Retraction

Retraction: Swallowable Glass Pill for Digestive Motility & Toxin Detection Using Cell-Based Biosensor (J. Phys.: Conf. Ser. 1916 012150)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Swallowable Glass Pill for Digestive Motility & Toxin Detection Using Cell-Based Biosensor

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Abstract. Beginning from the era of evolution, humans are biased towards constructivism to subtle the amplitude of strains confronted due to the dominance of will to ease the tasks. Enhancement of health and prevention of delicacy is inevitably predominant in the evolutionary trajectory. Delicate diagnosis is still serving as the contemporary hassle in the biomedical domain. Meanwhile, the bias towards the digital pills shows the hockey-stick traction among the experts and masses anticipating accurate diagnosis. Imparting the interdisciplinary contexts, smart drug adopting the principles of micro technology is capable of sensing the pH level, temperature, conductivity, DO (dissolved oxygen) and so on. Though there are many ways to deliver the smart pills inclusive of oral, transcutaneous and implantable drug delivery, the most opted delivery method is swallowable smart pills. Therefore, the paper approaches with the incremental smart pill technology integrated with cell-based biosensor for monitoring and analyzing the gastrointestinal motility through which the transit of ingestion and motor function can be diagnosed and toxins are detected such as mycotoxin, food-borne toxins, marine toxins and botulinum neurotoxins with more accuracy.

Keywords: Oral Digital Pills, cell-based biosensor (CBB), Gastro intestinal motility, toxin detection.

1. Introduction
In the era of modernization, conventional traditional modes of therapies are revamped through digitalization with the objective of reliability and better accuracy standards. The escalating demand for biomedical technology has increased leading to ample incremental innovation in the domain. The digitalization has extended its horizon over the smart pills or digital drugs to bestow the viability for rapid digitalization. Smart pills are best alternatives for traditional symptomatic diagnosis. In such an approach, the probability of accuracy in diagnosis is very unlikely and necessitates a meticulous response that weighs more either on the doctor or the patient. The smart pills are designed by adopting the micro technology in which the pills are fabricated employing the electron beam and photolithography that is controlled by the Application Specific Integrated Circuit (ASIC). The smart pills have significant opportunities in the pharmaceutical sector as it is highly tolerable by patients, increased accuracy and low cost. They can monitor and analyze the defined conditions that occurs within the body of a human being. Apart from digital pills, robotic technology can analyze inside-body conditions effectively but it incurs high capital and requires complex morphological design features. In all means, the digital pills are best suited for an effective monitoring of inside-body conditions
wirelessly. In this paper, the gastrointestinal (GI) motility is concentrated as most diagnosis prefers GI inspection to identify the common problems. The proposed digital pill is integrated with the cell-based biosensor which is used to sense the toxins and its reaction occurring in the GI tract. Therefore, the proposed system can analyze the toxic material that’s ingested, so that appropriate medications can be chosen to overcome the toxicity. The need for this system is raised, as in 2019 approximately around 7,40,400 people are affected by unintentional acute pesticide poisoning in 148 countries. If the rate of diagnosis could be increase, such conditions can be overcome in the future. An ASIC module of smart pill also has signal conditioning, signal sensing and mux microcircuitry within that. It also monitors the persons health, by tracking the transit of the ingested material within the GI tract. The motor function of the digestive track is also monitored. Besides, the monitored data is sent wirelessly without any latency to the transceiver circuit out of the body. The transceiver unit which lies out of the body, is used to regulate the smart pill operations and necessitate the control signals. It also receives the data sent from the smart pill wirelessly and stores it in the database for the purpose of proceeding with analysis on the data received. As the smart pills are cost effective solutions with optimized replacement alternative for traditional diagnosis, the system is the most reliable in the modern age.

2. Research background
The recent proposal [1] “Analyzing drug intake with Digital Pill: A Survey” studies the analytic background of digital pills which are used for monitoring and controlling the operations inside the body. The paper gives a brief study of method of its embedded development and so on. However, the paper didn’t cover the digital pills that entails the details about GI motility analysis. The paper [2] “Synergy between nanozymes and natural enzymes on the hybrid MoS2 nanosheets/graphite microfiber for enhanced voltammetric determination of hydrogen peroxide” focuses on development of biosensor for hydrogen peroxide. In this the microfiber hybrid structure is formed by developing and the assembly of MoS2 nanosheets and graphite. The sensor is used to determine the presence of hydrogen peroxide only. But it cannot monitor the transition in the motility of the element. In paper [3] “Crystal field, ligand field, and interorbital effects in two-dimensional transition metal dichalcogenides across the periodic table” the author did a comparative study between the crystal and ligand fields and determined the relative stability in order to fill the d-shell. The paper however fails to extend its interpretation over implementational aspects of the concept which is highly paramount for redefining the electronics. In paper [4, 5] “Swallowable Wireless Capsule Endoscopy: Progress and Technical Challenges”, the author proposes a non-invasive swallowable Wireless capsule endoscopy which is a revolutionary innovation in biomedical domain. But the technical challenge was latent due to the power supply [6]. But it is overcome with the help of wireless power transfer, which is the only possible solution for the WCE (wireless capsule endoscopy). However, the endoscopic application doesn’t determine the chemical reaction that occurs inside the GI tract but analyses the topological features of the GI tract effectively [7].

3. Proposed system
The proposed digital pill contains the cell-based bio sensor as the primary component which determines the reactions that occurs within the GI tract. The cell-based bio sensors can detect the toxins such as mycotoxin, marine toxin etc., The CBB and other components are integrated using photolithography pattern integration methodology. Along with this sensor, the signal conditioning, signal detector and mux circuits are also integrated using microfiber structural integration which adopts the principles of microtechnology. The 2D transition dichalcogenide material is used for integrating the circuit and is the most effective material for digital pills. The power supply used in the digital pill is the silver oxide battery. The digital pill thus acts as the transceiver in which the monitored data is sent wirelessly to the transceiver outside. The below is the block diagram of the digital pill and the receiver module,
Figure 1. Block Diagram of digital pill consisting of CBB sensor. Figure 2. Block diagram portray the receiver module of digital pill.

The Figure 1 and 2 Portrays the block diagram of transceiver section which is used to display the data outside. The transceiver sections consist of the Arduino microcontroller, wireless transceiver and LCD display. The Zigbee protocol is employed for wireless transmission which uses Radiofrequency for transmitting data wirelessly at 2.4GHz. The Zigbee employs half duplex communication that transmits and receive data at the rate of 9600 Baud. The Zigbee protocol is a seamless technology which is used for low power consumption feature and long-term networking capability. The proposed system is thus a cost-effective model for diagnosing the poisoning and the chemical reaction that occurred due to poisoning in the gastrointestinal tract of the human being. The proposed system comprises of two units namely the digital pill and the receiver module. The digital pill is developed adopting the microtechnology. Therefore, the electrical properties of dichalcogenide are best suited for 2D electronic application where nanoscale integration is a requisite. The bandgap of the material spans up to 2 eV. The application of the transition metal dichalcogenide is the numerous such as esaki diodes, resonant tunnelling diodes, RF and logic transistors etc., Therefore, the material is used for developing the digital pills.

Digital Pill
The digital pill has cell-based bio sensor that is used to sense the chemical reaction and changes in the gastrointestinal tract. Apart from the sensor, the ASIC unit of the digital pill has integrated circuit in which the signal detection, signal conditioning and mux plays an important role to transfer the data from the pill to the transceiver outside the body. The following is the circuit of signal detection,

1. Signal Detection Circuit

The above circuit is the s-5470 series signal conditioning circuit developed by CMOS technology. It is Ultra-low current consuming model where IDD ≤ 0.1 nA . The circuit performs well by detecting faint current, i.e, IDET = 0.7 nA. The wide operation voltage range of s-5470 is up to 0.9 V to 5.5 V. The circuit also detects the faint signals of approximately 0.7 nW (1.0 V, 0.7 nA) . It also detects the difference between strengths of two signals input at the same time and moreover it is Lead-free (Sn 100%) and halogen-free, therefore integration of such a model in the smart pill is harmless and safe.

2. Signal Conditioning Circuit
The above signal conditioning circuit is compatible to the biosensors which amplifies the electrochemical signals and optimizes it to the higher level in figure 3.

3. Cell-based Biosensor
The cell-based biosensors employ the principles of cell-based assays by using the living cells for different analytes such as food, environment, water etc. By this it means, the living cells responds to the toxic exposure with the magnitude respective to the susceptible subjects. The below representation shows the working principle of cellular based biosensor in figure 4.

While it comes to CBB sensor, the different living cells are used to sense different kind of toxins therefore, a modular design is needed to detect various kinds of toxins. Some cells exhibit optical properties when exposed to toxins and some generates measurable electrochemical signals when exposed to toxins. Therefore, electrochemical sensors/living cells are used in the proposed system and converting that into electrical signal the toxin can be diagnosed. The table 1. shows the sensor cell, detection mode and analytes for various purpose of toxin detection.

4. Wireless Transceiver
For wireless transceiver, the Zigbee 3.0 protocol is employed. The Zigbee supports for multiple network topologies such as peer-to-peer, peer-to-multipoint and mesh networks. The Zigbee 3.0 has low duty cycle therefore it provides long battery life. It also has low latency and has the range of Direct Sequence Spread Spectrum (DSSS)Up to 65,000 nodes per network. It also has 128-bit AES encryption for secure data connections. Moreover, it has additional features such as collision avoidance, retries and acknowledgements

5. Arduino Microcontroller
The Arduino is the low-cost microcontroller which operates at 5V. The UNO model has 14 digital pins and 6 analog pins. The operating current range is up to 40mA. The flash memory of Arduino is 32KB and SRAM is 2KB. The Zigbee is integrated with Arduino to process the communication. The LCD display which is interconnected with Arduino through I2C serial port is used to display the data which is harvested by the smart pill.

| Table 1. The table consists of CBB used in Toxicity Assays |
|------------------------------------------------------------|
| **Cell-Based Biomarkers (CBB)** | **Recombinant/Vesicular/Noncellular CBB** |
| **Sensor cell** | **Detection mode** | **Analyte** | **Sensor cell** | **Detection mode** | **Analyte** |
| E. coli DH5α (pTOL/GFP) | Fluorescence, Bioluminescence | BTEN[1] | Mycobacterium B- lymphocyte | Fluorescence, immunoassy |
| Pseudomonas putida (pTOL) | Electrochemical | Aromatic hydrocarbons | E. coli DH5α (pTOL/GFP) | Fluorescence, immunoassy |
| P. putida (pTOL) | Antigenroetry | Organophosphate nerve agents[2,2] | Novel enzyme | Optical/voltaic meter |

5. Future enhancement
In future, the concept can be extended to innovate a low cost and highly efficient treatable smart pills along with diagnosis. Therefore, all the patients can be monitored as well as treated at the same time. The pills can be integrated with the robotic technology to drive the motility of the smart pills to the required place of infection through wirelessly controlling it from outside.

6. Conclusion
The smart pills are thus reliable and is one of the safest and tolerable method of diagnosing in the modern era as the conventional modus operandi is becoming obsolete. The employment of CBB is the most effective method of detecting toxins as it responds to the vulnerability of the subjective physiology. The system requires intricate designing acquaintance to make it work effectively. However, the system is reliable and more functions other than this can be allocated.

References

[1] Nitish babu S, Parthasarathy and Dr A Sudha2020 Analyzing drug intake with Digital Pill: A Survey International Journal of Advanced Science and Technology Vol29 No 7 (2020) pp 963-970.

[2] Jian Zhang, Dong Han, Yanhui Wang, Longwei Wang, Xuanyu Chen, Xiran Qiao and Xin Yu Synergy between nanozymes and natural enzymes on the hybrid MoS2 nanosheets/graphite microfiber for enhanced voltametric determination of hydrogen peroxide Springer Nature (2020) 10:1007.

[3] A. Haldorai and A. Ramu, Security and channel noise management in cognitive radio networks, Computers & Electrical Engineering, vol. 87, p. 106784, Oct. 2020. doi:10.1016/j.compeleceng.2020.106784

[4] A. Haldorai and A. Ramu, Canonical Correlation Analysis Based Hyper Basis Feedforward Neural Network Classification for Urban Sustainability, Neural Processing Letters, Aug. 2020. doi:10.1007/s11063-020-10327-3 Rudden, R. A., Aleshire, N., Zibbell, J. E., and Matthew Gladden, R.Increases in drug and opioid overdose deaths - United States,” 2000-2014. Am. J. Transplant, vol. 16(4), pp. 1323-1327 2016.
[5] Vivolo-Kantor, A. M., Seth, P., Gladden, R. M., Mattson, C. L., Baldwin, G. T., Kite-Powell, A., and Coletta, M. A., Vital signs: trends in emergency department visits for suspected opioid overdoses—United States, July 2016–September 2017, Morb. Mortal. Wkly. Rep., vol. 67(9), pp. 279, 2018.

[6] Lassetter, J. H., and Warnick, M. L., Medical errors, drug-related problems, and medication errors: a literature review on quality of care and cost issues, J. Nurs. Care. Qual. vol. 18(3), pp. 175-183, 2003.