IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Attenuation correction in simultaneous MR-PET**	
Project Number	**IMURA0627**	
Monash Main Supervisor (Name, Email Id, Phone)	Zhaolin Chen zhaolin.chen@monash.edu +61-3-99050841	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)	Jon Shah Jon.shah@monash.edu	
Monash Head of Dept/Centre (Name,Email)	Tom Drummond tom.drummond@monash.edu	*Full name, email*
Monash Department:	Department of Electrical and Computer Systems Engineering	
Monash ADRT (Name,Email)	Associate Dean of Research Training Faculty of Engineering Emanuele Viterbo Emanuele.Viterbo@monash.edu	*Full name, email*
IITB Main Supervisor (Name, Email Id, Phone)	Suyash P. Awate suyash@cse.iitb.ac.in	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)		
IITB Head of Dept (Name, Email, Phone)	S Sudarshan sudarsha@cse.iitb.ac.in	*Full name, email*
IITB Department:	Computer Science and Engineering	

Research Academy Themes:

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. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Over the past decade, the introduction and development of simultaneous magnetic resonance (MR) imaging and positron emission tomography (PET) has significantly impacted on clinical diagnosis imaging and fundamental biomedical research. MR imaging has major strengths compared with other imaging modalities in soft-tissue contrast, resolution as well as its unique capability to investigate brain functions and connectivity. PET has excellent specificity in measuring metabolic process in humans and animals. The simultaneous MR-PET enables a comprehensive regional and global structural, functional, and molecular investigation of human brains.

One major technical challenge in simultaneous MR-PET imaging is the attenuation correction that is necessary for reconstruction of PET images from the corresponding measurements. In current MR-PET imaging, PET attenuation correction is performed based on MRI. However, unlike CT measurements in a traditional PET-CT system, the MR signal does not directly translate to tissue density and therefore cannot be mapped directly to attenuation correction maps. Furthermore, due to the low sensitivity of MR in imaging of bones, the MR based attenuation correction is often erroneous.

Various approaches have been investigated to improve the MR based attenuation correction for PET image reconstruction. One approach, known as pseudo-CT [1], maps a CT image template / atlas to the subject's MR images to generate an attenuation map. Another popular approach is to use special MR protocols, e.g. ultra-short echo (UTE), to better image bones [2]. However, MR based attenuation correction for MR-PET images is less accurate than the one in conventional PET-CT imaging. The CT-MR pairs in most case are not available, and can result in significant registration errors when dealing with abnormalities and when significant differences exist between the subject and CT template images. The UTE methods are confounded by susceptibility artefacts in regions such as the cartilage in the ears and the fibers associated with the sternocleido-mastoid, temporal, and masseter muscles [3].

Reference:

[1] Burgos, N., et al., IEEE Trans Med Imaging, 2014. **33**(12): p. 2332-41. [2] Ribeiro, A.S., et al., Nuclear Instruments & Methods in Physics, 2014. 734: p. 166-170. [3] Delso, G., et al., Journal of Nuclear Medicine, 2014. 55(5): p. 780-785.

Project aims

To address the above issues, the project aims to develop a quantitative anatomically based attenuation correction method. Specifically:
Aim1: develop and design quantitative MR imaging methods for imaging soft tissues and bones.
Aim2: design and validate a multimodality MR image based classifier / regressor for generating the attenuation correction images used for PET reconstruction

Expected outcomes

The overall outcome will be a framework for MR-PET attenuation correction that demonstrates superiority over existing methods. The framework will be validated in a large number of subjects (N>=20). Below lists the specific outputs:

Outcome1: developed a set of quantitative MR imaging methods for improved imaging soft tissues and bones
Outcome2: developed an attenuation correction algorithm that is based on the above set of MR protocols.
Outcome3: validated of the developed attenuation correction method in a large number of subjects (N>=20).

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

Advanced computational engineering, simulation and manufacture

The core aim of the project is in line with the above theme. The project will bring a new design and solution for MR-PET imaging in a multi-disciplinary setting. The project involves optimisation, medical image computing, signal and image processing, machine learning, and physics which falls in the areas of expertise of the Academy.

Capabilities and Degrees Required

The ideal candidate should have knowledge / skills in the following domains:

1. *Image processing*
2. *Machine learning*
3. *Medical image computing*
4. *Basic statistical modelling and inference, optimisation, linear algebra*
5. *Code development and data analysis*
6. *Desirable background: Computer, Electrical engineering*

Although not mandatory, candidates with experience in MR and/or PET imaging is highly regarded.

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

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

Medical image computing; Medical imaging; Image processing; Signal processing; Machine learning; Biomedical Engineering;

Additional costs and equipment

Scanner time cost
10 hours x 600 $/per hr = $6000.

Additional development scan times will be provided by Monash Biomedical Imaging.

Collaboration will be arranged to validate the method in clinical research setting.

Detailed justification - Additional costs and equipment

Please justify why is this level funding is required?

	INR/$AUD	
What is the total funding required for the entire project?		(X)
How much bare minimum seed funding will be required to kick off the collaboration?		(Y)
What are the additional funds that will need to be sourced?		(X-Y)

How will the additional funds (X-Y) be sourced?

What happens if the PIs are unsuccessful in sourcing (X-Y) and we have a student selected?

Is there any industrial partner that might fund this project that we might approach?

Please also fill up the Project Consumables Budget Excel spreadsheet template(available from The Academy) which is required for any budget request which is in excess of INR 3 lakhs OR $6000.