Nazeih Botros, J Biosens Bioelectron 2014, 5:3
http://dx.doi.org/10.4172/2155-6210.S1.022

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference and Exhibition on
Biosensors & Bioelectronics
August 11-13, 2014 Hilton San Antonio Airport, San Antonio, USA

Biological mechanism on a chip

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To understand the function of biological mechanisms in human body and to develop drugs to treat the malfunction in a particular mechanism, scientists and researchers need to carry out an extensive investigation of the mechanisms. Because of ethical issues or other constraints, performing medical experiments on humans or animals are extremely limited and in some instances prohibited. Biomedical researchers are always in search of new and innovative ways to test out different drugs but they cannot always risk the harmful side effects it may have on the subject under test. The latest advancements in computer and digital technology have opened the door for development of smart devices that perform complex medical tasks. The human biological mechanisms such as glucose-insulin mechanism or renal mechanism are very complicated and involves complex mathematical equations; however with the latest development of high-speed large-storage density computers and with the introduction of high-speed digital platforms such as Field Programmable Gate Arrays such complex mechanisms can be simulated and synthesized (built) on a stand-alone compact electronic chips. The goal of this project is to synthesize biological mechanisms on a compact electronic chip such as Xilinx FPGAs. The steps followed to synthesize the mechanism can be summarized. The first step is to develop a mathematical model that describes the function of the mechanism. The theoretical model is then converted to a software code that can be synthesized and downloaded into an electronic chip. A Hardware Description Language (HDL) such as VHDL or Verilog can be used to write the code. After writing the code, it is simulated and verified that it is accurately describe the mechanism. The next step is to synthesize the code and downloaded into a chip such as Field Programmable Gate Arrays (FPGAs). The chip now mimics the function of the mechanism and can be utilized as portable electronic version of the simulation. Adding the appropriate sensors to the chip, a complete compact portable-independent electronic system can be attached to the patient to monitor and execute decision regarding the status of the patient. An example of such decision is a trigger signal to a small pump attached to the patient's body and filled with insulin. When the chip senses an increase in the blood sugar (Glucose) that merits insulin injection, the chip sends the trigger signal to the pump to release insulin. The chip controls the amount and duration of the release. Several devices developed by the author and his team. These devices include: Glucose-insulin mechanism (artificial pancreas), renal mechanism, colon cancer mechanism, and simplified renal mechanism.

Biography

Nazeih Botros, PhD, is the Coordinator of the Biomedical Engineering Program at Southern Illinois University Carbondale. He is also a Professor in Department of Electrical and Computer Engineering at Southern Illinois University Carbondale. He obtained his PhD degree from University of Oklahoma in 1985. His research focuses on smart devises, modeling and simulation of biological mechanisms, pattern recognition and digital signal analysis. He is a senior member of IEEE and a member of several biomedical engineering advisory committees. He has authored a book in hardware simulation. He has numerous publications in conferences and Journals.

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