Collaborative Learning, Educational MashUp, Online Laboratory
The BioNEC Platform

Cristian Ravariu¹, Andrei Sevcenco¹, Michael Auer², Florina Ravariu³, Constantin Ionescu-Tirgoviste⁴, Florin Babarada¹

UPB, Carinthia University of Applied Sciences, UMF, IMT

Key words: e-Learning, virtual labs, adaptive content, e-Healthcare

Abstract:

The BioNEC is the acronym of the name: Bio-devices and Nano-Electronics of Cells. This is a course that was approved in the Curricular Area of the Faculty of Electronics, Micro-systems master specialization. The paper wish to present all the fields developed around this course, which proposal was announced 3 years ago at ICL’2005 Conference. This paper will present the e-Healthcare implying, the partnerships and main fields focused as a promising research platform in expansion for the next future. The BioNEC course kept its firsts aims to be an interactive and an adaptive learning environment, which can be extended in the future toward the great public. This must be do because the internationals reports alert us that in the next tens years the medical assistance responsibility will move toward patients.

1 Introduction

The bio-electronics has rapidly developed in the lasts ten years, as a strong interdisciplinary chapter of BioScience. As bridge over history, can be mentioned: in 1987, D. Begreld manufactured a micro-assay for immunoglobulin detection with albumin till $10^{-5}$mol/l, but with high non-linearity, [1], establishing the basis of Immunosensors and in 2006, the same analyte was detected in an almost linear range about $10^{-5}...10^{-7}\mu$g/l, [2]. Some huge steps were performed in the biosensor integration in this period. Many others Bio-electronic devices arisen: Enzyme-FET, Immuno-FET, Microbial-FET, ADN-FET, complex Lab-On-Chips that integrate on the same chip the miniaturised biosensor besides to the VLSI associated electronics, [3].

But the living matter still offers many others opened doors for investigations. Our research group platform, debuted in 2002 with a first subject related to the application of a special MOSFET with a piezoelectric material included in the gate region, designed for the human blood pressure measuring, [4]. In 2004 was published a description of the first experimental bio-device helpful to the electrical characterization of the epinephrine – an important catecholamine, involved in the inter-cellular electrical pulse transmission, [5]. In that period others papers in bioelectronics were developed in our group, [6, 7, 8], and arisen the idea of a new course proposal, “3B” named at that time. In 2005, the ICL Conference was our host to disseminate this idea, [9]. Unfortunately, the academic scholarship period reduced, number of years was reduced from 5 to 4 in our university and therefore many courses disappeared, or reduced as number of hours. Despite of these restrictions, the first author of this paper, gained in 2006 as first titular, the course of BioNEC at master science department, firsts two years as a pilot course. From 2008, this course was permanently introduced in the new master
curricular area. Now, the Polytechnic University of Bucharest works with 4 year for engineer title, plus 1.5 years for master engineer title. The BioNEC course benefits on 2 hours of course and 2 hours of applications, weekly at Microsystems Specialization of the Electronics Faculty.

2 Adaptive BioNEC course content

The BioNEC course kept its promise to be interactive, with an adaptive learning environment. The first chapter – Introduction – moved its contents from the “Receptor principle in the living being” as a preambul for Biosensors in the 2006-2007 university year, I\textsuperscript{st} pilot year, toward “News challenges in Bioengineering”, in the 2007-2008 II\textsuperscript{nd} pilot year. In this way the students find out about the largest spectrum of nowadays bioengineering, like: electronic prothesis, implantable devices, tissue and cellular engineering, nanomedicine, minimum invasion surgery tools, functional imagistics by PET SPET, proteomics & genomics, computational electrophysiology, bio-informatics like internet-healthcare, remote diagnosis.

The chapter 2 approaches the biosensors. The link of electronics with ionic conductors was necessary to be introduced in the II\textsuperscript{nd} year, besides to amperometric, potentiometric and conductometric methods, making the course more clearly for electronics students, closer to the previous disciplines: general physics, general chemistry, electronics materials.

The chapter 3 refers to the Bio-Transistors and specific technological aspects of fabrication, [10]. In the I\textsuperscript{st} year, the impact was low due to a huge and quite exhaustive domain of all BioFETs depicted in the specialty literature and as summary as possible introduced in the course. In the II\textsuperscript{nd} year, only ISFET, ENFET and those Microbial-FETs that are based on the consumed Oxygen detected by Electrodes, were studied. In this way, the students are focused only to the main integrated nowadays transducers. Hence, the link with the ionic conductors and electrochemical methods exposed in chapter 2 is ensured.

The following two chapters 4 and 5 are a result of a strong interaction with the master students. Both the first and the second generation was very reserved at the course beginning, when they heard about the Nano-Electronics of Cells. Constantly, both generations, expressed their maximum sympathy regarding this last chapter at the end of the course. Due to the students encouragements we enhance the chapter 4 contents and we introduced the additional chapter 5, for the moment just for homework themes, dedicated to Bio-informatics.

Chapter 4 treats the biosignals transmission at cell level, nano-electronics phenomenon in ionophore channels of membrane, interneuronal electrical pulse transmission. This chapter was enhanced in the II\textsuperscript{nd} year as a request of the I\textsuperscript{st} generation of students and it is in agreement with the research trends. A project example is presented in the following paragraph.

Chapter 5 was introduced just in the II\textsuperscript{nd} pilot year, providing opportunities for the electronists students to produce bio-informatics studies, like software for e-Healthcare, a Virtual Pharmacy, Fuzzy- systems in medicine modelling.

3. The project type applications

We take into account the life problems of our students (jobs, family problems etc) and let them to select the preferred domains of homework, since to have an optimal feedback. If a student is interested by the signal transmission at cellular level, his final work could be a software that simulates the inter-neuronal pulse propagation; he will deeply study the cellular electronic emerging toward neuro-electro-physiology.

The projects subjects list included (but not restricted) to some topics: (1) biosignals processing at macro level for ECG, EEG, then MEG, PET, or new electrical recording in digestive signals; (2) intercellular biosignaling, synapses modeling, axonal conduction modeling, transmembranar transport modeling; (3) cellular nanoelectronics, cells on chips,
nanomaterials in biomedicine, (4) bioinformatics, soft-ware for labs usage in virtual diagnosis and virtual pharmacy; (5) biosensors; (6) biodevices.

As in the first year, the preferred subjects were finally devoted to the microscopic phenomenon at cellular level. Then follow: the bioinformatics subjects, the practical circuits of measurements as a mobile ECG platform and biodevice with 3 terminals, medical interfaces and the lowest impact subjects approached some biosensors.

4.1. e-Pharmacy

Here is presented a first type of project of a virtual pharmacy pointcare or in others words an electronic-pharmacy. First time must be installed apache-tomcat-6.0.14.exe. In the second step must be installed mysql-5.0.45-win32.exe and the database with active substances are moved into MySQL / MySQL Server 5.0/data. Then Eclipse is starting, with a new project defining; the name is “Farmacie” in fig.1. Then the project can be running, selecting the tomcat 6 as server. This soft-ware ensures a good security both for client and pharmacists.

![Image of e-Pharmacy implementation](image)

Fig. 1. A step in the e-Pharmacy soft-ware implementation.

4.2. Software for Bio-Learning

The second example is a student project selected in 2007-2008 year, regarding an animation soft-ware for a better biological phenomenon learning, or in others words for Bio-Learning. The animation was performed in Sothink SWF Quicker Soft-ware. It uses Flash in order to animate a series of images, describing the sinapse work regime into a movie of the entire process. Figure 2 a, b, c presents some sequences from this movie, for the electrical pulse transmission along axon. When the action potential – green zone – open the Ca-channels, the neurotransmitter exocytosis occurs, fig. 2. d, e, f. The neurotransmitter is recovered into the terminal butons after the Calcium reuptaken and ensures the preparation for a new pulse transmission, fig. 2. g, h, i.
Fig. 2. (a) – (i) Intermediates steps for the intra- and inter-neuronal electrical pulse transmission.

5. The BioNEC research platform

Our engineer team developed in the last years some new tools to investigate some biological medium: a tactile biosensor [6], the analysis of the non-linear responses of biosensors with
tools borrowed from microelectronics – Non-Linear Electrical Conduction Theorem [11], a 
biodevice with diamond electrodes for some neurotransmitters electrical characterization [12].

Around the BioNEC course, a research platform was developed, as a BioNEC group in the 
Faculty of Electronics. Besides to the Politehnic team, some external partnerships reinforce 
the research capacity.

The human resources in the BioNEC research platform consist in: 2 correspondent members 
of the Romanian Academy, 1 professor, 3 associated professors, 1 Principal Researcher I, 3
Principal Researcher II, 4 Scientific Researchers, (hence 14 Seniors) and 1 resident 
physicians, 1 young researcher debutant, 7 PhD students, 3 students, 2 masters students, 
(hence 14 Junior Researchers). They have the affiliation: P1 – Politehnic University 
Bucharest, P2 – Institute of Microtechnology, P3 - Institute V. Babes of anatomo-pathology, 
P4 – University of Medicine and Pharmacy Carol Davila Bucharest, P5 – private company. 
The distribution of the peoples on institutions is presented in fig. 3.a. They have 
complementary specialities. Figure 3.b presents the number of persons affiliated at one 
speciality.

The research directions available for the entire BioNEC platform are: monitoring in electrophisiology, 
cellular signal recording and processing, Langerhans islands isolation for 
characterization and transplants, intercellular communications, biomodeling in living 
structures, contributions in neuroscience, e-healthcare and the list is opened.

6. Conclusions

Accordingly with the UE predictions the people must be instructed in the next years for the 
problems of the remote electronically healthcare, using behavior models, bio-electronically 
deVICES, being capable for recording and interpretation of their own analysis or to manage 
some complicate e-Healthare systems, like glucose monitoring integrated with an insulin 
micropump for drug delivery.

The main target of this course is related to an e-Healthcare system implementation in 
medicine. The paper presents the BioNEC adaptive course content and two applications as 
student projects. The first one is dedicated to an interactive computer Bio-Learning method, 
based on animation, taking into account that visual memory is the strongest. Then a data-base 
storage into an electronic pharmacy, which can be accessed both by clients and pharmacists. 
The links of the engineer team with others complementary specialists was presented.
In the future, this course integrated in some research projects can be a starting point for a large dissemination toward the great public, after scholarship period, to offer knowledgements about patient monitoring, personalised diagnosis, electronic-Healthcare and to prevent the problems related to the population aging, especially in Europe.

References:


Acknowledgements:
The author thanks to Professor Adrian Rusu from “Politehnica” University of Bucharest, Romania, for the useful discussions. The financial support is by the PN2: Biotechnology and IT sections from the ANCS Romanian Program.

Author(s):

Cristian Ravariu¹, Associated professor
Andrei Sevcenco¹, Master student
Michael Auer², Professor
Constantin Ionescu-Tirgoviste³, Professor
Florina Ravariu⁴, Scientific researcher
Florin Babarada¹, Associated professor
1Politehnica University of Bucharest, Romania, Faculty of Electronics Telecommunications and Information Technology, Microelectronics Department, BioNEC Group, B-dul Iuliu Maniu 1-3, Sector 6, Postal zip: 061071, www.arh.pub.ro/cravariu, cravariu@arh.pub.ro
2Carinthia University of Applied Sciences, Electrical Engineering Dept, Fachhochschule Technikum Kärnten, Villacher Strasse 1, A-9800 Spittal, Austria, M.Auer@cti.ac.at
3National Institute for Research and Development in Microtechnologies (IMT Bucharest) Str.Erou Iancu Nicolae 32B,72996 Bucharest, Romania, florina.ravariu@imt.ro
4University of Medicine and Pharmacy Carol Davila, Bucharest, cit@paulescu.ro