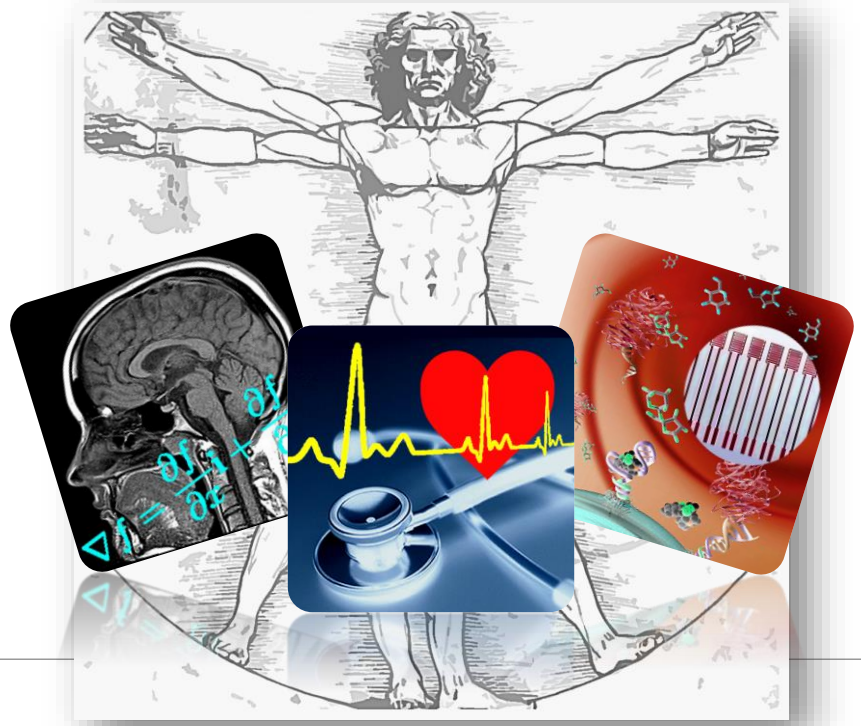
Department of Electrical Engineering

ELECTRICAL ENGINEERING
CHULALONGKORN UNIVERSITY

Cluster Bioelectronics (**BIO**)



May, 2018

Smart Medical Devices

Smart Healthcare

Assistive Devices for Disabled & the Elderly

Rehabilitation Devices

ELECTRICAL ENGINEERING
CHULALONGKORN UNIVERSITY

Courses

- 2102588 Biomedical Electronics
- 2110675 Biomedical Information and Communication Systems

- 2102668 Biosensors
- 2102785 Advanced Sensor Theory

- 2102585 Biomaterial Science

- 2102547 Cognitive Engineering
- 3017767 Human Body for Biomedical Engineering

BIO & EE Department Members

Professor
Dr. Boonchai Techaumnat
(Kyoto University)

- Particle Electromechanics
- Bioelectromagnetics
- Bioengineering

Associate Professor
Dr. Mana Sriyudthsak
(Tokyo Institute of Technology)

- Medical instrumentation
- Biosensors
- Chemical sensors

Associate Professor
Dr. Chedsada Chinrungrueng
(University of California, Berkeley)

- Adaptive filtering
- Biomedical signal processing
- Biomedical image processing

Associate Professor
Cherdkul Sopavanit
(Chulalongkorn University)

- Sensors
- Semiconductor gas sensors
- Medical instrumentation

Assistant Professor
Dr. Charnchai Pluempitiwiriyawej
(Carnegie Mellon University)

- Image processing
- Medical image processing & analysis
- Character recognition

Assistant Professor
Dr. Arporn Teeramongkonrasmee
(Chulalongkorn University)

- Sensors
- Semiconductor gas sensors
- Medical instrumentation

BIO & EE Department Members

Assistant Professor
Dr. Chanchana Tangwongsan
(University of Wisconsin-Madison)

- Medical instrumentation
- Bioelectronics
- Biomaterial

Assistant Professor
Dr. Supatana Auethavekiat
(Tokyo University)

- Image processing
- Video processing
- Compressed sensing

Assistant Professor
Dr. Jitkomut Songsiri
(University of California, LA)

- Convex optimization
- Biological system modeling
- EEG signal analysis

Lecturer
Dr. Apiwat Lek-uthai
(Karlsruhe Institute of Technology)

- Medical instrumentation
- Medical signal processing
- ECG, EEG signal analysis

Lecturer / BME Program
Dr. Pakpum Somboon
(Tokyo Institute of Technology)

- Biosensors
- Medical instrumentation
- Electronic nose

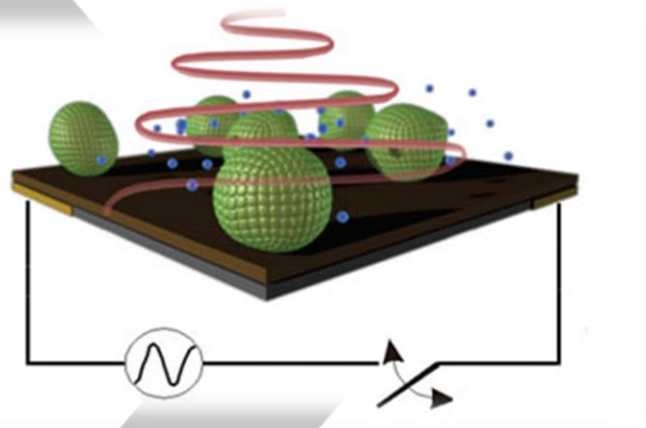
BIO Research Highlights

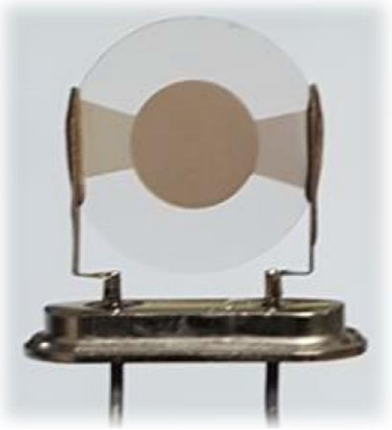
Biomedical Engineering Fundamentals	• Cell monitoring system using quartz crystal microbalance • Lab-on-a-Chip biomedical sample preparation
Biomedical Instrumentation	• Handheld ECG; Wireless ECG for stroke patient • Walking stimulation device for Parkinson patient
Biosensors	• On-chip malaria detection • Glucose sensor; Nitric oxide sensor
Medical Signal & Image Processing	• ECG analysis; Cardiac arrhythmia detection • EEG analysis; Seizure detection • Medical image segmentation

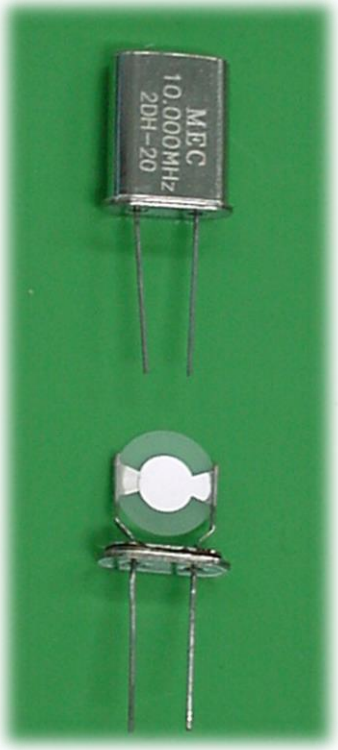
Associate Professor
Dr. Mana Sriyudthsak
- Medical instrumentation
- Biosensors
- Chemical sensors

Biomedical engineering fundamentals:

Cell monitoring system using quartz crystal microbalance (QCM)





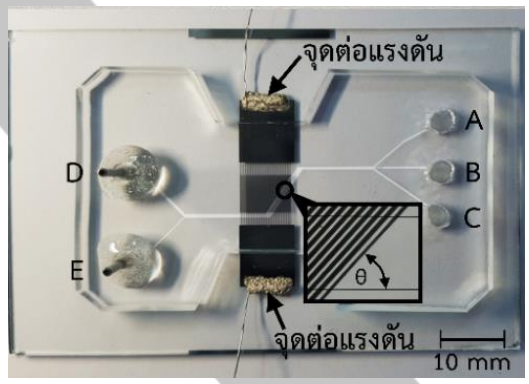


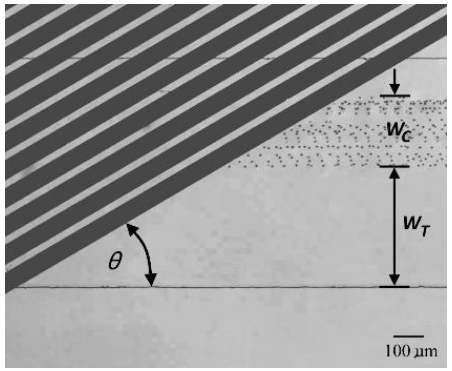
12 MHz QCM-D with gold electrode

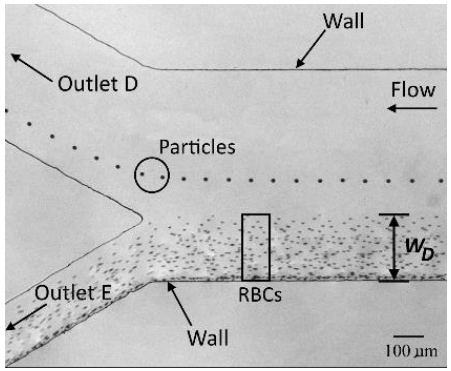
Professor
Dr. Boonchai Techaumnat
- Particle Electromechanics
- Bioelectromagnetics
- Bioengineering

Biomedical engineering fundamentals:

Lab-on-a-Chip Platform for Biomedical Sample Preprocesses







Separation between polystyrene particles and red blood cells for target enrichment

- New methods to pre-concentrate or enrichment target cells/particles in sample can improve the level of detection (LOD) for diagnostics.
- Using lab-on-a-chip or micro total analysis system, we can reduce sample volumes needed for diagnostic, and enhance the sensitivity of detection.

CHULA ENGINEERING
Foundation toward Innovation

Medical instrumentation:

Wireless ECG Monitor for Stroke Patient

Assistant Professor
Dr. Arporn Teeramongkonrasmee
- Medical instrumentation
- Sensors

Lecturer
Dr. Pakpum Somboon
- Medical instrumentation
- Biosensors

- Two-electrode ECG amplifier
- Continuous ECG monitoring
- Data transfer via Bluetooth
- Detect abnormal heart rhythms

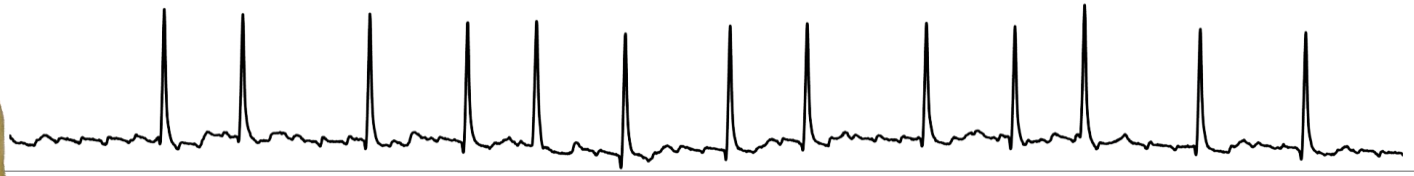
Wireless ECG Belt

Handheld ECG

in cooperation with

Chulalongkorn Stroke Center
King Chulalongkorn Memorial Hospital

โรงพยาบาลจุฬาลงกรณ์
สภากาชาดไทย



Biomedical instrumentation:

Wireless handheld ECG for stroke patient (CU ΣCG)

in cooperation with
Chulalongkorn Stroke Center

Chulalongkorn Stroke Center
King Chulalongkorn Memorial Hospital

โรงพยาบาลจุฬาลงกรณ์ สภากาชาดไทย

Assistant Professor
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- Sensors
- Semiconductor gas sensors
- Medical instrumentation

Lecturer
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- Medical instrumentation
- Medical signal processing
- ECG, EEG signal analysis

Lecturer / BME Program
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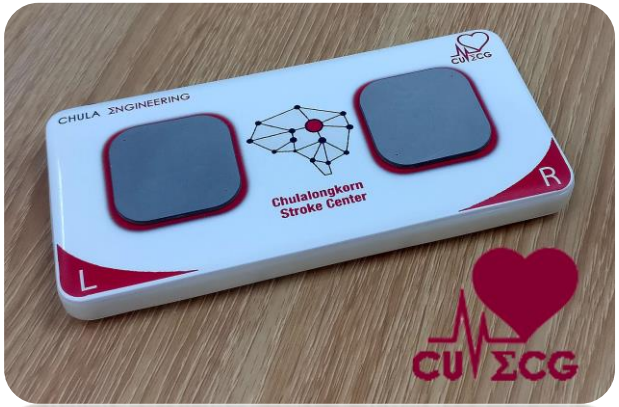

Biomedical instrumentation:

Walking stimulation device for Parkinson patient (CU Walking)

Associate Professor
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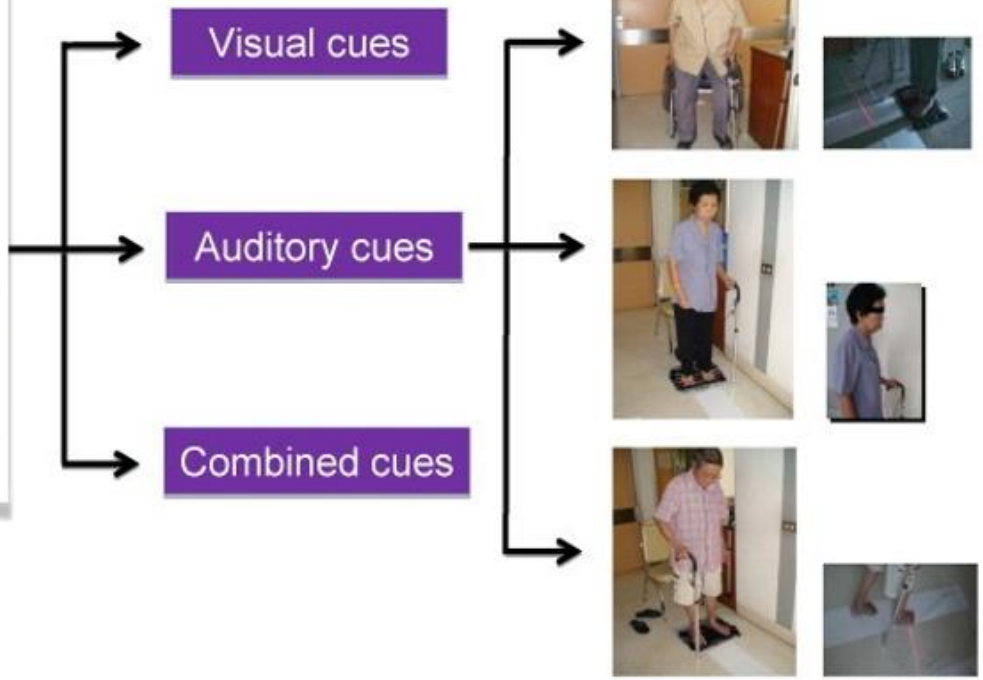


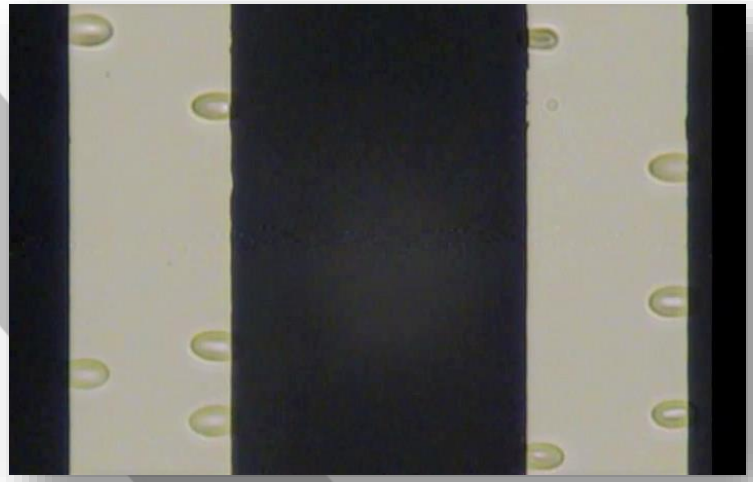
in cooperation with
King chulalongkorn memorial hospital

โรงพยาบาลจุฬาลงกรณ์ สภากาชาดไทย

Biosensors:

Professor
Dr. Boonchai Techaumnat
- Particle Electromechanics
- Bioelectromagnetics
- Bioengineering

On-chip malaria detection



Elongation of red blood cells trapped on the edges of electrodes under 5-MHz electric field. Center electrode width is 50 um.

Different electrical or electromechanical responses between normal and infected cells are used for detecting and sorting in a microfluidic platform

Associate Professor
Dr. Mana Sriyudthsak
- Medical instrumentation
- Biosensors
- Chemical sensors

Biosensors:

Optical sensor for determining nitric oxide changes

Associate Professor
Dr. Chedsada Chinrungrueng
- Adaptive filtering
- Biomedical signal processing
- Biomedical image processing

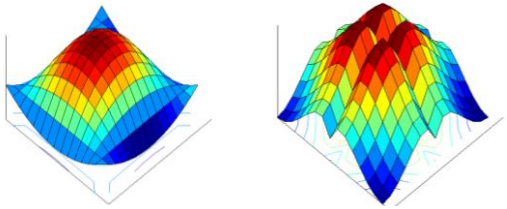
Medical signal processing:

Real-time Ultrasound Denoising based on Adaptive Regularization Savitzky-Golay (ARSG) Filter

The Objective function: $\mathcal{E}(\vec{c}) = \mathcal{E}_d(\vec{c}) + \lambda\, \mathcal{E}_r(\vec{c})$

$$\mathcal{E}_d(\vec{c}) = \sum_{(m,n,o)\in\mathcal{W}_{i,j,k}} \{f(i+m, j+n, k+o) - p_{i,j}(m,n,o)\}^2,$$

$$\mathcal{E}_r(\vec{c}) = \sum_{(m,n,o)\in\mathcal{W}_{i,j,k}} \{D_x p_{i,j,k}(m,n,o) - \mathcal{K}\Delta_x f(i+m, j+n, k+o)\}^2 + \sum_{(m,n,o)\in\mathcal{W}_{i,j,k}} \{D_y p_{i,j,k}(m,n,o) - \mathcal{K}\Delta_y f(i+m, j+n, k+o)\}^2 + \sum_{(m,n,o)\in\mathcal{W}_{i,j,k}} \{D_z p_{i,j,k}(m,n,o) - \mathcal{K}\Delta_z f(i+m, j+n, k+o)\}^2$$



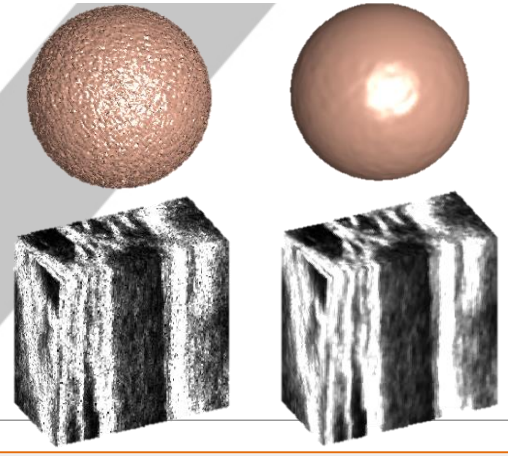
Input Signal Adaptive Adjusting

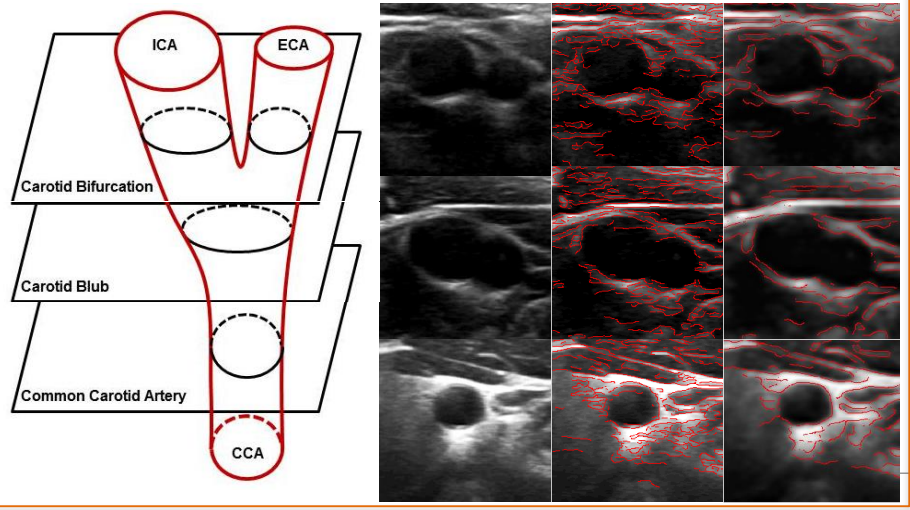
$\mathcal{K}$ is adaptive adjusting based on local homogeneity

$$\mathcal{K}_{i,j,k} = 1 - h_{i,j,k}/h_{max}$$

$$h_{i,j,k} = \sigma^2_{i,j,k}/\mu_{i,j,k}$$

3D&2D Ultrasound Denoising





Medical signal processing:

Automatic seizure detection using EEG

Assistant Professor
Dr. Jitkomut Songsiri
- Convex optimization
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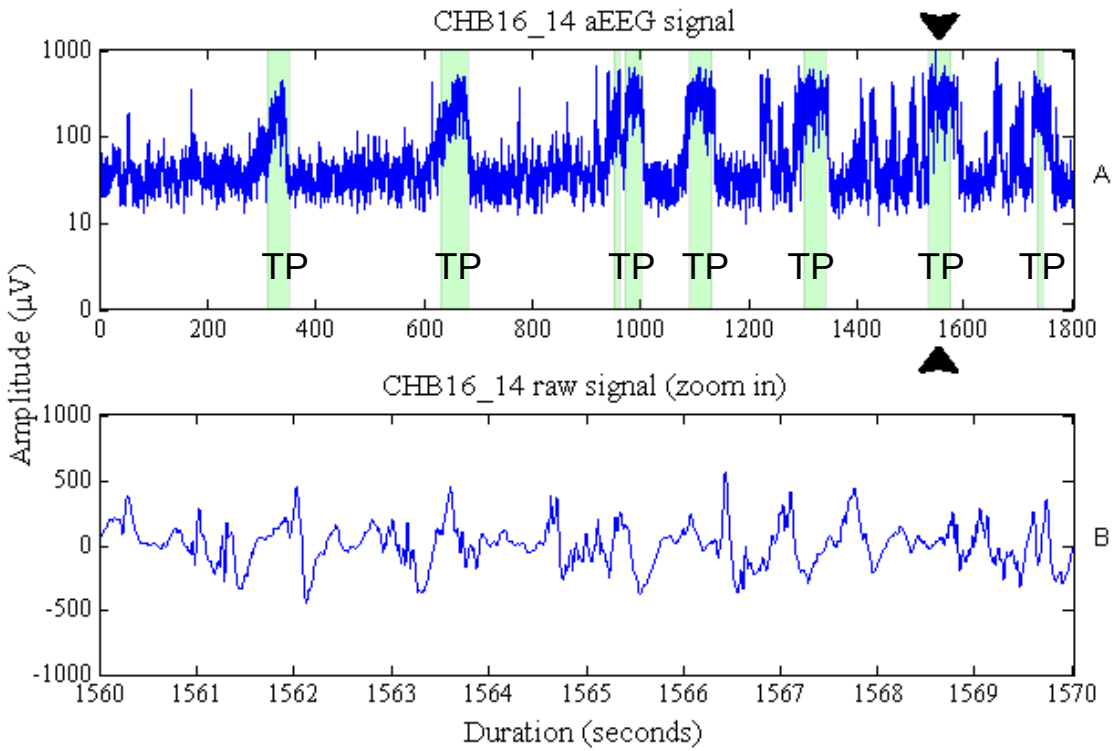

Assistant Professor
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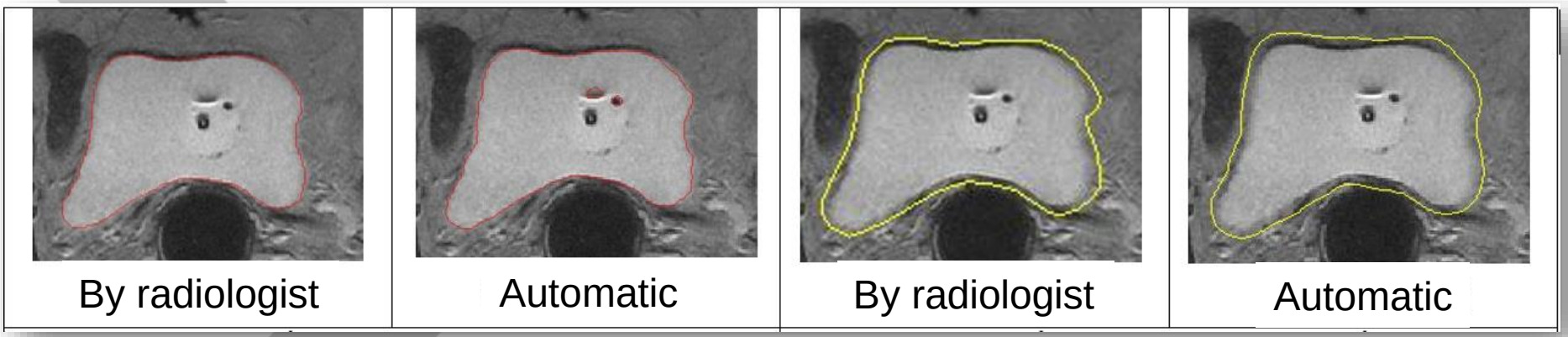
- Compressed sensing

Medical image processing:

Localization of urinary bladder lumen



Directional local mean difference level set method for locating a urinary bladder lumen in brachytherapy

Q & A