Project Title:	**Novel health monitoring system with analysis for patients with mental disorders**	
Project Number	**IMURA0672**	
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Research Clusters:

Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*		**Highlight which of the Academy's Theme(s) this project will address?** *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*	***1***	*Advanced computational engineering, simulation and manufacture*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*	2	*Infrastructure Engineering*
3	*Math, CFD, Modelling, Manufacturing*	3	*Clean Energy*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*	4	*Water*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*	5	*Nanotechnology*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*	6	*Biotechnology and Stem Cell Research*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*		
8	*HSS, Design, Management*		

The research problem

Define the problem

Mental disorders contribute to 14% of the global burden of disease worldwide[1]. Accurate diagnosis and appropriate management of these disorders such as depression and schizophrenia is still among the global grand challenges. Current methods to diagnose the mental disorders are mostly subjective, and the medication for treatment of the disorders such as first generation antipsychotic (FGA) medications are likely to cause adverse side effects such as Drug-Induced Parkinson's (DIP).

DIP is broadly defined as a clinical constellation of tremor, bradykinesia, postural instability and rigidity as a result of dopamine blockade by drugs. Despite the importance of diagnosing DIP, there are limited tools available in clinical practice to effectively diagnose DIP. The most objective method utilises various rating scales such as the Barnes Akathisia Rating Scale (BARS) and Simpson-Angus Scale (SAS) but they do not provide quantitative measure of the DIP, resulting in inability to monitor for deterioration or improvements.

Psychiatric disorders appear to have profound effects on wide-ranging aspects of the lives of persons with Multiple Sclerosis (MS). MS has a variable and unpredictable course, with symptoms that can include weakness, visual loss, bowel and bladder incontinence, fatigue, cognitive impairment and mood symptoms. Persons with MS appear to have a higher prevalence of a number of psychiatric symptoms and disorders or serious mental illness such as bipolar disorder or schizophrenia.

Hence, monitoring of the state of mental health through physiological measurements and identifying the development of tremors for the patients under treatment are vital and could assist the clinician to manage the care of the patients more effectively and safely.

The effect of exercise has been studied in healthy adults, and the persons with psychiatric conditions. Across studies, exercise appears to be more beneficial than no treatment, and in some studies it has been as effective as antidepressant medication and psychotherapy for mild to moderate depression.

The wireless technology and the miniature sensors make the use of technology very efficient, and inexpensive, easily applicable and non-invasive methods can be widely used in many studies investigating movement disorders, including characterising tremors in patients with PD, tardive dyskinesia (TD), idiopathic PD (IPD), stroke and the effect of exercise on such patients.

Project aims

Define the aims of the project

In this research study, we will investigate various sensors which would be useful to monitor the development of tremors and other symptoms in subjects with mental disorders. This will be followed by designing and developing a compact system built with multiple sensors to quantify the severity of DIP and other symptoms developed in these subjects.

Participants will be assessed using BARS, SAS and the Movement Disorder Society – Unified Parkinson's Disease Rating Scale (MDS-UPDRS) rating scales as well as having their muscle movements assessed using an accelerometer & other sensors.

The multiple sensor data will be processed and analysed, and the data quality will be assessed automatically to ensure the reliability of the recordings. This requires improvement of the existing signal quality indices and development of innovative measures, such as template-based approaches.

Advanced signal processing algorithms will be developed to extract the physiological parameters. Using machine learning approaches such as Neural Networks, automated methods will be developed to quantify the stage and severity of mental illness based on the physiological data.

Discriminative features will be extracted from the sensor readings, statistical analyses will be performed to evaluate their correlation with SAS, BARS and MDS-UPDRS clinical rating scores and a regression model will be developed to estimate the rate of DIP from the features.

A graphical user interface will also be developed in Matlab which could potentially be used by the clinicians in order to assess the gait using accelerometer signals which could provide a real-time data on patients' movements.

Phase 1: Design the compact adaptive system with the wireless interface between the compact system

[1] Global Mental Health – Information Sheet, Grand Challenges Canada (http://www.grandchallenges.ca/wp-content/uploads/GMH-InfoSheet-2016Apr8-EN.pdf)

and a handheld device and the laptop, which provides feedback to the clinician (India, 6 months)
Phase 2: Test the compact system in the laboratory (India, 6 months)
Phase 3: Develop novel signal processing and machine learning algorithms to analyse and process the data from multiple sensors and estimate the degree of mental illness and DIP (Melbourne 6-12 months)
Phase 4:Evaluate and test the system remotely on controlled and subjects with pathology (Melbourne 6 months, Monash Alfred Psychiatry Research Centre)
Phase 5: : Optimize the methods and design based on the results obtained (India, 6 months)
Phase 7: Thesis Completion (India, 3 months)

Expected outcomes

Highlight the expected outcomes of the project

This research will lead to the following outcomes:

1. Design and development of a compact flexible system which integrates number of wireless sensors used to assess and monitor various physiological parameters in patients
2. Wirelessly transmit the processed sensor signals to the computer and alert if the readings are not valid.
3. Develop novel algorithms to process the sensor signals and monitor the physical and psychological conditions of the patients.
4. Evaluate the compact system and finalise the design.
5. Develop the wireless interface between the compact system and a handheld device or a laptop/computer.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The theme relevant to this project is "**Advanced computational engineering, simulation and manufacture".**

The first part of the project is to develop a compact system using sensors, microcontrollers and wireless IC's. This will require extensive hardware manufacturing skills. In order to develop algorithms for signal processing part of the project advanced computations and software simulations can be used.
Once these algorithms are tested for accuracy, they will then be implemented on the system developed.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Candidate should have an MEng degree with an expertise in Wireless Sensor networks, Embedded System Design, C, C++ Programming, and signal processing tools such as Scilab or Matlab. The student should have knowledge in microprocessor hardware and software programming techniques.

Potential Collaborators

Prof. Jayashri Kulkarni - Monash Alfred Psychiatry Research Centre (MAPrc)

Please provide a few key words relating to this project to make it easier for the students to apply.

Biomedical/Biosensors instrumentation, signal processing, machine learning, mental health