Assad Al-Shueli

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Education

PhD in Electronic and Electrical Engineering, University of Bath, UK, 2009-2013

Thesis Title: Signal Processing for Advanced Neural Recording Systems

Supervisors: Professor John Taylor and Dr Christopher T Clarke

Brief Synopsis of Research:

Many people around the world suffer from neurological injuries of various sorts that cause serious difficulties in their lives, due to the loss of important sensory and motor functions. Functional electrical stimulation (FES) provides a possible solution to these difficulties by means of a feedback connection allowing the target organ (or organs) to be controlled by electrical stimulation. The control signals can be provided using recorded data extracted from the nerves (electroneurogram, ENG). The purpose of this thesis to investigate an alternative approach using artificial network for APs detection and extraction in neural recording applications to increase the velocity selectivity based on VSR using MECs. The prototype systems impose four major requirements which are high velocity selectivity, small size, low power consumption and high reliability. The proposed method has been developed for applications which require online AP classification. A novel time delay neural network (TDNN) approach is used to decompose the recorded data into several matched velocity bands to allow for individual velocity selectivity at each band to be increased. Increasing the velocity selectivity leads to more accurate recording from the target fibre (or fibres) within the nerve bundle which can be used for applications that require AP classification such as bladder control and the adjustment of foot drop. The TDNN method was developed to obtain more information from an individual cuff without increasing the number of electrodes or the sampling rate. Moreover, the optimization of the hardware implementation for the proposed signal processing method permits savings in power consumption and silicon area.

A detailed synopsis is in the attached appendix to this CV.

During my PhD I have also led seminars, supervised undergraduates in the laboratory and taken a course on "Teaching in labs and tutorials and problem classes".

Research Interests:

My current research is centred on IC design and Signal Processing, analogue and mixed analogue and digital system design, particularly implantable systems for biomedical applications such as brain–computer interface (BCI) and interfacing between nerve and electronics.

1998 - 2001 MSc (Hons) in Electronic and Communication Engineering, University of Mustansiriya, Baghdad, Iraq:.

First-Class Honours (74.333%)

Modules included: Digital Techniques, Advanced Mathematics, Communication theory, Digital signal processing, Radar systems, Digital Control, Data transmission, Microelectronics.

Dissertation Title: Analysis and Redesign of High Precision Bucklush Compensated Radar Servo System.
I achieved 80% marks (very good) for this Dissertation.

1994 - 1998 BSc (Hons) in Electrical Engineering, University of Mustansiriya, Baghdad, Iraq:.

First-Class Honours (70.297%)

My rank is (5) in a class of (84) students.

Modules included: Electronics, Advanced Mathematics, Communication theory, Digital signal processing, Antennas and propagation, Control, power electronics, electrical machine, Structured Programming, Software Engineering .

Group project on digital control system design. I achieved well above average marks for this project.

Employment

2013 - 2015 Lecturer, Dept. of Biomedical Engineering, University of Thi-Qar, Thi-Qar, Iraq

I worked as a Lecturer in Dept. of Biomedical Engineering

- Taught the flowing academic course (Introduction to Biomedical Engineering, Electronic, Digital electronic, D.S.P, Programming)
- Supervising more than 5 graduation projects for final year.
- Participated in evaluation juries and marked BSc. projects.
- Head of Biomedical Engineering Department.
- Research

2011-2013 Lab Demonstrator, Dept. of Electronic and Electrical Engineering, Faculty of Engineering and Design, University of Bath, United Kingdom.

- Supervised and taught technicians undergraduate students in university of Bath, adapting to different scientific levels and backgrounds, stimulating discussion and response.
- Invigilation during the examination periods in the University of Bath.
- Assist students with design, development, integration and testing on their final year project.
- Assist students with assembly and wiring of hardware systems.
- Assist students with the documentation of software and engineering data.

2002-2009 Teaching Assistant, Dept. of Electronic and Electrical Engineering in the Thi-Qar University, Iraq.

- Supervised and taught technicians undergraduate students in university of Thi-Qar, adapting to different scientific levels and backgrounds, stimulating discussion and response.
- Invigilation during the examination periods in the University of Thi-Qar.
- Assist students with design, development, integration and testing on their final year project.
- Assist students with assembly and wiring of hardware systems.
- Assist students with the documentation of software and engineering data.

Skills

General skills in research project management and data analysis. Specific expertise and interests in:

Computing Skills:

- Applications: Microsoft Office Suite, Internet Explorer, Dreamweaver and several e-mail packages.
- Programming Languages: C++, Python, Matlab, Verilog HDL&VHDL.
- Statistical software: extensive experience with SAS.
- Operating Systems: Unix, Windows 8, Windows 10.
- System Design Software: LabVIEW, Simulink, Xilinx, Modelsim, AutoCAD

Teaching Skills:

- Postgraduate Demonstrator. Regularly supervise practically for undergraduate students and have supervised the undergraduate research projects of 5 final year students.
- Have lead several seminars for undergraduates in the Electronic and electrical department.

Management and organization:

- Managed several tasks and work in parallel, set up work to reach targets on time, managed realistic project, improved and created solutions to different challenges.
- Organized the data to be easy to explore and access and selected the best choice for organization large amounts of information, to identify the reasons and boundary conditions of each case study. In addition find out accessible choices and to apply my own skill and that of others to move things forward.

Other skills

- Knowledge of research methodologies.
- Statistical software: extensive experience with SAS.
- Data and information collection.
- Writing and presenting reports.
- Full current clean driving licence.

Interests

I enjoy football and swimming and was a member of the Thi-Qar University football Club. I also enjoy travelling and reading.

References

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APPENDIX

Detailed Synopsis of PhD

Many people around the world suffer from neurological injuries of various sorts that cause serious difficulties in their lives, due to the loss of important sensory and motor functions. Functional electrical stimulation (FES) provides a possible solution to these difficulties by means of a feedback connection allowing the target organ (or organs) to be controlled by electrical stimulation. The control signals can be provided using recorded data extracted from the nerves (*electroneurogram*, ENG). The most common and safe approaches for interfacing with nerves is called cuff electrodes which deliver the required feedback path for the implantable system with minimum risk. The amount of recorded information can be improved by increasing the number of electrodes within a single cuff known as multi-electrode cuffs (MECs) configuration. This strategy can increase the signal to noise ratio for the recorded signals which have typically very low amplitude (less than 5μV). Consequently multiple high gain amplifiers are used in order to amplify the signals and supply a multi-channel recorded data stream for signal processing or monitoring applications. The signal processing unit within the implantable system or outside the body is employed for classification and sorting the action potential signals (APs) depending on their conduction velocities. This method is called *velocity selective recording* (VSR). Basically, the idea of this approach is that the conduction velocity of AP can be determined by timing the appearance of the signal at two or more points along the nerve and then dividing the distance between the points by the delay.

The purpose of this thesis to investigate an alternative approach using artificial network for APs detection and extraction in neural recording applications to increase the velocity selectivity based on VSR using MECs. The prototype systems impose four major requirements which are high velocity selectivity, small size, low power consumption and high reliability. The proposed method has been developed for applications which require online AP classification. A novel time delay neural network (TDNN) approach is used to decompose the recorded data into several matched velocity bands to allow for individual velocity selectivity at each band to be increased. Increasing the velocity selectivity leads to more accurate recording from the target fibre (or fibres) within the nerve bundle which can be used for applications that require AP classification such as bladder control and the adjustment of foot drop. The TDNN method was developed to obtain more information from an individual cuff without increasing the number of electrodes or the sampling rate. Moreover, the optimization of the hardware implementation for the proposed signal processing method permits savings in power consumption and silicon area.

Finally, a nerve signal synthesiser and noise generator for the evaluation of the VSR method is described. This system generates multiple artificial AP signals with a time offset between the channels with additive white Gaussian noise (AWGN) to simulate the MEC and hence reduce the cost and the number of the animals required for experimental tests.

Conferences, Presentations and Courses Attended

- English language course for academic writing.
- Introduction to creative thinking and problem solving.
- Information skills: Literature and data searching for Engineering and Design.
- Speed reading.
- Personal effectiveness for researchers.
- Mind mapping.
- How to be an effective researcher.
- Preparing for transfer.
- Academic integrity training & test.
- Effective communication skills for international researchers: Reading for academic writing - for engineering & design.
- Presentations: Planning conference posters
- Presentation skills: Planning and delivering more confidently
- Presentation skills: Feedback on your presentation skills
- Teaching in labs and tutorials and problem classes
- Making the most out of conferences
- Working effectively with your supervisor

Publications/Conference Papers

[1]. A.I. Al-Shueli, "*Design and Implementation of Electrocardiogram (ECG) Signal Generator Based on FPGA*" International Journal of Engineering Sciences & Research Technology (IJESRT),2015,Vol.11,No.11,pp.517-525.

[2]. A.I. Al-Shueli, "*Design and Optimization of a Low DC Offset in Implanted System for ENG Recording Based on Velocity Selectivity Method*" International Journal of Engineering and Applied Sciences(IJEAS),2015,Vol.2,No.8,pp.1-6.

[3]. A.I. Al-Shueli, "*FPGA Implementation of A Neural Network for a Real-Time Velocity Selective Recording Using Multi-Electrode Cuffs System*" International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE),2015,Vol.5, No.8,pp.41-53.

[4]. A.I. Al-Shueli, "*Validation of Artificial Neural Network Method for Action Potential Detection and Classification Based on Velocity Selective Recording*" International Journal of Computer Science and Mobile Computing(IJCSMC), 2014,vol.3, no. 10, pp. 10-19

[5]. A.I. Al-Shueli, C.T. Clarke, N. Donaldson, and J.T. Taylor, "*Improved Signal Processing Methods for Velocity Selective Neural Recording Using Multi-Electrode Cuffs*," Biomedical Circuits and Systems, IEEE Transactions on , vol.8, no.3, pp.401,410, June 2014

[6]. A.I. Al-Shueli, "Signal Processing for Advanced Neural Recording Systems," PhD Thesis, University of Bath, Bath, UK, 2013

[7]. A.I. Al-Shueli, C.T. Clarke, and J.T. Taylor, "*Simulated Nerve Signal Generation for Multi-electrode Cuff System Testing*," Biomedical Engineering and Biotechnology (iCBEB), 2012 International Conference on , vol., no., pp.892,896, 28-30 May 2012.

Awards, Fellowships, and Grants

- Awards from Iraqi Ministry of Higher Education and Scientific Research 2009 – 2013.
- USA Army Equipment Grant 2003.
- Awards from Iraqi Ministry of Higher Education and Scientific Research 1998 – 2001.

Professional Memberships

Member of Al-Kindi Society for Engineers in UK

Consultant in Iraqi Engineer Union/ Iraq