

The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

Project title	Quality Assessment of Exportable Commodity Goods of Australia and Indian Subcontinent Using Non-contact, Non-invasive THz Imaging Technique
Project code Project description	<p>UQIDAR 00118</p> <p>With increasing living standards and consumer awareness, safety and quality protocols required for exporting agricultural commodity goods across the world has risen dramatically. One of the main concerns in this category, is the presence of bacterial and fungal organisms stemming out of the presence of increased humidity levels. Tea, coffee, cocoa, spices, dry fruits and nuts, wool and animal hair and other major exportable commodity goods of Australia and the Indian sub-continent come under this increased scrutiny, where, a fast, minimally invasive quality assessment technique is essential; especially before packaging to gain confidence in the world export market. Unwanted presence of humidity in these products cause bacterial and fungal infection during trans-continental transport, ultimately leading to rejection at the point of entry, leading to severe economic losses for the concerned country.</p> <p>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 in food packaging. Several locally available and branded exportable items such as tea, coffee, spices, dry fruits and nuts, and different varieties of wool will be studied. Following strict protocols, the detection limit of the level of hydration in each product under study will be calibrated using a broadband, THz time-domain spectroscopy and imaging set-up. This is critical as most of these products will present variable scattering response due to variations in their morphological topography. 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 towards achieving higher confidence bounds. This is required for high efficiency classification analysis using artificial neural network type identifier.</p>
Project outcomes	<p>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 in the packages of several exportable commodity items having significant economic and societal impact both in India and Australia.</p> <p>We will develop a terahertz (THz) frequency imaging/scanning surveillance tool to detect the presence of harmful bio-organisms and increased humidity level in several exportable commodities, such as, tea, coffee, dry fruits and nuts, wool etc. before their packaging for transport.</p> <p>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 very fast package inspection in real, field applications.</p> <p>The development of the proposed platform-technology for monitoring the content of 'unwanted' bio-organisms and water in relevant products operating at multiple THz frequencies will have far-reaching impact encompassing academic, economic and societal aspects. Technology will have immediate and disruptive</p>

impact in reducing the true burden of spoilage and rejection during packaging and transport in both countries.

Academics will also benefit in the field of THz metrology associated with molecular spectroscopy through the use of these fast and sensitive spectroscopic and imaging systems.

There is a 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 Micro 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 interdisciplinary 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.

Advisory team

UQ Principal Supervisor

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Additional Supervisor(s)

Dr Aparajita Bandyopadhyay

Type of student
Discipline
background of student

Applications are open to: i-students who meet [eligibility criteria](#).

Ideally, this project requires students with a background in:

Optics,
Electrical Engineering,
Physics,
Biology

Ideal candidate

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)

Application process

Apply online by the due date: <https://www.uqidar.org/students/how-to-apply/>