power from the analog module. Separate on-chip power supply trees and pad-ring segments were used for the analog and digital electronics sections in order to discourage noise propagation and interference.

C. Radio transmitter:

The radio transmitter was assembled prior to integration in the capsule using discrete surface mount components on a single sided printed circuit board (PCB). The footprint of the standard transmitter measured 8x5x3 mm including the integrated coil (magnetic) antenna. It was designed to operate at a transmission frequency of 40.01 MHz at 20 C generating a signal of 10 kHz bandwidth. A second crystal stabilized transmitter was also used.

This second unit was similar to the free running standard transmitter, apart from having a larger footprint of 10x5x3 mm, and a transmission frequency limited to 20.08 MHz at 20 C, due to the crystal used. Pills incorporating the standard transmitter were denoted Type I, whereas the pills incorporating the crystal stabilized unit were denoted Type II. The transmission range was measured as being 1 meter and the modulation scheme frequency shift keying (FSK), with a data rate of 1 kbs^{-1}.

D. Capsule:

The microelectronic pill consisted of a machined bio compatible (nontoxic), chemically resistant polyether-terketone (PEEK) capsule (Victrex, U.K.) and a PCB chip carrier acting as a common platform for attachment of the sensors, ASIC, transmitter and the batteries. The fabricated sensors were each attached by wire bonding to a custom made chip carrier made from a 10-pin, 0.5-mm pitch polyimide ribbon connector.

The ribbon connector was, in turn, connected to an industrial standard 10-pin flat cable plug (FCP) socket (Radio Spares, U.K.) attached to the PCB chip carrier of the microelectronic pill, to facilitate rapid replacement of the sensors when required. The PCB chip carrier was made from two standard 1.6-mm-thick fiber glass boards attached back to back by epoxy resin which maximized the distance between the two sensor chips. The sensor chips were connected to both sides of the PCB by separate FCP sockets, with sensor Chip 1 facing the top face, with Chip 2 facing down. Thus, the oxygen sensor on Chip 2 had to be connected to the top face by three 200- m copper leads soldered on to the board. The transmitter was integrated in the PCB which also incorporated the power supply rails, the connection points to the sensors, as well as the transmitter and the ASIC and the supporting slots for the capsule in which the chip carrier was located.

The connection to the matching socket on the PCB carrier provided a three point power supply to the circuit comprising a negative supply rail (1.55 V), virtual ground (0 V), and a positive supply rail (1.55 V). The battery packwas easily replaced during the experimental procedures.

INTERNAL VIEW & PILL CAMERA PLATFORM OF CAPSULE

A. INTERNAL VIEW OF THE CAPSULE

The figure shows the internal view of the pill camera. It has 8 parts:

1.Optical Dome.

2.Lens Holder.

3.Lens.

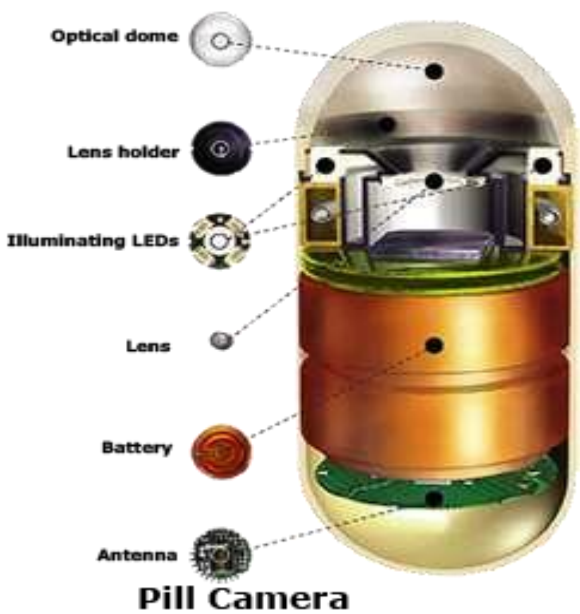
4.Illuminating LED's.

5.CMOS Image Sensor.

6.Battery.

7.ASIC Transmitter.

8.Antenna.



1. *Optical Dome*

It is the front part of the capsule and it is bullet shaped. Optical dome is the light receiving window of the capsule and it is a non- conductor material. It prevent the filtration of digestive fluids inside the capsule.

2. *Lens holder*

This accommodates the lens. Lenses are tightly fixed in the capsule to avoid dislocation of lens.

3. *Lens*

It is the integral component of pill camera. This lens is placed behind the Optical Dome. The light through window falls on the lens.

4. *illuminating LED's*

Illuminating LED's illuminate an object. Non reflection coating id placed on the light receiving window to pr event the reflection. Light irradiated from the LED s pass through the light receiving window.

5. *Cmos image sensor*

It have 140 degree field of view and detect object as small as 0.1mm. It have high precise.

6. *Battery*

Battery used in the pill camera is bullet shaped and two in number and silver oxide primary batteries are used. It is disposable and harmless material.

7. *ASIC Transmitter*

It is application specific integrated circuit and is placed behind the batteries. Two transmitting electrodes are connected to this transmitter and these electrodes are electrically isolated.

8. ANTENNA

Parylene coated on to polyethylene or polypropylene antennas are used. Antenna received data from transmitter and then send to data recorder.

B. PILL CAMERA PLATFORM COMPONENTS

In order for the images obtained and transmitted by the capsule endoscope to be useful, they must be received and recorded for study. Patients undergoing capsule endoscopy bear an antenna array consisting of leads that are connected by wires to the recording unit, worn in standard locations over the abdomen, as dictated by a template for lead placement.The antenna array is very similar in concept and practice to the multiple leads that must be affixed to the chest of patients undergoing standard lead electrocardiography. The antenna array and battery pack cam be worn under regular clothing. The recording device to which the leads are attached is capable of recording the thousands of images transmitted by the capsule and received by the antenna array. Ambulary (non-vigorous) patient movement does not interfere with image acquisition and recording. A typical capsule endoscopy examination takes approximately 7 hours.

Mainly there are 5 platform components:

- Pill-Cam Capsule-SB or ESO
- Sensor Array Belt
- Data Recorder

- Real Time Viewer

APPLICATIONS

- Biggest impact in the medical industry.
- Nano robots perform delicate surgeries.
- Pill cam ESO can detect esophageal diseases, gastrointestinal reflex diseases, barreff's esophagus.
- It is used to diagnose Malabsorption
- Pill cam SB can detect Crohn's disease, small bowel tumours, small bowel injury, celiac disease, ulcerative colitis etc.It is used to detect ulcers

ADVANTAGES

- It is being beneficially used for disease detection & abnormalities in human body.
- Painless, no side effects.
- Accurate, precise (view of 150 degree).
- High quality images.
- Harmless material.
- Simple procedure.
- High sensitivity and specificity.
- Avoids risk in sedation.
- Efficient than X-ray CT-scan, normal endoscopy.
- Micro Electronic Pill utilizes a PROGRAMMABLE STANDBY MODE; So power consumption is very less.
- It has very small size; hence it is very easy for practical usage.
- Very long life of the cells (40 hours), Less Power, Current & Voltage requirement (12.1 mW, 3.9 mA, 3.1 V).
- Less transmission length & hence has zero noise interference.

DISADVANTAGES

- Gastrointestinal obstructions prevent the free flow of capsule.
- Patients with pacemakers, pregnant women face difficulties.
- It is very expensive and not reusable.
- Capsule endoscopy does not replace standard diagnostic endoscopy.
- It is not a replacement for any existing GI imaging technique, generally performed after a standard endoscopy and colonoscopy.
- It cannot be controlled once it has been ingested, cannot be stopped or steered to collect close-up details.
- It cannot be used to take biopsies, apply therapy or mark abnormalities for surgery.
- It cannot perform ultrasound & impedance tomography. Tomography is imaging by sections or sectioning, through the use of any kind of penetrating wave.
- Cannot detection abnormalities.
- Cannot perform radiation treatment associated with cancer & chronic inflammation.
- Micro Electronic Pill are expensive & are not available in many countries.
- Still its size is not digestible to small babies.

CONCLUSION

Wireless capsule endoscopy represents significant technical breakthrough for the investigation of the small bowel, especially in light of the shortcomings of other available techniques to image this region. Capsule endoscopy has the potential for use in a wide range of patients with a variety of illnesses. At present, capsule endoscopy seems best suited to patients with gastrointestinal bleeding of unclear etiology who have had non-diagnostic traditional testing and whom the distal small bowel(beyond reach of a push enetroscope) needs to be visualized.

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