UQIDAR: The University of Queensland - IIT Delhi Academy of Research

Joint PhD Project Proposal Template

1. Project Title:	**Terahertz Spectroscopy and Imaging in Quantitative Assessment of Plant Hydration Towards Implementing Optimized Irrigation Management in Australia and India**
Project ID	**UQIDAR-00119**

2. Supervision Team

Please visit the IITD website www.iitd.ac.in and UQ Website http://researchers.uq.edu.au/ to highlight potential collaborators that would be best suited for the proposed project. Complete where possible – advise if you'd like assistance establishing contacts.

	University of Queensland	***IIT Delhi***	***External/Industry (if applicable)***
Supervisor Name	*Professor Aleksandar D. Rakić*	*Professor Amartya Sengupta*	
School or Department (or company, if applicable)	*School of IT and Electrical Engineering*	*Department of Physics*	
Phone Number	*+61 7 3365 3569*	*+91 11 2659 1382*	
Email-ID	*a.rakic@uq.edu.au, adee@eait.uq.edu.au*	*amartya@physics.iitd.ac.in*	
URL for more info	*https://researchers.uq.edu.au/researcher/473*	*http://web.iitd.ac.in/~amartya/*	

3. Other Supervisor Details

Please include other associate supervisors below:

Full Name and Title(s): Dr Aparajita Bandyopadhyay
Phone/Email/URL: +91 95827 33987; loveofconcept@gmail.com

2. Field of Research CODES:

(Specify up to four four-digit FOR codes for your project – see **here** for more detail on FoR codes)

1 020503	3 090606
2 070306	4. 970109

3. Keywords: *(this will assist in classifying project and presenting projects to students on the applications portal)*

Choose up to 4 keywords for your project.

Eg: nanotechnology, data science, novel batteries, etc

1 Terahertz	3 Spectroscopy
2 Interferometry	4. Photonics

4. Discipline Background of Candidate: *(this will assist in presenting projects to applicants on the apps portal)*

Ideally this project requires students with a

1 Optics	3 Physics

background in... Eg: organic chemistry, physiology, topology, CFD, etc		
	2 Electrical Engineering	4. Biology

5. Project description

UN World Water Development Report predicts an increase in water demand in agricultural sector by 70 – 90% without improved methods to satisfy the basic feeding demand of the growing world population. Moreover, global climate change is causing steep rise in temperatures, increased temperature variability, changes in levels and frequency of precipitation, a greater frequency of dry spells and droughts and increasing intensity and frequency of extreme weather events. These problems collectively result in plant growth retardation and an overall increase in the stress level of the plants. Stressed plants become susceptible to disease, insect infestation and other maladies causing loss in both quantity and quality of the agricultural produce. Therefore, it is essential to establish a fast, accurate and a non-invasive technique for quantitative assessment of plant hydration levels. This will further help in implementing 'smart' irrigation management reducing water usage and wastage in agriculture.

This project will explore spectroscopy and imaging using terahertz (THz) range (3000 – 30 µm in wavelength or 0.1×10^{12} – 10×10^{12} Hz in frequency) which is an extremely sensitive non-contact, non-invasive technique to measure hydration levels. Several representative plants having specific hydration schemes that are available both in Australia and India, such as, mango, banana and bamboo will be initially studied with broadband, THz time-domain spectroscopy and imaging set-up. Standardization protocol and calibration charts of transpirations of all plant species under study will be prepared under normal and drought conditions. In the second phase, high power THz sources working in a relatively narrow frequency range will be used to target the high-frequency THz water signature. This will result in increased image resolution required in a practical, field deployable instrument that can accurately map the water uptake and release by plants.

6. Project deliverables/outcomes

This programme brings together the unique combination of expertise and facilities at two internationally-leading research groups to develop an innovative technology for broad-scale hydration level surveillance of crop plants of significant economic and societal impact both in India and Australia.

We will develop a novel terahertz (THz) frequency tool for surveillance of hydration levels in crops and estimating the need of irrigation to introduce new best-practice control strategy in agriculture.
Furthermore, by leveraging the world-class expertise in developing THz laser and time domain THz imaging systems at both UQ and IIT-D, we will explore the applicability of our new platform to the standoff irrigation management surveillance in real, field applications.

The development of the proposed platform-technology for monitoring of hydration levels operating at multiple THz frequencies will have far-reaching impact encompassing academic, economic and societal aspects.
Technology will have immediate and disruptive impact in reducing the true burden of water wastage during crop production in both countries.

Academics will also benefit in the field of THz metrology associated with molecular spectroscopy (with applications in plant biology and agriculture), through the use of these fast and sensitive spectroscopic systems.

There is potential for significant economic and societal impact through the translation of these technologies to industry, the licensing for manufacture by Indian and Australian industries, and through the creation and growth of engineering companies.

Both IITD and UQ have a strong track record of industrial collaboration, protecting and licensing IP, and marketing of technologies. Rakic group at UQ is undeniably one of the premier research groups in laser-feedback interferometry worldwide, with a numerous research 'world-firsts' in LFI sensors and a close working relationship with L3 Micreo Ltd, a subsidiary of L3 Technologies based in Queensland, Australia. The group also boasts the only dedicated THz QCL facility in Australia, which has been previously supported through ARC grants and the Advance Queensland Research Fellowship scheme. Overall this AU$3.8M facility consists of 150 m2 of laboratory space dedicated to LFI sensor development spanning the visible, infrared and THz regions of the spectrum.

This programme will also generate impact through the creation of a vibrant inter-disciplinary research environment across UQ and IITD sites that will through UQIDAR attract and retain outstanding young researchers who will grow to be future academic and industrial leaders in India and Australia, and advocates in science and engineering.
PhD students associated with this programme will visit and work at partner sites for joint experiments, simulations and discussion, leading to the sharing of skills and the dissemination of scientific outcomes to aligned research programmes at these sites.

The proposed research will give rise to publications in leading scholarly journals in the fields of photonics and terahertz engineering including Optics Letters, Optics Express, Applied Physics Letters, and IEEE Transactions on Terahertz Science and Technology.

We also anticipate communicating our research outcomes at premier international conferences in the field. Additionally, we will promote open access to our research findings, and plan to communicate research results both within and beyond the academic community.

7. Research Impact Themes:

Highlight which Research Impact Theme(s) this project will address?
(*Feel free to nominate more than one. For more information, see http://www.uq.edu.au/research/impact/)*

1. Healthy Ageing
2. Feeding the World
3. Resilient Environment
4. Technology for Tomorrow
5. Transforming Societies

8. Type of Student

This project is best suited for an:

i-student	
a-student	
i- or a-student	

Note that an i-student will be expected to spend year-1 at IIT-D, year-2 at UQ and the remaining time at IIT-D.
An a-student will spend year-1 at UQ, year-2 at IIT-D and the remaining time at UQ.
All students will be required to complete some amount of coursework in their first year.

9. Student capabilities and qualifications

Essential Capabilities: 1. Basic undergraduate coursework in Physics/Chemistry/Biology/Electrical Engineering/Computer Sciences; 2. Excellent English Communication skills

Desirable Capabilities: 1. Working knowledge of MATLAB and LABVIEW; 2. Prior experience in working on Adobe Creative Suite products (Adobe Illustrator, Photoshop)

Expected qualifications (Courses/Degrees etc): BTech (Elec Engineering/Engineering Physics/Bio-Engineering/Chemical Engineering); MSc (Physics/Chemistry/Bio-Chemistry); MTech (Elec Engineering/Applied Physics/Bio-Engineering/Chem Engineering/Nanotechnology)


UQ
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AUSTRALIA


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