



Notice for the PhD Viva-Voce Examination

Ms Greeshma Jacob, Registration Number: 1770081, PhD Scholar at the Department of Electronics and Communication Engineering, School of Engineering and Technology, CHRIST (Deemed to be University), Bangalore will defend her PhD thesis at the public viva-voce examination on Tuesday, October 28, 2025 at 10.30 am in the Conference Room, Block I, Bangalore Kengeri Campus, Bengaluru - 560074, Karnataka, India.

Title of the Thesis	: Early Detection of Breast Cancer: Numerical and Experimental Phantom Study Using Vibro-Acoustic Thermography
Discipline	: Electronics and Communication Engineering
External Examiner - I	: Dr M Krishnasamy Associate Professor School of Electronics Engineering (SENSE) VIT-AP University, Amaravati Andhra Pradesh - 522237
External Examiner - II	: Dr G Muralidhar Bairy Additional Professor Department of Biomedical Engineering Manipal Institute of Technology Manipal Academy of Higher Education Manipal - 576104, Karnataka
Supervisor	: Dr Sujatha S Associate Professor Department of Electronics and Communication Engineering School of Engineering and Technology Bangalore Kengeri Campus CHRIST (Deemed to be University) Bengaluru - 560074, Karnataka
Co-Supervisor	: Dr Iven Jose Professor (Former) Department of Electronics and Communication Engineering School of Engineering and Technology Bangalore Kengeri Campus CHRIST (Deemed to be University) Bengaluru - 560074, Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

ABSTRACT

Breast cancer remains one of the leading causes of cancer-related deaths among women, with early detection being the most effective strategy for improving outcomes. One key biomarker for breast cancer is the alteration in surface heat patterns of the breast, which thermography leverages for detection. A major advantage of thermography over other imaging techniques is its ability to identify tumours at an early stage. However, a significant limitation is its reduced sensitivity to deeper tumours due to low thermal contrast. To address this challenge, we have developed a novel imaging approach, Vibro-Acoustic Thermography, which is a non-invasive, advanced, and dynamic technique capable of detecting deeper tumours. This method enhances thermal contrast by using differences in acoustic and mechanical properties between normal and malignant tissues.

Computational analysis is performed to evaluate its effectiveness in realistic tissue models. Acoustic wave propagation through tissue is modelled using the Westervelt equation, while the Pennes bioheat equation is used to determine temperature distribution. Both homogeneous and heterogeneous tissue cases are analysed. Results show that this technique can increase the temperature in the malignant region by up to 3°C. Depth-wise analysis indicates that a 3 mm tumour, typically detectable only at a 4 mm depth using conventional thermography, can now be detected at a depth of up to 10 mm.

The computational findings are validated experimentally using an agar-based tissue phantom, chosen for its similarity in Young's modulus to pathologically measured invasive ductal carcinoma. Dual Focused Ultrasound is used to excite the tissue at its resonant frequency. The experiment also evaluates temperature changes due to induced vibrations and explores acoustic absorption behaviour within the tissue.

Keywords: *Breast cancer, Thermography, vibro-acoustography, Active thermography, Pennes Bioheat Equation.*

Publications:

1. **Greeshma Jacob**, Iven Jose, and S. Sujatha. "Breast cancer detection: A comparative review on passive and active thermography." *Infrared Physics & Technology* (2023): 104932.
2. **Greeshma Jacob**, Iven Jose, Sriram R Chandran and S. Sujatha. "A study on Resonant vibro-acoustography for tissue heating: A pathway towards Breast Cancer Detection" *Research on Biomedical Engineering* [In Press].
3. **Greeshma Jacob**, Iven Jose, and S. Sujatha. "Computational and experimental investigation on the breast tumor depth characteristics performed using infrared Thermography." *Proceedings of the 26th National and 4th International ISHMT-ASTFE Heat and Mass Transfer Conference* December 17-20, 2021, IIT Madras, Chennai-600036, Tamil Nadu, India. Begel.
4. **Greeshma Jacob**, Iven Jose, and S. Sujatha. "Numerical and experimental investigation of the influence of tumour parameters on surface temperature" *6th International Conference on Recent Trends in Bioengineering (ICRTB 2023)*, MIT School of Bioengineering Sciences and Research, MIT-ADT University, Pune-412201.