22nd Asia and South Pacific Design Automation Conference
ASP-DAC 2017

Date : Jan. 16-19, 2017
Place: Chiba/Tokyo, Japan

Session 4S (Special Session) Emerging Technologies for Biomedical Applications: Artificial Vision Systems and Brain Machine Interface

Organizer: Masaharu Imai (Osaka Univ., Japan),
Moderator: Yoshinori Takeuchi (Osaka Univ., Japan)

- 3 Talks and short panel
- Panel discussion:
- Panelists

Jun Ohta (NAIST, Japan)

Gregg Jorgen Suaning (Univ. of New South Wales, Australia)

Chung-Yu Wu (National Chiao Tung Univ., Taiwan),

Napoleon Torres-Martinez (CEA-Leti, France)

- Jun Ohta (NAIST, Japan)

(Invited Paper) Smart Electrode - Toward a Retinal Stimulator with the Large Number of Electrodes –

- Gregg Jorgen Suaning (Univ. of New South Wales, Australia)

(Invited Paper) Strategic Circuits for Neuromodulation of the Visual System

- Cheng-Hsiang Cheng (National Chiao Tung Univ., Taiwan)

(Invited Paper) Design Considerations and Clinical Applications of Closed-Loop Neural Disorder Control SoCs

• Panel for Emerging Technologies for Biomedical Applications: Artificial Vision Systems and Brain Machine Interface

Jun Ohta (NAIST, Japan)

Gregg Jorgen Suaning (Univ. of New South Wales, Australia)

Chung-Yu Wu (National Chiao Tung Univ., Taiwan)

Napoleon Torres-Martinez (CEA-Leti, France)

1. What are the most difficult points to proceed Biomedical Applications research?

2. Are there any special projects or specific institutes for biomedical applications in your country?

STRATEGIC CIRCUITS FOR NEUROMODULATION OF THE VISUAL SYSTEM

Professor SUANING, Gregg J.

Graduate School of Biomedical Engineering

University of New South Wales, Sydney, Australia

1. What are the most difficult points to proceed Biomedical Applications research?

Funding the cost of the translation from laboratory research to clinical practice.

Operating in compliance with regulatory requirements in a university environment.

Medical Research Partners…

Finding appropriate medical research partners is perhaps the most import aspect of success as it is these partners who determine if a device shall proceed into clinical testing. Being able to speak a common ‘language’ (engineering vs medical language as opposed to e.g. Japanese/English) is essential.

Biocompatibility…

Biocompatibility can be achieved by utilising materials well known in clinical practice. For a small research organisation (laboratory) it is too expensive to proceed to qualify additional materials in my opinion.

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

From 2010 to 2015 there was a 5,000,000,000 Yen (5B Yen) project to build a bionic eye. We advanced the technology significantly, but there was limited follow-on funding so that the work of the 5B may become undone.

In Australia…

Cochlear implants are the most popular but they are mature and research to make them better is being reduced.

22nd Asia and South Pacific Design Automation Conference (ASP-DAC 2017)

Special Session 4S: Panel Discussion

Emerging Technologies for Biomedical Applications

Panelist: Chung-Yu (Peter) Wu

Biomedical Electronics Translational Research Center

Department of Electronics Engineering
National Chiao Tung University, Taiwan

BETRC

1. What are the most difficult points to proceed biomedical applications research?

1) Team

Medical Doctors: Unmet clinical needs.

Biological Scientists

Engineering Professors in different fields:

- **Microelectronics (Analog, DSP, Power Management);**
- **Bio-Materials;**
- **Packaging.**

1. What are the most difficult points to proceed biomedical applications research?

2) Implantable Systems

Not a pure engineering research!

Not a component research!

It is a stand alone system!

SOC, Electrodes, Wires, Hermetic Package, Battery,

Coils, Feedthrough, ……

1. What are the most difficult points to proceed biomedical applications research?

3) Regulation

Animal Test (University)

Pre-clinical trial (University)

Clinical trial (Company)

“ If something wrong, we can reset a computer. But could we reset a human body??”

1. What are the most difficult points to proceed biomedical applications research?

4) Company

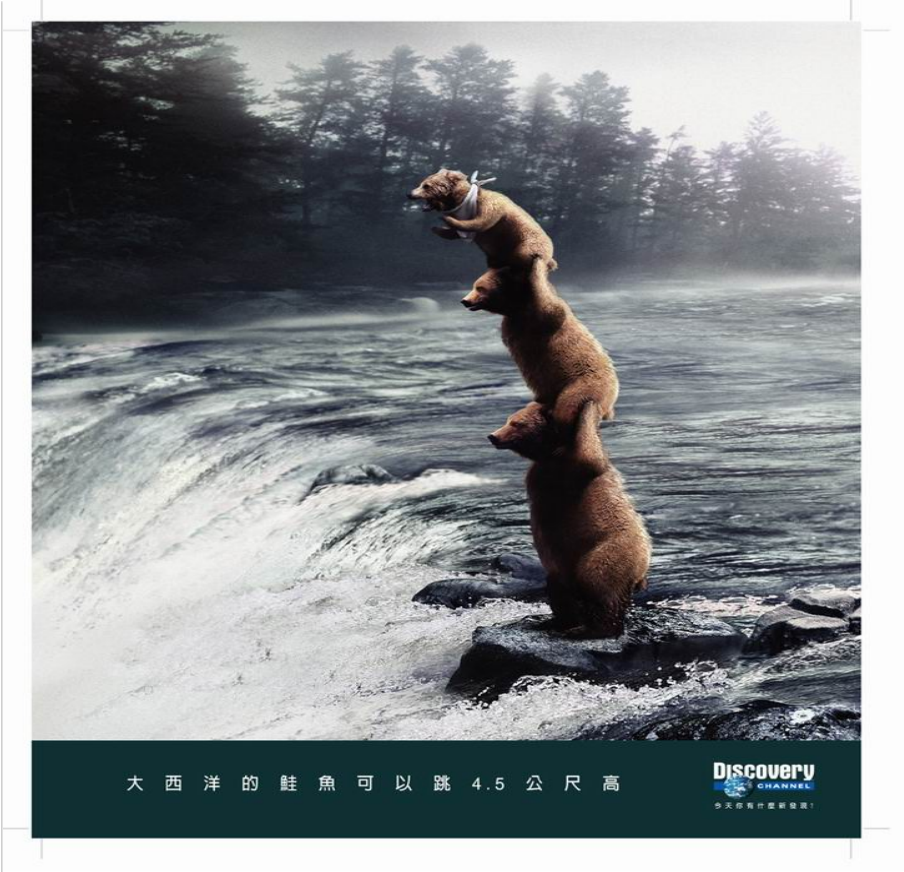
Clinical trial should be done in a company!

Spin-off? Technology Transfer?

Money burning?

Dealing with FDA?

HOW?



Atlantic Salmon could jump up 4.5 meters high……

Open Mind

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

1) 5+2 Industry Promotion (NT$100B/Year)
   Biomedical Industry (Biotech + Pharmaceutical)
2) Biomedical Electronics Translational Research Center (BETRC) at National Chiao Tung University

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

2) Biomedical Electronics Translational Research Center (BETRC) at National Chiao Tung University

Subretinal Implant

Closed-Loop Epileptic Seizure Control System

Spin-Off: Amazine-Neuron Electronic Corperation

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

2) Biomedical Electronics Translational Research Center (BETRC) at National Chiao Tung University

Closed-Loop DBS for PD

Bone-Guided Cochlea Implant

Other Implantable Neuromodulation Systems

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

3) Hsinchu Biomedical Science Park (HBSP)

Objective: To emphasize the industrial incubation and developmental planning of industries concerning "advanced medical devices" and "pharmaceuticals."

2. Are there any special (national) projects or specific institutes for biomedical applications in your country?

4) ITRI (Industrial Technology Research Institute)

Biomedical Technology and Device Research Laboratories

Biomedical Electronics and Medical Imaging

Biomarkers and In-vitro Diagnostic

Combination Device and Orthopedic

Thanks for your attention !

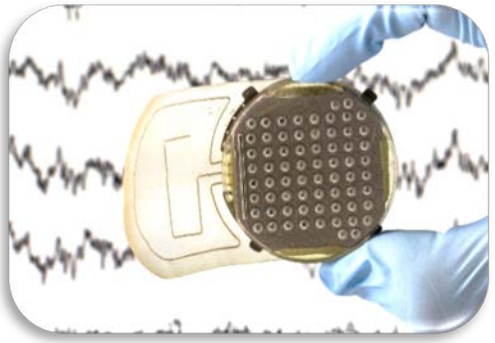
PANEL DISCUSSION EMERGING TECHNOLOGIES FOR BIOMEDICAL APPLICATIONS: ARTIFICIAL VISION SYSTEMS AND BRAIN MACHINE INTERFACE

PANELISTS: JUN OHTA (NAIST, JAPAN), GREGG JORGEN SUANING (UNIVERSITY OF NEW SOUTH WALES, AUSTRALIA), CHUNG-YU WU (NATIONAL CHIAO TUNG UNIVERSITY, TAIWAN), NAPOLEON TORRES- MARTINEZ (CEA-LETI, FRANCE)

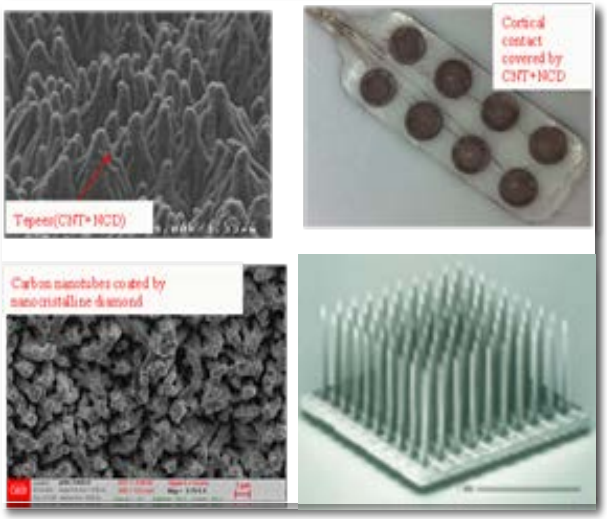
MOST DIFFICULT POINTS TO PROCEED IN BIOMEDICAL APPLICATION RESEARCH

CHALLENGES FACING ECOG MOTOR BRAIN MACHINE INTERFACE

Goal: Ideal BCI → Capable of sample and stimulation precise neural features minimally invasive → Highly Unlikely



ISSUE FACING BCI ECOG IMPLANTS



Materials

1.Improve patency of chronically implanted electrodes and extend the lifespan

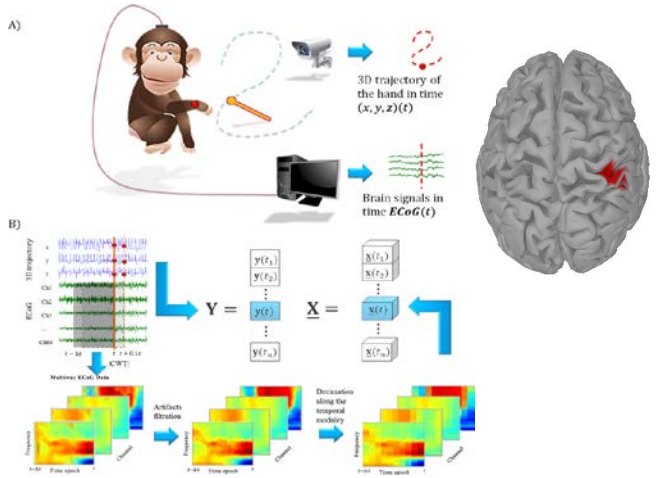
Decoding:

1.Find reliable recording sites

2.Decoding algorithm do not need to recalibrate

3.Adaptive decoders (automatic recalibration)

4.Reduce need of fully technical support



Effectors

1.Increase smoothness movement

2.Sensory Feedback

DESIGN TRADE-OFF BCI SYSTEM

Technical Performances : number of recording channels, Signal to Noise Ratio, low power, miniaturization, wireless data throughput, real time processing …

Manufacturability :
ISO 13485 manufacturing process
turity of the technology :
tability, reliability

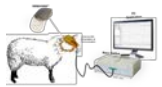
Clinical operability and safety:
Minimal Invasiveness: Non penetrating electrodes, Epidural matrix, Wireless Connections
Simplest Procedure: Ø5cm trephination

Regulatory compliance:
Biocompatibility (ISO10993) , **mechanical and electrical safety** (ISO45501-1, ISO60601-1), **software reliability** IEC62304, ISO14971 risk management of medical device

Medical needs: Chronic ECoG implant to record motor activity of Tetraplegic Patients in a BCI project

Device tests:
Preclinical data

Clinical trials



National projects or specific institutes for biomedical applications in your country

BIOMEDICAL APPLICATIONS IN FRANCE

- **CEA:** Center for Atomic and Alternative energy
  - 3th largest patent filer in France
  - Areas: defense and security, nuclear energy (fission and fusion), technological research for industry, fundamental research in the physical sciences and **life sciences.***
- **CNRS:** National Center for Scientific Research
  - 6th largest patent filer
  - largest **fundamental** research organization in Europe
- **INSERM:** French National Institute of Health and Medical Research
  - **Focus entirely on human health**

advancing the frontiers

Instituts thématiques

Institut national de la santé et de la recherche médicale

- **UNIVERSITY HOSPITALS CENTERS**

GT STIM AVIESAN : https://aviesan.fr/en

- *CEA Tech Japan Office, Embassy of France, Tokyo

5 STRATEGIC DOMAINS…

X and Y-ray detectors

X, Y-ray and optical detectors for medical imaging and security

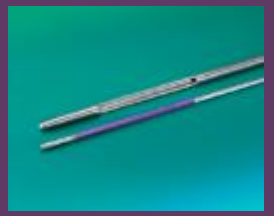
Nanocarriers

Nanocarriers for diagnostics and drug delivery

Lab-on-chip and µfactory

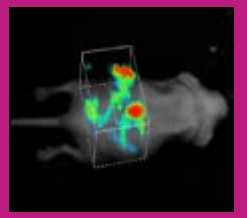
Microsystems for in vitro diagnostic, environmental and industrial monitoring

Medical devices



Wearable and implantable devices & sensors

Molecular imaging

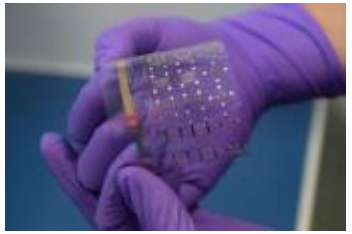


Optical imaging

MEDICAL DEVICES

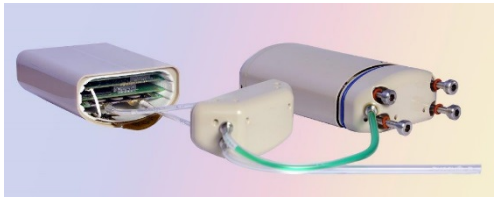
ISO 13485

- **Wearable devices: miniaturized, multiparametric**
  - Impedance, motion, biological sensors (SpO2, pCO2, pH…)
  - Close-to-sensor electronics, system integration
  - Electro stimulation and measurement
  - Automatic regulation loop
- **Implantable devices**
  - Sampling systems
  - Micro-electrodes for retina implant, nervous stimulation
  - µpumps and µvalves for local drug delivery
  - Biopackaging



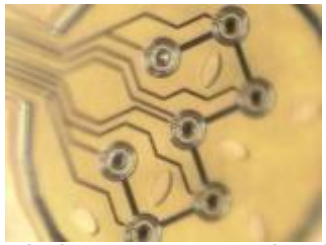
Electrochemical sensor

Diabetes regulation loop

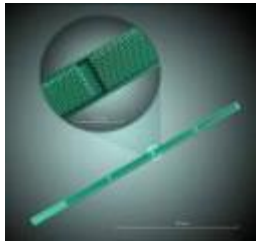


µpump for drug delivery

Vagus nerve electrodes



Retinal photoreceptor stimulation



µbiopsy system

<u>Applications</u>: Diagnosis, Drug Delivery, Chronic Disease Monitoring (respiratory, sleep, diabetes, epilepsy...), e-Health, Activity Monitoring, Sport, Wellness, Rehabilitation, Smart Textile, User Feeling Monitoring

THANK YOU
FOR YOUR ATTENTION

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