ARTIFICIAL INTELLIGENT INSERTS IN HEALTHCARE SYSTEMS

BALAN PILLAI
PROFESSOR, D.Sc. (TECHNOLOGY)
KISBED ORG, Teknillinen korkeakoulu [Helsinki University of Technology], Espoo, Finland

Abstract

The presentation is here to make a technical walk through to the most recent initiatives in healthcare technology INSERTS predominantly in European Union Countries. We may penetrate on bio-materials and Implants.

Early adopters of new technologies require both innovative product partners and clinical teams. With this in mind, a group of leading-edge researchers, forward-thinking clinical experts, and innovative product partners have formed the Healthy Aims Consortium. They have chosen a range of implants and diagnostic equipment to demonstrate how key Micro- and nano-systems technology components and processes can be developed and integrated into new products. To rapidly demonstrate technology integration, some products have been chosen which can be designed, fabricated and prepared for clinical trials within few years. We reveal here the Functional Electrical Stimulation (FES) implant, an implant intra-cranial pressure sensor system, retina and cochlear implants, and glaucoma, sphincter, and inertial sensors.

Within this short speech, we could merely walk through the state-of-the-art; confirm technically the emerging need of engineering and human-body science-fusion; into the next-level of cross-cultural scientific body that could achieve the future “connected” smart systems, and or are rolling at the bit stream technology trajectory and the “free-sky”.

1 INTRODUCTION

The health care is a local and at the same time global conspiracy subject to handle. Mr. Bill Clinton, last President of the United States of America [2000], introduced the Medicare Bill that could not successfully passed as final Law enforcement at the Senate in the Capital Hill, at Washington, D.C.,US, and still it is hanging with Mr. George W. Bush’s cabinet, who lives his Offices as President at 2008. It is obviously a never-ending process on healthcare; now and tomorrow and no one wants to make any compromises to decision! Demand for nanotechnology in health care products will jump 48% annually through 2009, led by improved cancer and central nervous system therapies; based on solubilization technologies. Diagnostic tests focused on nanoarrays and quantum dots, and imaging agents conducted on superparamagnetic iron oxide nanoparticles; would also see strong growth.

1.1 A study [1] analyzes the $ 906 million US market for nanotechnology in health care products. It presents historical demand data for 1999 and 2004, and forecasts to 2009, 2014 and 2020 by material and product (e.g., nanoparticles, nanoarrays, nanotubes, dendrimers); by application (e.g., pharmaceuticals, diagnostic products, medical supplies and devices); and by indication (e.g., cancer, central nervous system conditions, infectious and viral conditions). The study also considers market environment trends and indicators, details industry structure and profiles 73 industry participants including Elan Drug Delivery, NUCRYST Pharmaceuticals, Quantum Dots, Bristol-Myers Squibb, Dow Chemical, and GlaxoSmithKline[1].

1.2 This speech is not anticipated to be a large sum of paper supplies; except to show that a great number of studies that are not made any efforts to get there a road map on medical technology or policy; not to mention about the drivers and trend in medically used chemicals to human-body systems. The *“Committee for Future,”* consistently offered the plot with a sundry scenario on political-cum-financial prospective. A paper [Elina Savola, *et.al. (2005)]* produced last year in Finland; showing the global evaluation methods in medical practices and its footings. To land a real-touch-road-map of the future; one needs much more time and ground-to-earth studies, which, of course, is not expected due to either of the both or available monies.

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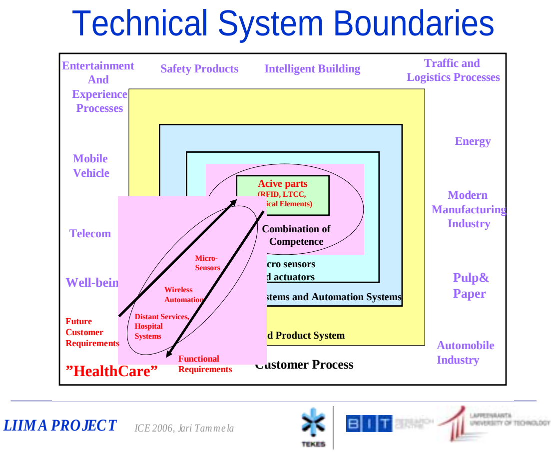
[1] Notes extracted from the publication Source of NIST, Gaithersburg, MD, USA. [2005].

1.3 The Finnish government funding agency, [TEKES], beside the other European Union Countries; have conducted a "map-out project" on competitiveness and Healthcare. See figure below:



The figure [Salminen. V, 2005] shows above the broad boundaries that interleaving with several emerging technologies; and endless entities.

2 ARTIFICIAL INTELLIGENTS IN HUMAN-BODY-SYSTEMS

2.1 The present era of Internet, people around the globe are searching ways to be happy and long living healthily. The legal instrument in some extent preventing or doing so; this is due to rejection of embryonic inserts or use. This is also a moral issue; to use or insert artificial intelligent into the human-body-system [Pillai, B (2006). The implants; we now consider mainly for the teeth-based levels. While ago, we revolutionized with immense success; the Internet, wireless connectivity, handheld devices, and cell phones. Now "the-time" to-go; for the human health issues with; smart systems implants that could help an extended comfortable life to the elderly, chronic or otherwise sick and handicapped human-beings. We owe many thanks to our elderly citizens of the world who dedicated their expensive life to us now to flourish. We should now consider helping them to survive in guiding again to an extended success in healthy-life.

2.2 Apparently we bump into several challenging obstacles; they are the following:

• Microfabrication technology
• Range of electrode and sensor capability for current and future applications
• Challenge is to work with suitably biocompatible materials
• Dense arrays that require microfabrication
– New markets / devices (e.g. retinal)
• Automation of processing which is very difficult / expensive by "conventional" means
– Offers a key to substantially larger, valuable market (e.g. Cochlear)
• Enables novel sensors (e.g. glaucoma, sphincter-closure)

3 ELECTRODES AND SENSORS

3.1 In a generic thinking, electrodes and sensors are very sensitive in their surveillance due to the following reasons: Electrodes are; key to active implants –

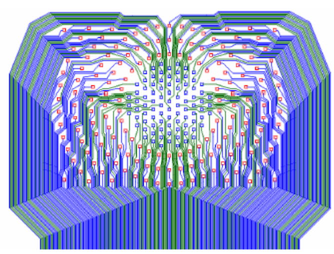
- They provide the interface to the body tissue
- Applications range from short term <1day to entire life implants
- Active electrodes are being developed to allow dense arrays with minimal wiring
- Electrode is integrated to multiplex component

3.2 The lifecycle is downscaled to meet eminent processes at the body system; and electrodes and sensors are therefore needed to be (see table) -

	Long term (electrodes)	Short term (sensors)
Macro Micro		Sphincter closure
(array)	Muscle stimulation Cochlear Retina	Glaucoma

Table: Shows the long-term and short term applications.

3.2 Let us take a quick at another smart device, that is; Retinal stimulator -
• This requires a dense array of electrodes
• This can only be made by microfabrication techniques. See the image –

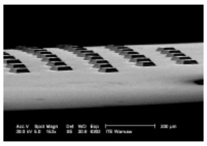


3.3 This is a fantastic stimulator. It has proven working perfecty though the microfabrication techniques are extremely high. In this application the electrode structure is very thin (10µm) and;

• The electrode tips are formed as truncated pyramids,

• This improves the contact to the tissue.

3.4 See also a couple of other images below –

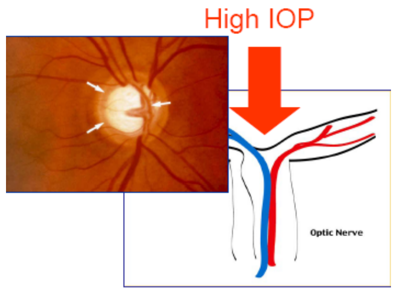


4 BIOMATERIALS & FUNCTIONAL INTERFACES

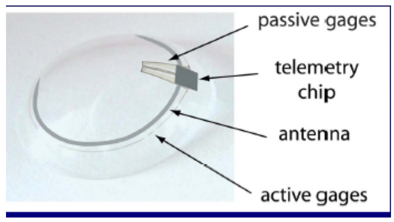
4.1 Biomaterials and Functional Interfaces - exists to address the need for achieving optimal interface between implanted devices and the host tissues. The active implants being developed within the Healthy Aims [2] project present considerable additional challenges over current devices owing to the integration of active electronics and multi-electrode arrays on flexible substrates. One partner, QMUL, is developing biocompatible, flexible, and impermeable device coating materials to the product partners' specifications and evaluating their performance using cell-culture and other models of biocompatibility. The other partner, INEX, is developing physical and biological surface treatments for electrodes that improve coupling with the target cells (primarily nerve cells) to eliminate much of the loss of efficiency with time currently seen in many implanted electrodes. This is particularly important for the very small electrodes making up the complex stimulation arrays being developed within the project. A development roadmap has been produced and tasks allocated in consultation with others. Activity is now being focused on three materials developments at QMUL; polyurethane, primarily for the urethral device, modified silicones for the other devices and the application of diamond-like carbon to impart an impermeable yet biocompatible coating. QMUL have also established detailed biocompatibility test strategies in partnership with the product partners. Test methodologies have been developed and initial tests have been completed on key materials. At INEX studies have focused on topographic surface modifications in relation to the behavior of mixed populations of cells. In addition a sophisticated and systematic approach to chemical and biomolecular surface fictionalization has highlighted the importance of specific chemical groups in the adhesion of cells to surfaces.

[2] European Union Initiative, funded by the FP 6 Framework Program, and is being continued unto 2010 and beyond.

4.2 It is mentioned earlier that the artificial intelligent inserts; are no longer an imaginary thinking; virtually they are already here. Ubiquitous and ambient system integration needs more accurate performance in experimenting; though it is a time-consuming effort that could yield the next generation healthcare technology for sure. At the beginning this presentation started in saying that the technical walk includes the glaucoma sensor development. This disease is affecting more than seventy million human-being around the globe. Leonard, et al [2006] reported in Dissemination Day at EPF de Lausanne, Switzerland that glaucoma sensor develops story and its successes. Human-being lost their retina cells due to excessive intraocular pressure (IOP) and also natural phenomenon that causes a gradual and irreversible loosing their vision leading to complete blindness, when not treated properly and timely. An image presented below the vision problem -



4.3 The future wireless contact lens would be like the one shown below. This implant would create a new generation technology to sustain the health and sight.



5 THE IMLANTS

5.1 Latest implantable telemetric pressure measurements are aiming to monitor quality and functionality of therapeutic implants inserted; by simply invasive procedures. In order to reduce, the hospital stay of patients to a minimum number of days; implantable sensors for therapy control, integrated into commercial Tele-healthcare applications; provide cost-saving option in monitoring, and allowing the patient to carry on participating their everyday life normally. In a wireless hybrid sensor system approach (Fig below) as described by T Eggers et al (5), the basic components are –

- a long-term stable absolute capacitive pressure sensor,
- an ultra-low power interface circuitry,
- a radio-frequency transponder for bi-directional communication to an outside body area network unit, and
- a micro coil for inductive data and energy transmission to the implant.

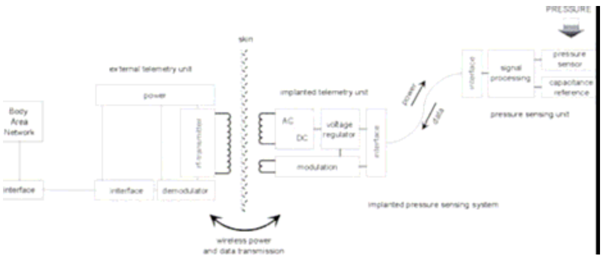


Fig: Block diagram of an implantable telemetric pressure measurement system.

5.2 To avoid the lifetime of the system being limited to the capacity of a battery; contemporary systems use a passive, inductively coupling method; to provide the implant with power from outside. However, at the same time transfer the data over a sufficiently long transmission distance; to an external reader unit. Consequently ultra low power consumption on part of the implant is essential. The encapsulation of the implant has to provide hermetically sealing in order to assure a driftfree and highly reliable system; over the entire lifetime of the implant. An additional nanotype coating ensures highly biocompatible performance of the implant. The latest three-dimensional micro packaging technologies facilitate the development of flexible devices; like integrated pressure sensor systems that meet the elevated demands of modern surgical insertion procedures; and could stay stable and reliable inside the human body over a long period of time.

6 Summary

6.1 The next generation technology scenarios are already set; for connecting into human-body-science, and information technology. This is not a trap but value-added well-being technology and permanent approach to better and happy life; the life time available or provided by the nature.

6.2 Let me conclude this presentation here with thanks to you all.

Acknowledgement

At this point, my personal greetings and thanks go to two eminent professors, who got dirtied their hands in arranging this Conference successful here. They are namely Professor Masanori Sugisaka, Department of Electrical Engineering of Oita University, Japan, and Professor Ju-Jang Lee, Korea Advanced Institute of Science and Technology, Daejeon, South Korea.

References

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[5] Eggers, T, et.al [2000]: MEMS2000.