Brain Signal Processing

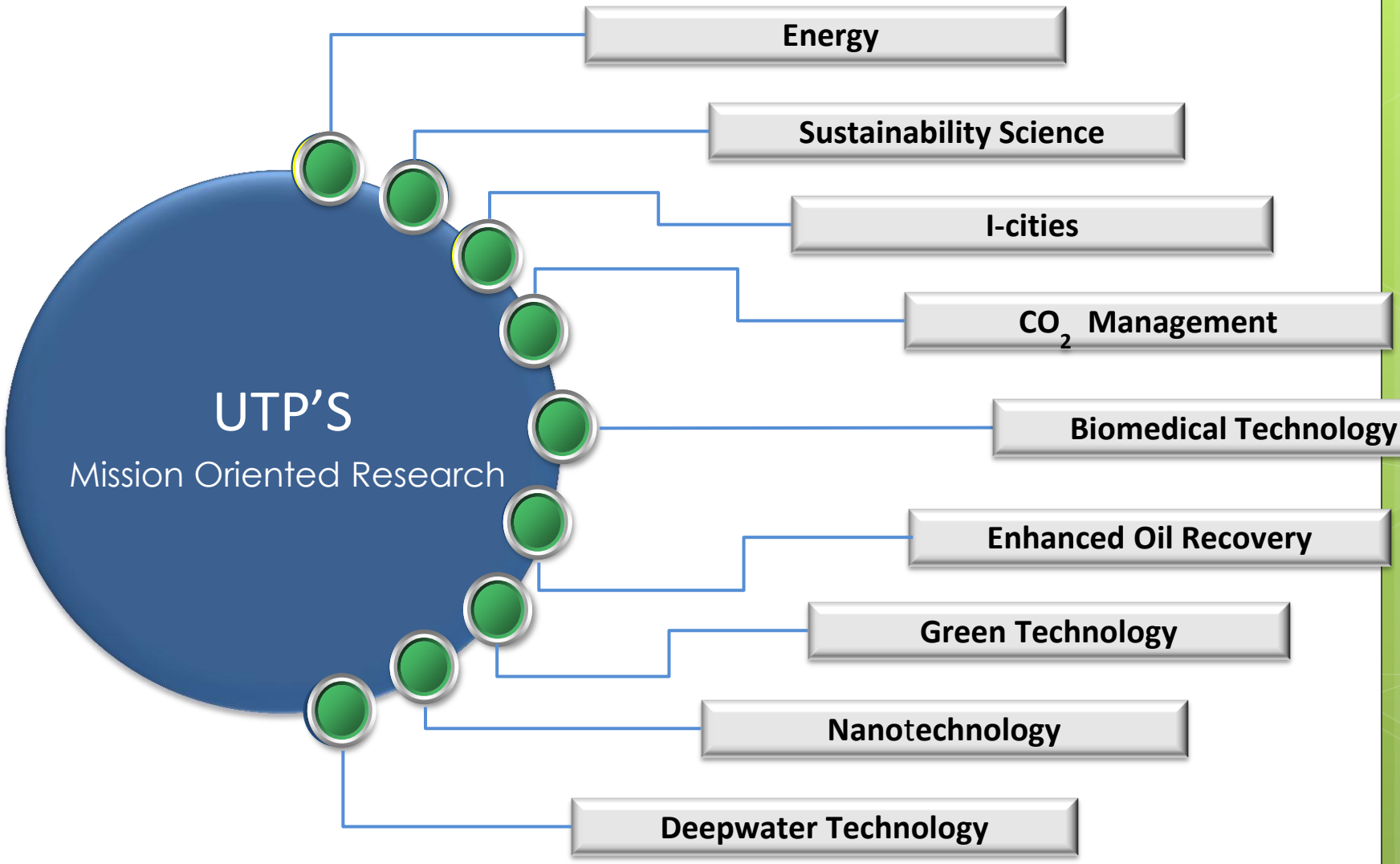
Mohd Zuki Yusoff

Neuro-Signal Processing Group
Universiti Teknologi Petronas (UTP)
Malaysia

UNIVERSITI TEKNOLOGI PETRONAS

- Universiti Teknologi PETRONAS is a wholly-owned subsidiary of PETRONAS, Malaysia's national oil and gas corporation. Established in 1997
- 3 Faculties with over 300 academics - Faculty of Engineering, Faculty of Geoscience and Petroleum Engineering, Faculty of Science and Information Technology
- 9 Mission-Oriented Research and 10 research centres
- 5600 UG and over 1000 PG students

MAIN RESEARCH GROUPS



MOR: Biomedical Technology

The team focuses on application of science and engineering principles and techniques to the medical field; to combine the design and problem solving skills of engineering with medical and biological sciences to improve medical diagnosis, treatment efficacy and healthcare.

ASPIRATION

VISION

To be a Leading Centre in Biomedical Technology Research

MISSION

- To explore the frontiers of technology in biomedical science and engineering
- To provide solutions in improving healthcare diagnosis, monitoring and therapy

MOR BMT- ORGANISATIONAL CHART

Assoc. Prof. Dr. Aamir Saeed Malik
Director ,
MOR Biomedical Technology

Center of Excellence

Prof. Ir. Dr. Ahmad Fadzil M Hani
Head,
Centre for Intelligent Signal and Imaging Research (CISIR)

Groups

Intelligent Medical Imaging

Leader: AP Dr Ibrahima Faye

Members:
Prof. Ahmad Fadzil M Hani
Dr Aamir Saeed Malik
Dr. Ibrahima Faye
Dr. Ahmad Majdi
Dr. Walter Nicolas

Neuro-Signal Processing

Leader: AP Dr Nidal Kamel

Members:
AP Dr Aamir Saeed Malik
Dr Mohd Zuki Yusoff
Dr Likun xia
Dr Nasreen Badruddin
Dr ibrahima faye
Dr TANG TONG BOON

Pervasive Computing & Embedded Systems

Leader:AP Dr Tang Tong Boon

Members:
AP Dr Nor Hisham Hamid
AP Dr Fawnizu Hussin
Dr Noohul Basheer Zain Ali
Dr Likun Xia
Dr Nasreen Badruddin
Dr Azlan Awang Dr Azrina
AP Dr Varun Jeoti

Health Informatics & Modeling

Leader: AP Di Vijanth Asirvadam

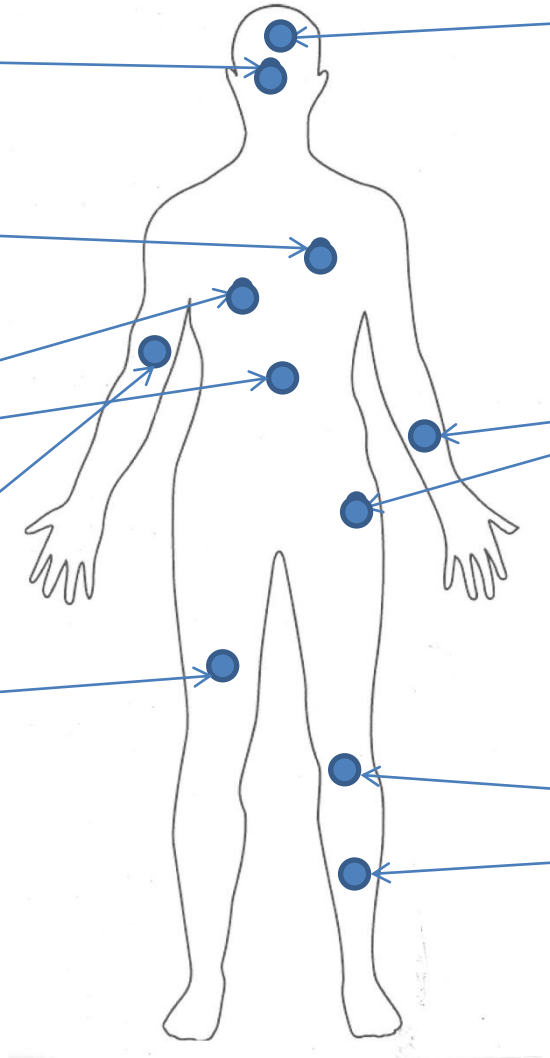
Members:
AP Dr Sarat Das
AP Dr. Aamir Malik*
Narinderjit Singh (2012)
Dr Azrina Abd Aziz* (2012)

Assistive and Adaptive Bio-engineering

Leader: AP Dr Irraivan

Members:
Dr Hasan Fawad
Dr Anis Suhaila
Dr Turnad Lenggo Ginta
Dr Mohd Azmuddin Abdullah
Dr Bambang Ari Wahjoedi

Biomedical Health Research



Eye
- Diabetic Retinopathy (DR)

Heart & Blood Circulation
- Heart-related Diseases
- CAD

Internal Organ
- Breast Cancer
- Lung Cancer
- Crohn's disease detection (FAH)

Whole Body Health & Wellness
- Health Alert System
- Stress Therapy
- Hand Rehabilitation
- Bone Drilling
- Biomaterials and biomarkers development

Brain
- Event Evoked Potential
- Motion induced sickness
- Brain-Computer Interface
- Epilepsy Monitoring
- Drug Addiction monitoring
- Dementia
- Memory retention and recalling

Skin
- Psoriasis Assessment
- Skin Pigmentation
- Acne Analysis
- Ulcer Wound Assessment

Limb
- Osteoarthritis Detection
- Long Bone Fracture

Medical Informatics
- Web/Cloud databases

BRAIN RECORDING

Hans Berger

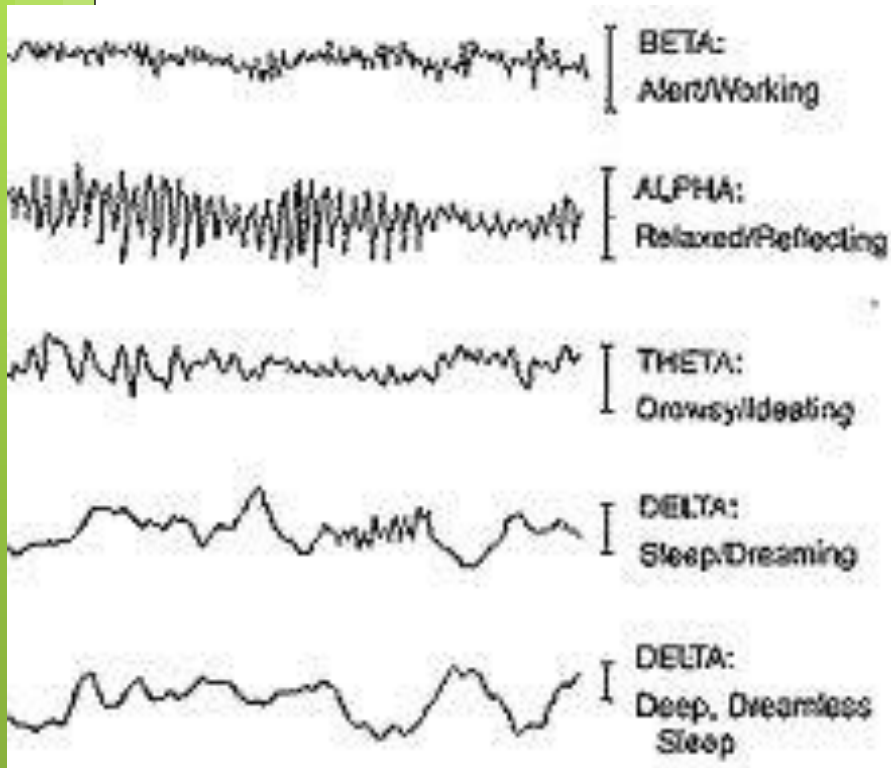
- The first recording of the electric field of the human brain was made by the German psychiatrist Hans Berger in 1924 in Jena
- He gave this recording the name *electroencephalogram (EEG*
- From 1929 to 1938, he published 20 scientific papers on the EEG

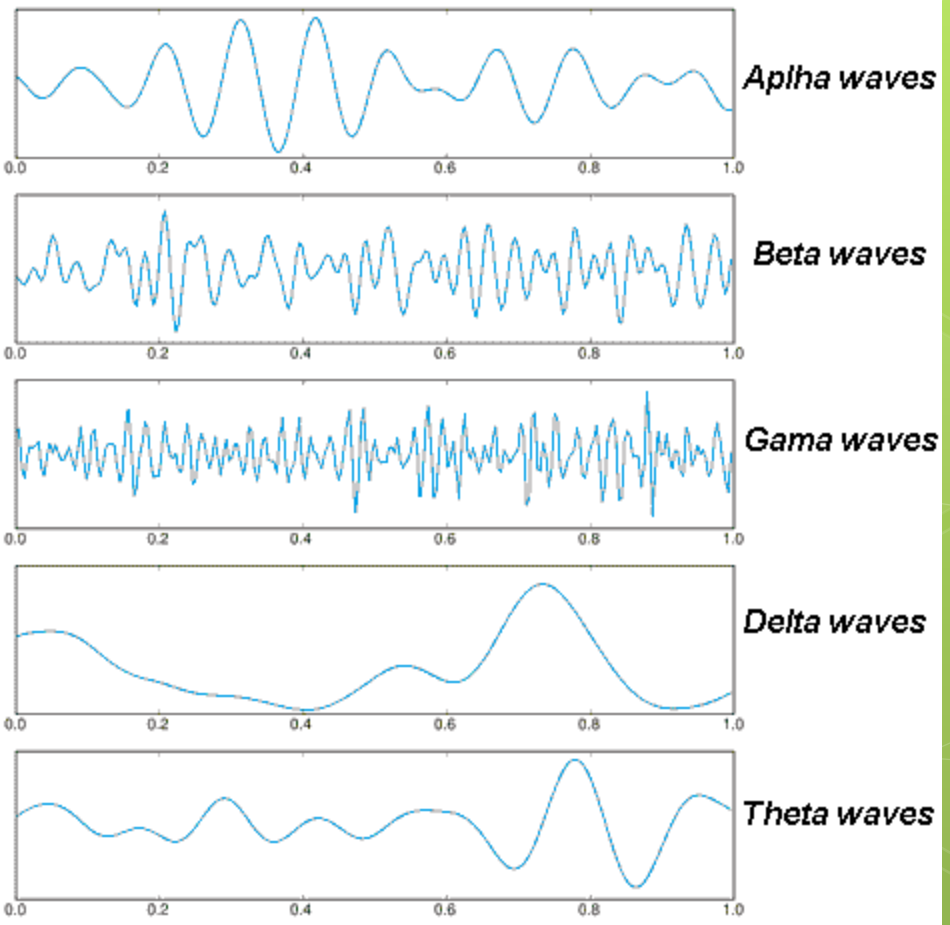
EEG Activity

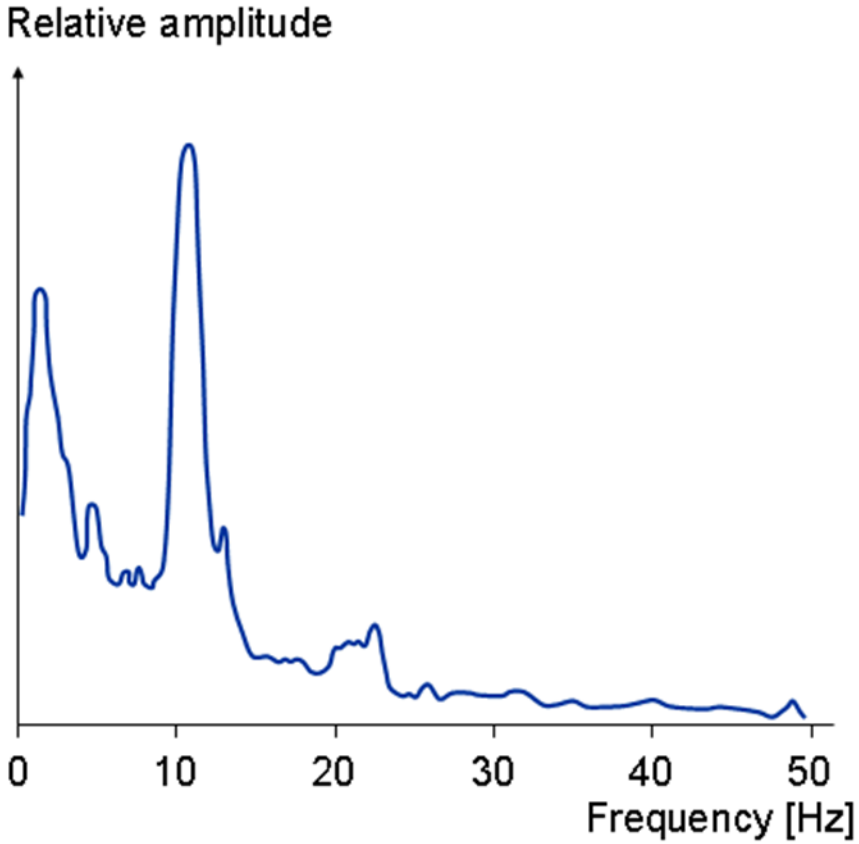
- **Spontaneous activity:** is measured on the scalp or on the brain and is called the electroencephalogram
  - The amplitude of the EEG is about 100 µV when measured on the scalp
  - Its about 1-2 mV when measured on the surface of the brain
  - The bandwidth of this signal is from under 1 Hz to about 50 Hz (see figure)
  - As the phrase "spontaneous activity" implies, this activity goes on continuously in the living individual

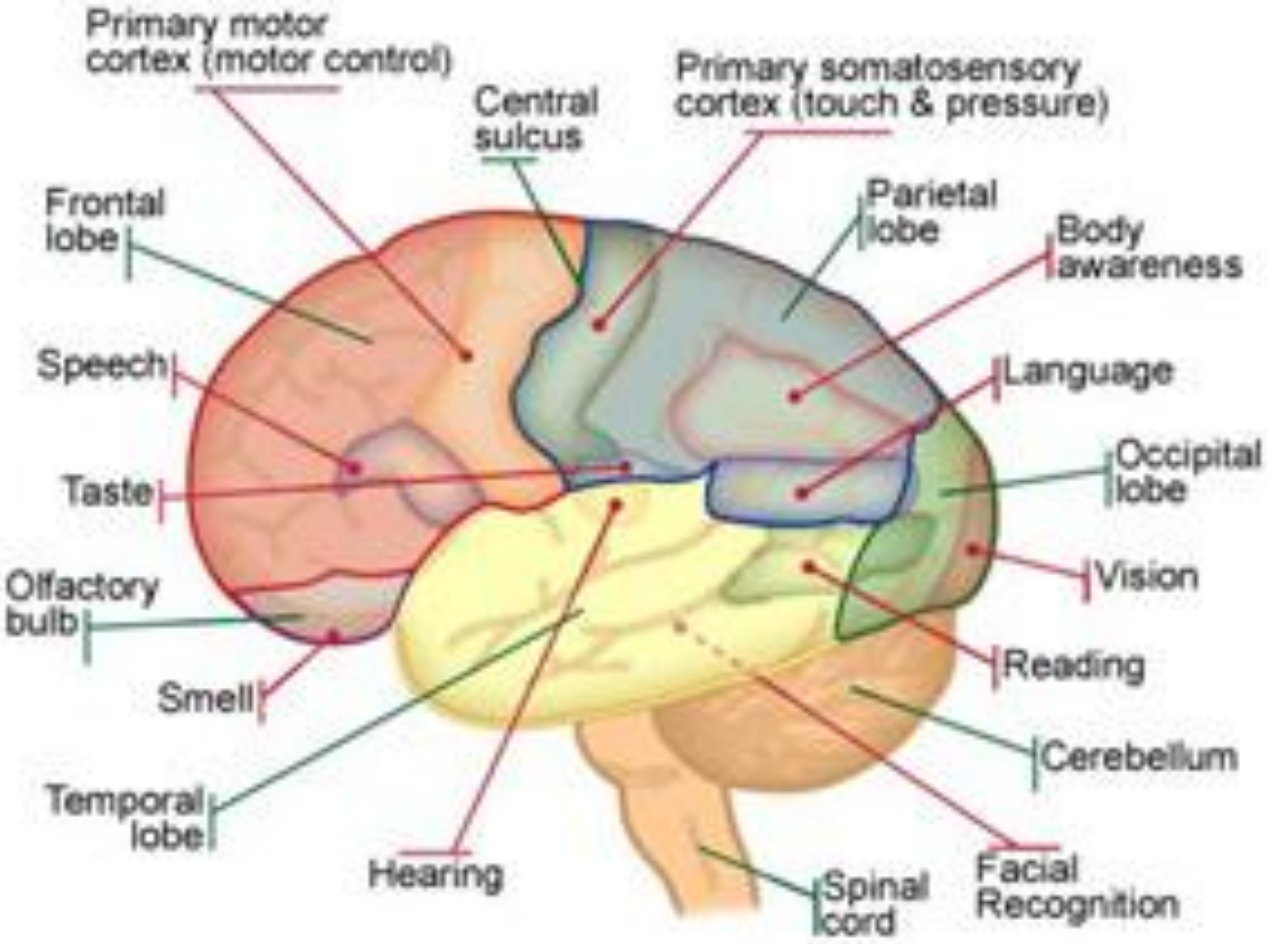
EEG Bands

- Typical EEG component bands:
  - Delta (1-4 hz)
  - Theta (4-7 hz)
  - Alpha (8-12 hz)
  - Low Beta (12-15 hz)
  - Beta (15-20 hz)
  - High Beta (20-30 hz)
  - Gamma (40 hz and above)
  - Ranges are typical, not definitive
  - Anyone of these bands can occur outside the above frequency ranges
  - There may be overlap between these bands


BETA:
Alert/Working
ALPHA:
Relaxed/Reflecting
THETA:
Drowsy/Ideating
DELTA:
Sleep/Dreaming
DELTA:
Deep, Dreamless
Sleep


Aplha waves
Beta waves
Gama waves
Delta waves
Theta waves
0.0
0.2
0.4
0.6
0.8
1.0


Relative amplitude
0
10
20
30
40
50
Frequency [Hz]


Primary motor cortex (motor control)
Central sulcus
Primary somatosensory cortex (touch & pressure)
Frontal lobe
Parietal lobe
Body awareness
Speech
Language
Taste
Occipital lobe
Vision
Olfactory bulb
Reading
Smell
Cerebellum
Temporal lobe
Hearing
Spinal cord
Facial Recognition

BRAIN WAVE USAGE [1]

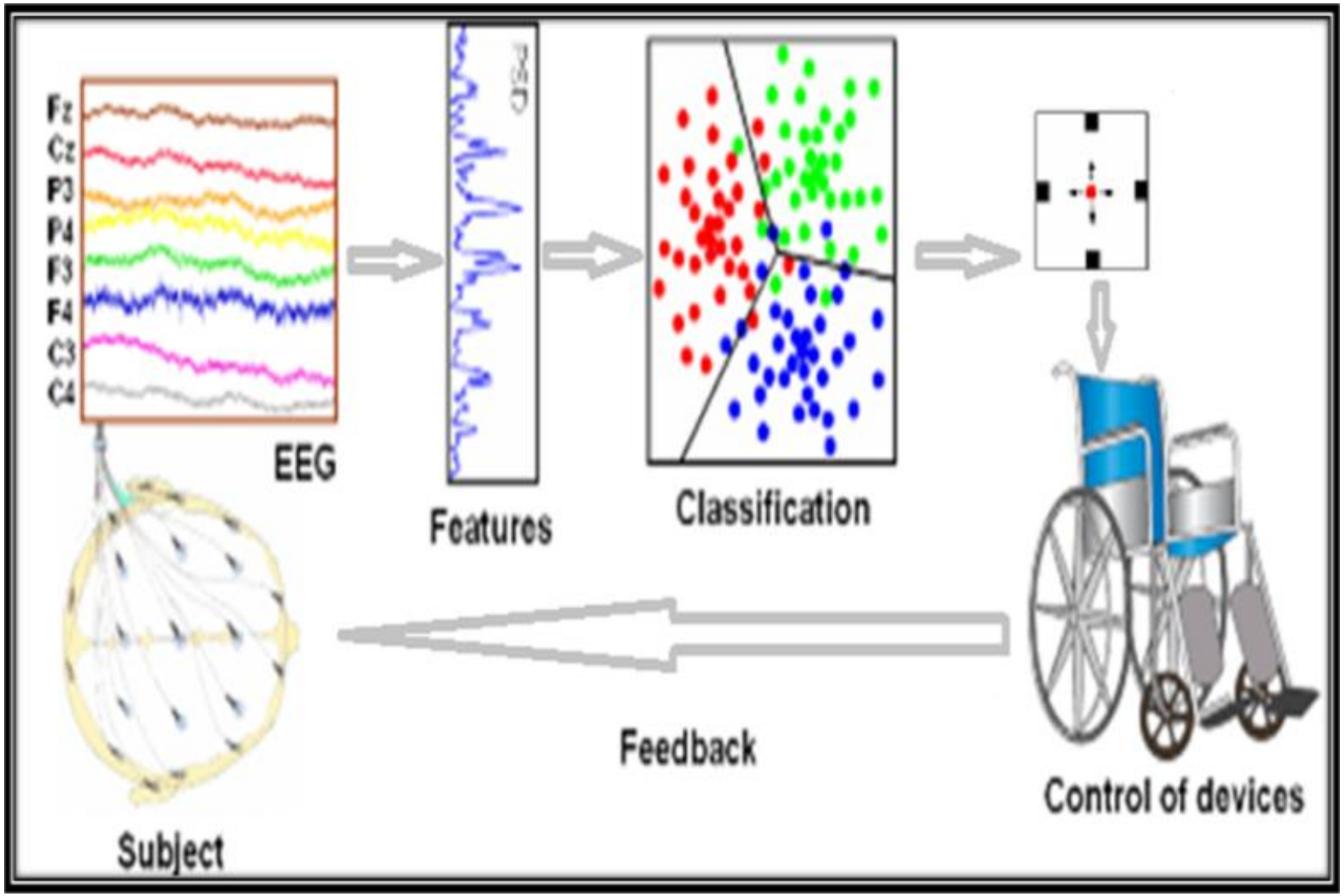
- **Evoked potentials:** are those components of the EEG that arise in response to a stimulus (which may be electric, auditory, visual, etc)
- Such signals are usually below the noise level and thus not readily distinguished
- One must use a train of stimuli and signal averaging to improve the signal-to-noise ratio

BRAIN WAVE USAGE [2]

Brain Computer Interface

- EEG wave recording
- Feature extraction
- Feature classification

Brain Computer Interface (cont'd)



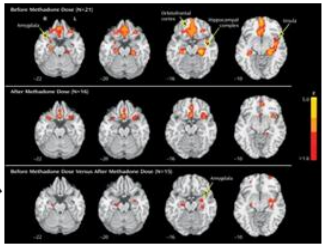
BRAIN WAVE USAGE [3]

Mental State Detection

- Driver drowsiness detection
- Aggressiveness detection

Current Projects: Biomedical Research

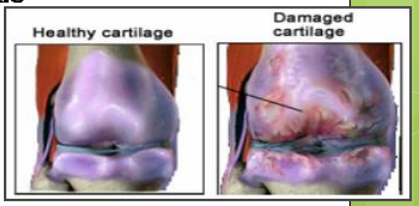
EEG-fMRI for Early Alzheimer Detection



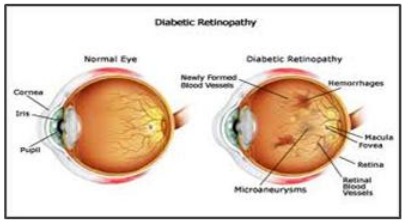
fMRI in Drug Addiction

Skin Pigmentation Analysis

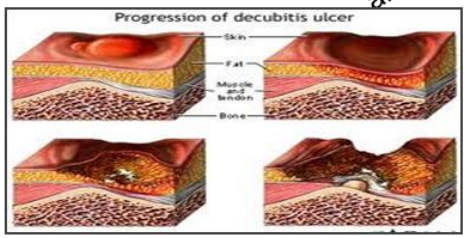
Early Osteoarthritis Detection qMRI



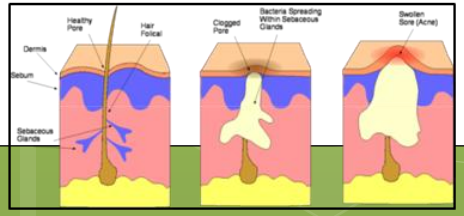
Diabetic Retinopathy Assessment & grading



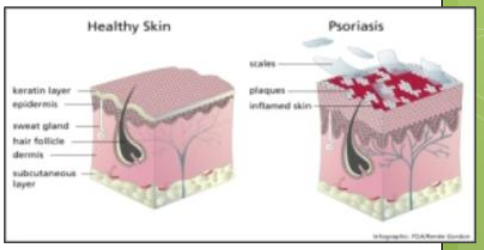
Ulcer – Assessment and measurement



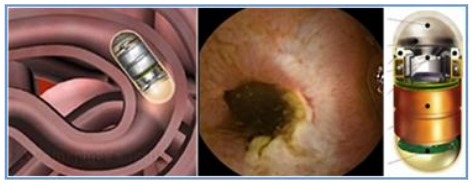
Acne Analysis



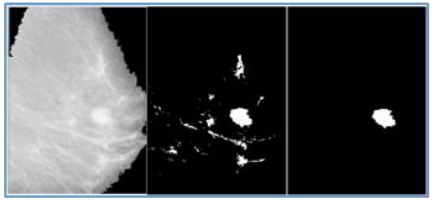
Psoriasis Assessment



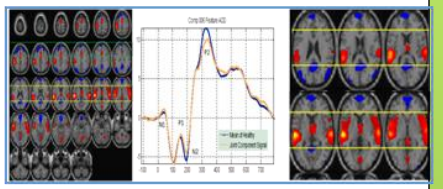
Current Projects: Biomedical Research



Detection of Crohn's Disease



Breast Cancer Detection

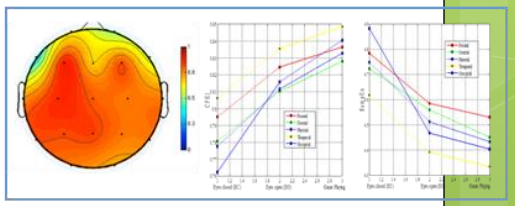


EEG-fMRI fusion for brain Activity

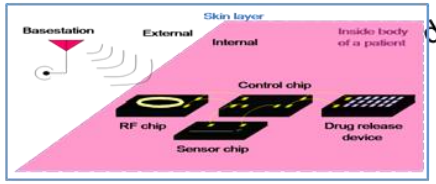
Bone Fracture Detection using Ultrasound

Projects

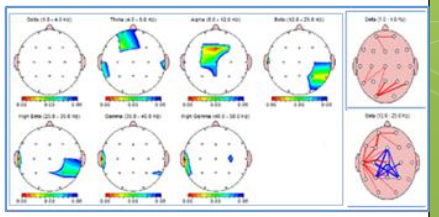
Major Depressive Disorders (MDD)



Drug Delivery System development

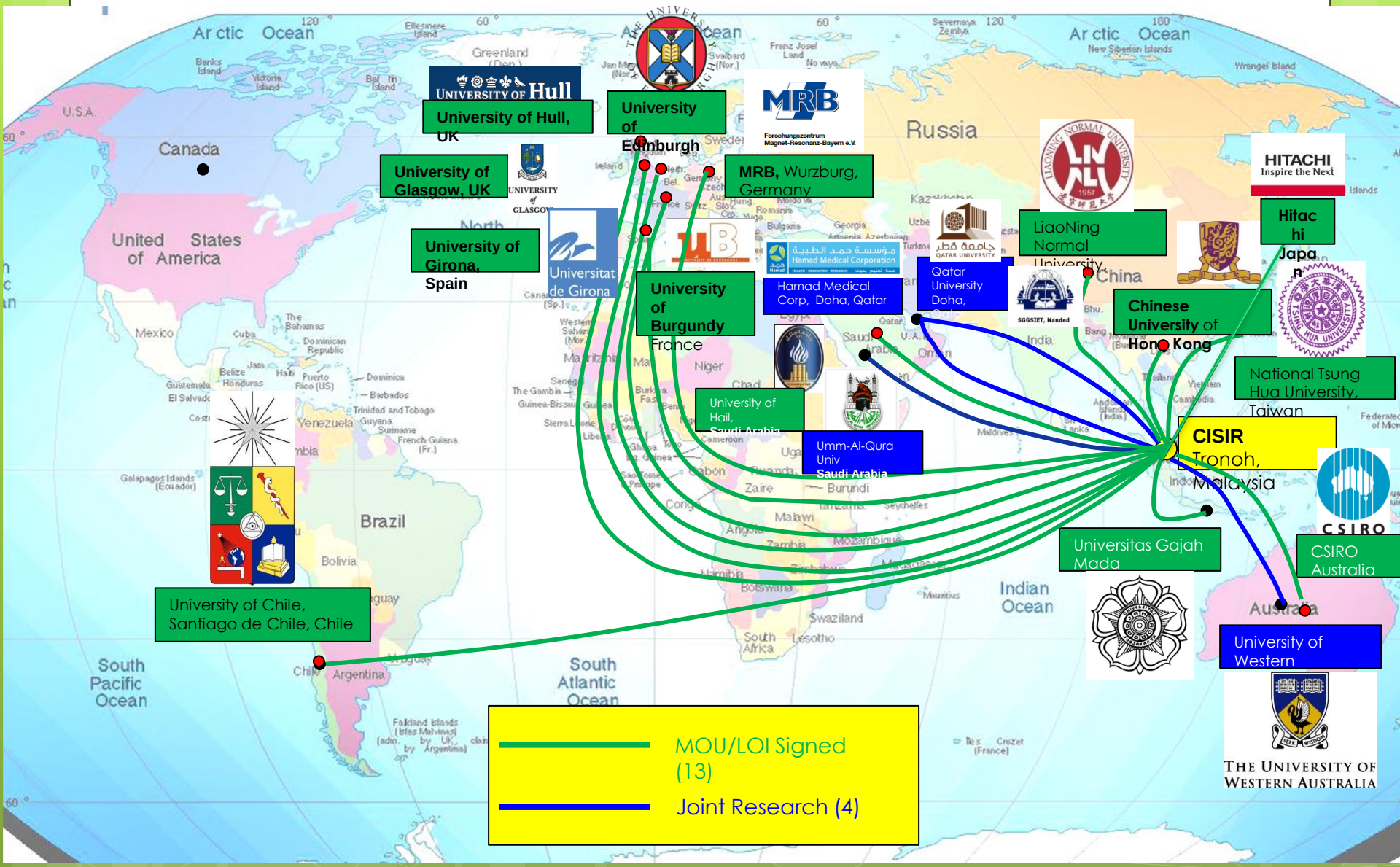


2D & 3D content estimation using EEG



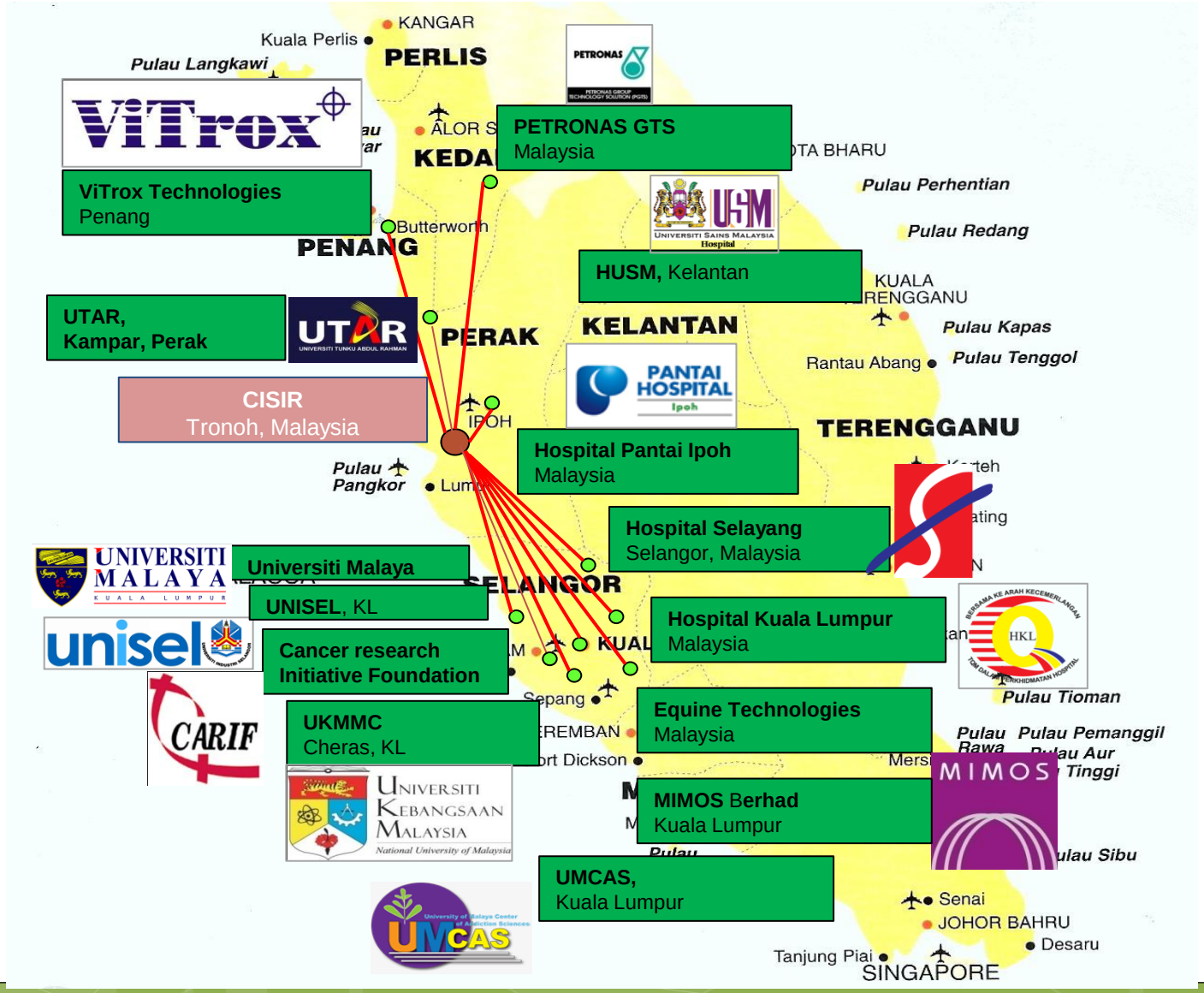
EEG analysis for Memory retention and Recall

Alliances & Research Collaborators: International



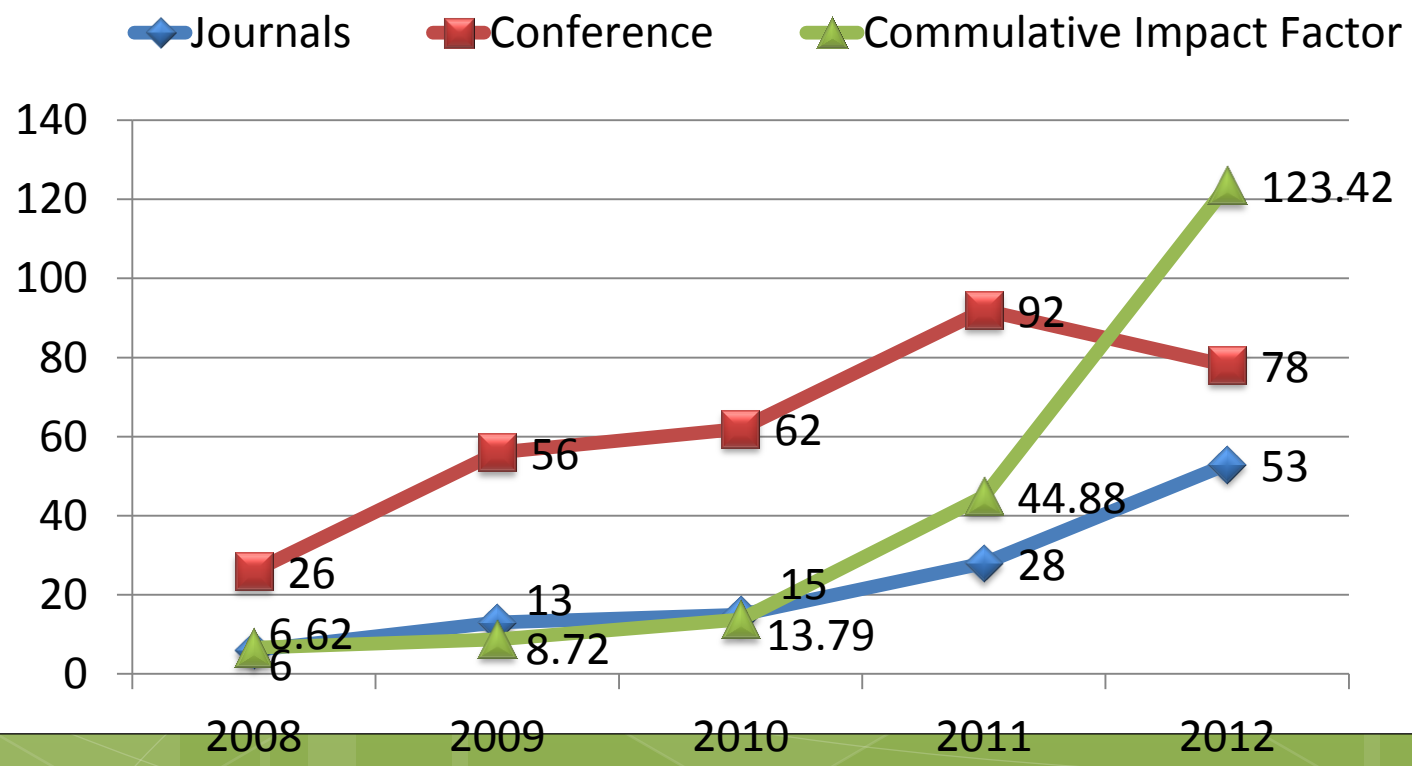
Alliances & Research Collaborators: National

Total LOI/MOU/MOA signed = 16



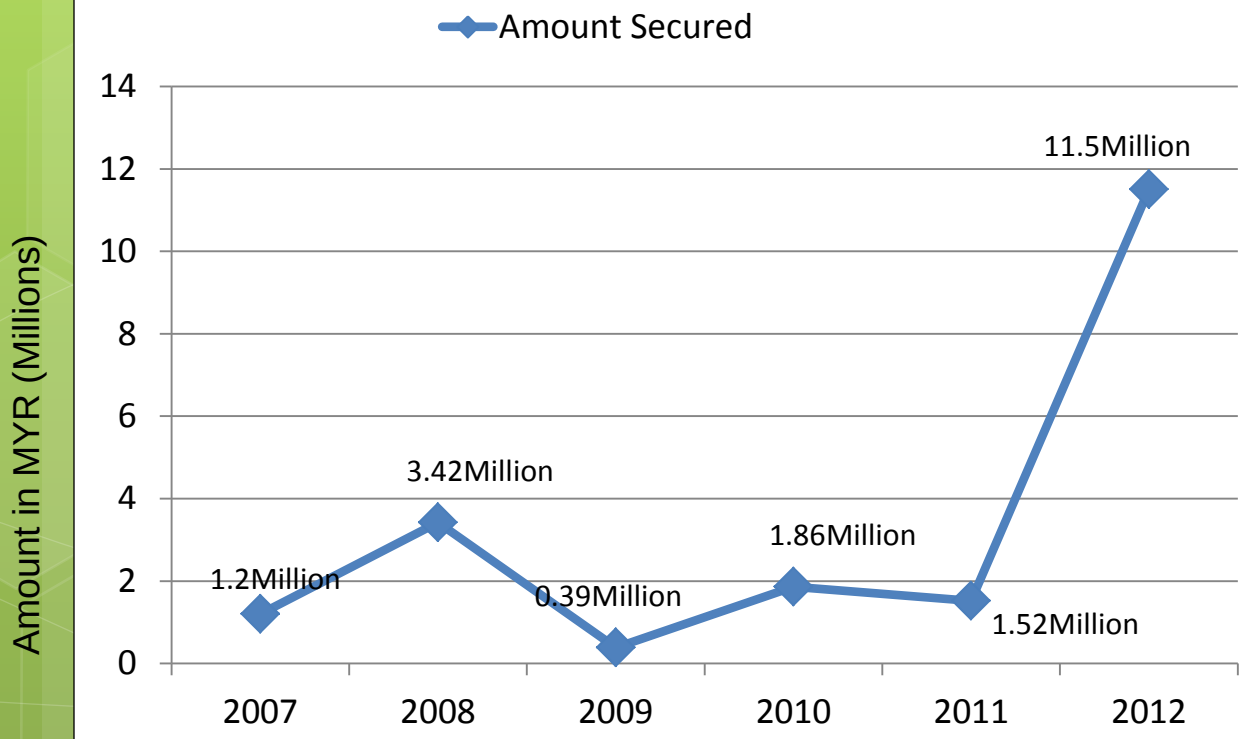
Achievements: Publications (Past 5 Years)

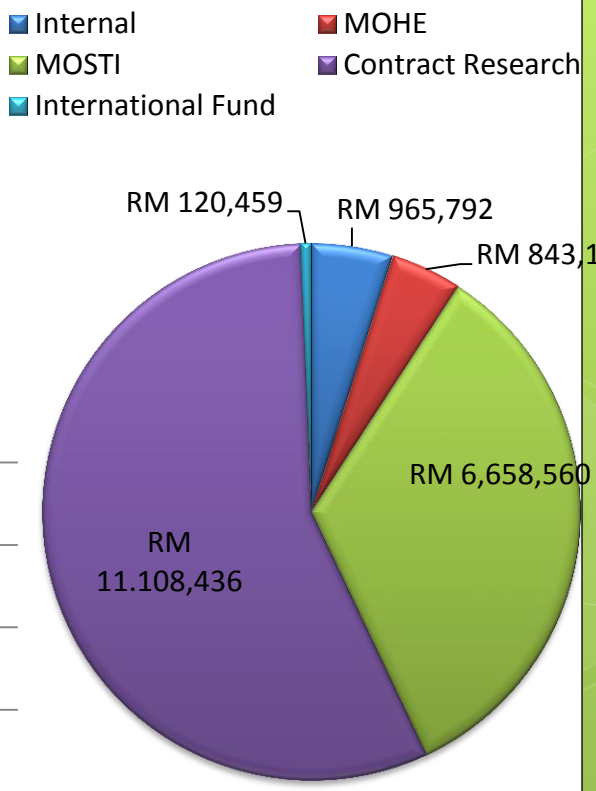
Item	Quantity
Total Number of Publications	429
Average publications/Year (2008-2012)	85.8
Core Members	10
Publications/Year/Member	8.58
Cumulative Impact Factor (5 Years)	123.42



Achievements: Grant Secured

Item	Quantity
Total Number of Grants (2007-2012)	64
Total amount (RM2007-2012)	RM 19,696,377
Total amount secured/Year (2007-2012)	RM 3,282,729

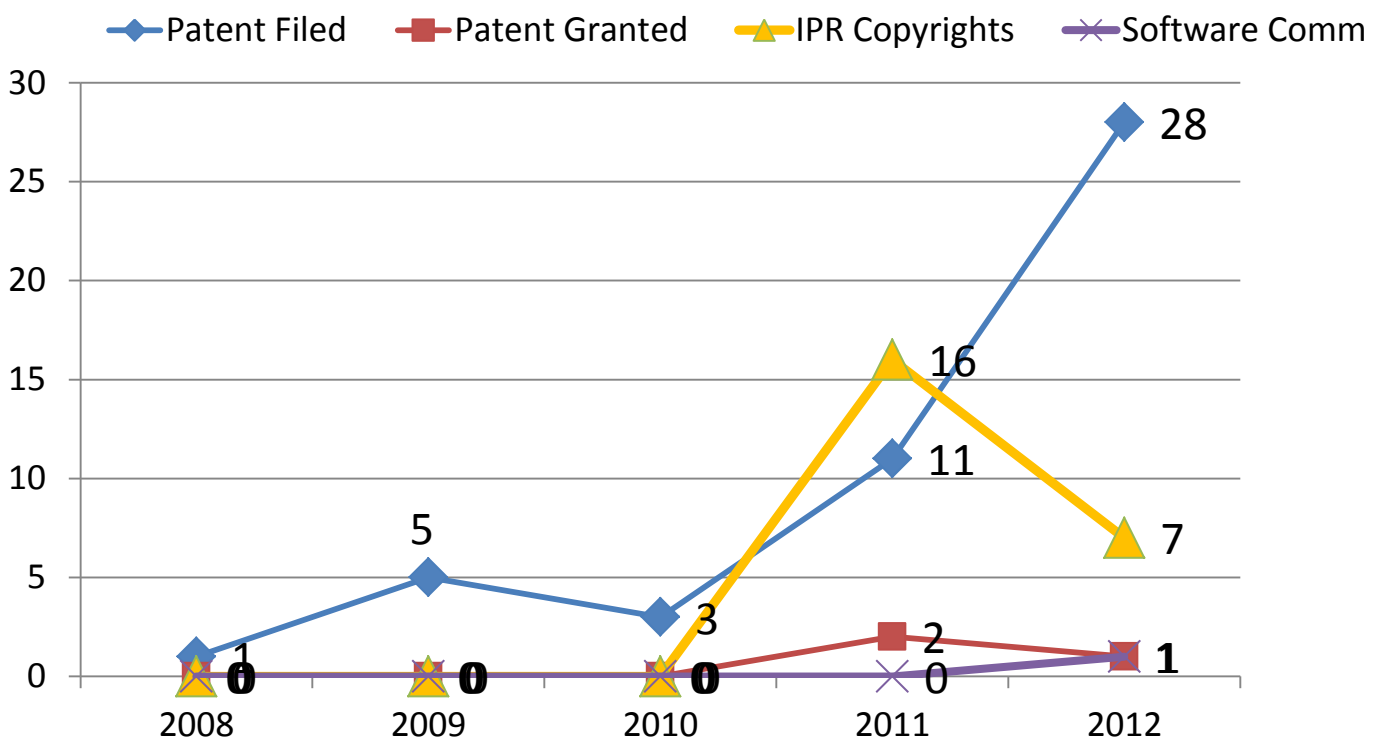




Grant secured from various funding bodies

nt, IPR and Commercializ on

Item	Quantity
Total Number of Patent Granted	3
Total Number of Patent Filed	48
Total IPR obtained	23
Total Software Commercialisation	1



Thank You