Project Title
A smart diagnosis tool for comprehensive clinical assessment of peripheral neuropathy

Project Summary
The aim of the proposed research project is to develop an intelligent diagnosis tool for comprehensive assessment of peripheral neuropathy. Neuropathy is nerve damage caused by high blood sugar; about 50% of diabetic patients develop neuropathy. Tingling and numbness in the extremities are common in neuropathy and the condition continues to get worse if not diagnosed and treated early on. Vibration Perception Test by neurothesiometer have been used in the assessment of diabetic neuropathy for a number of years but the cut-off for definition of neuropathy within different age groups remained unestablished. This research aims to establish possible correlations with age and body composition with neuropathy. To start with, a simple platform based weighing scale-like equipment with a vibrating plate will be developed with varying amplitude. The subject can stand on this platform mimicking the neurothesiometer as the cut off for sensation, above which one would have neuropathy. The weight of patient would change the reproducibility of the device which would need to be intelligently incorporated to be able to adjust for age, height and weight to results. This would enable classifying patients as ‘good sensation’ or ‘poor sensation’ to conduct confirmatory tests for evaluating the equipment and to make it more clinically valid and robust. This can be later enhanced with temperature and pain threshold perception with an advanced user interface to deliver a comprehensive assessment tool for neuropathy. Currently no such devices are available on the market. We intend to design an integrated system that can objectively assess and able to make subjective predication of onset of neuropathy based on expert patient information.

In order to deliver this, novel approaches in stimulation technology supported by intelligent inference engine need to be developed that may increase reliability, reduce cost and enhance patient’s care in the health sector. The proposed design will ensure that it provides accurate assessment of neuropathy backed by intelligent patient history for early diagnosis. The timeliness of this project could not be over emphasized as the population of diabetic patients is growing at an alarming rate without being diagnosed for peripheral neuropathy and leading to amputations. This fits in very well with our earlier work conducted in collaboration with Royal Bournemouth Hospital NHS Foundation Trust on pressure sore identification and alarming systems. The development of this device will also heavily draw from our ongoing PhD research on “Creating artificial sensation by tactile sensing and intelligent stimulation of sensory nerves”. The part of the supervisory team from the previous research is proposed to be involved in this project as we see a clear synergy of techniques and technologies being developed. This project will also benefit from the collaborative research being conducted on Parkinson’s disease with Columbia University (USA). Our team has a wide range of expertise in the proposed areas and we wish to employ our knowledge for improving the quality of life of people who may be at the risk of developing peripheral neuropathy due to the lack of a suitable diagnosis tool.

Academic Impact
As the proposed research differs from all the existing approaches the academic impact of this research will be quite significant. The design is going to be based on relevant engineering considerations of vibratory, electrical and temperature based stimuli backed by the clinical history of patient on a knowledge-based system. The project will look at three different aspects in this research namely the development of appropriate stimulating technologies for neuropathy assessment, creation of knowledge base on patient data and intelligent interface for wireless data transfer. This will generate patient specific knowledge for assessment of neuropathy based on age, height, weight and clinical history of the patient i.e. intelligent processing of data for early diagnosis. Through this research we aim to address the following fundamental research questions: (i) what types of stimulation technology can be used for neuropathy assessment? (ii) how to calibrate these stimuli to the level of neuropathy? (iii) how to integrate these
devices with the clinical history of patients in a knowledge-based system? (iv) how to transfer data/information to the care giver wirelessly? The findings of this research will be aimed at publishing in biomedical engineering journals e.g. Journal of Medical Device, Journal of Engineering in Medicine and Neural Systems and Rehabilitation Engineering.

**Societal Impact**

Recent figures from the World Health Organisation indicate that the prevalence of diabetes mellitus is approaching two million in the United Kingdom and continuing to rise. An estimated 5% (50,000) of the total diabetic population are affected by foot ulcers. Approximately 60% are classified as neuropathic ulcers, which tend to occur on the sole of the foot. Plantar ulcers are subject to continuing trauma and there is significant risk of infection spreading through the foot and lower limb. Complications arising from diabetic foot ulcers are the largest single cause of below knee amputations in the UK. There is a significant impact on the quality of life and treatment is estimated to cost the NHS £13 million per annum. To reduce the social and economic impact, early identification of risk factors is essential, however, there is no single unified approach to assess onset of neuropathy. This project aims to tackle this problem by developing a smart diagnosis tool for comprehensive clinical assessment of peripheral neuropathy. This could significantly save potential treatment costs by early management of neuropathy and improve quality of life before progressing to a dangerous level.

**Training Opportunities**

This project will provide an excellent training opportunity to the student undertaking this research in the field of design and control engineering. This will be supported by the existing collaboration of the principal investigator with Columbia University (USA) and University of Southampton in the area of robotics and control. This will be further supported by our ongoing collaborative research with the Royal Bournemouth Hospital. In addition, this project will further provide opportunity to work closely with clinicians and patient user groups to meet their aspirations for improving the quality of life of vulnerable patients. Due to the nature of the project it will provide a unique training opportunity in multidisciplinary areas combining mechanical & electrical engineering, sensing/actuation technology and an appreciation of clinical practices. Additionally there are number of training opportunities available throughout the year on research methods, skills training and teaching and learning experience within the university. The student will be encouraged to attend such training and developmental courses and will be supported for attending conferences and publish their research in academic journals. This will provide personal and professional development to the student undertaking this research.

**SUPERVISORY TEAM & RESEARCH ENVIRONMENT**

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<th>First supervisor</th>
<th>Dr Venky Dubey</th>
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<td>Additional supervisors</td>
<td>Dr David Coppini</td>
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PhD Studentship Project Description

INFORMAL ENQUIRIES

To discuss this opportunity further, please contact Dr Venky Dubey via email: vdubey@bournemouth.ac.uk

ELIGIBILITY CRITERIA

All candidates must satisfy the University's minimum doctoral entry criteria for studentships of an honours degree at Upper Second Class (2:1) and/or an appropriate Masters degree. An IELTS (Academic) score of 6.5 minimum (or equivalent) is essential for candidates for whom English is not their first language.

HOW TO APPLY

Please complete the BU Research Degree Application 2014 and submit it together with your supporting documents (certificates and transcripts, IELTS if needed, your published papers or evidence of previous research work if available) via email to the School Research Administrator – Naomi Bailey- scitechresearch@bournemouth.ac.uk and Dr. Raian Ali rali@bournemouth.ac.uk by 26th August 2014. Further information on the application process can be found at www.bournemouth.ac.uk/phd2014.

In everyday practice. PDI 2011; 28, 151-2.


Khattab, AD; Griffiths, S; Vincent, G; Bujanova, J; Davies, SJ and Coppini DV. Age-related measurements of vibration perception threshold (VPT) in healthy individuals: implications for diagnosing peripheral neuropathy in diabetes, Diabetic Medicine, 2013, 30 (Suppl. 1), 69-70.