VRIJE UNIVERSITEIT BRUSSEL

PhD in Medical Sciences
2022-2023

INVITATION to the Public defence of

Md Abu Hanif Shaikh

To obtain the academic degree of

'DOCTOR OF MEDICAL SCIENCES'

Wiener-Hammerstein System Identification Applied to Bio-impedance Spectroscopy: Computationally fast model configuration

The defence will take place on

Wednesday, **21 September 2022 at 6 p.m.**

In Auditorium Piet Brouwer
Faculty of Medicine and Pharmacy, Laarbeeklaan 103, 1090 Brussel

and can be followed online, accessible through the following link**:**

https://qf.vub.ac.be/redirects/PhD_defense_Abu_Hanif_Shaikh.php

Summary of the dissertation

A popular class of nonlinear systems is the block-oriented structure. It is composed of series and/or parallel connections of both static nonlinearity (N) and linear dynamical block (L). The Wiener-Hammerstein (W-H) system is an L-N-L structure which is linearized into a single cascaded transfer function by Best Linear Approximation (BLA). The Auto-Regressive-Moving-Average modelling of the BLA consists the numerators of m zero(s) and the denominators of n pole(s). As two LTI blocks are cascaded into the BLA, a pole/zero can be either from the first dynamic or the second dynamic. The standard technique makes 2^{m+n} possible unique guesses of the LTI blocks configuration, proceeded by an estimate of the nonlinearity. These parameter should be further optimized to minimize the output error. This computationally intensive task can be speed-ups by proposed Spearman Correlation based technique. Assume a guess of the LTI blocks from the BLA are G_1 and G_2 for the input-output (u,y). If there is a monotonic nonlinearity between $p=G_1(u)$ and $q=G_2^{-1}(y)$, the Spearman Correlation will be high.

The random forest can further speed-ups the computation by suggesting a single model for optimization. Each possible model configuration is a tree in the forest and its performance is measured on the out-of-bag Prediction Error (PE). After growing a user-defined number of trees in the Forest, half of the trees are removed, performing less than the median PE. If there is a B number of trees in the forest then this iterative procedure converges at $log_2(B)+1$ iterations. Finally, the proposed theory is assessed on an electrosurgery application. The current flow induces a voltage due to the bio-impedance of the biological tissue. Although the nonlinearity is weak, the goodness of fit improves by 5.85% using W-H system compared to linear system.

Curriculum Vitae

Md Abu Hanif Shaikh was born and brought up in Bangladesh. He received his bachelor and masters degree in Computer Science and Engineering from Khulna University of Engineering and Technology, Bangladesh in 2009 and 2016 respectively. With some wonderful outcome from his masters thesis, he started his doctoral study just before Christmas of 2016.

With the proper guidance and mentoring of Prof. Kurt BARBE, several parts of his PhD thesis are already published in reputed journal and more are in queue. The title of his PhD thesis is ''Wiener-Hammerstein System Identification Applied to Bio-impedance Spectroscopy: Computationally fast model configuration''.