

# DESIGN AND IMPLEMENTATION OF AUTONOMOUS ROBOTIC SCANNING OF THE BREAST

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## ABSTRACT

Breast cancer is the most common type of cancer in women worldwide, with nearly 1.7 million new cases diagnosed in 2012.<sup>[1]</sup> Improvement of breast biopsy methods, allowing early detection and reliable diagnosis, can reduce the mortality rate significantly.<sup>[2]</sup> The MURAB project stands for MRI and Ultrasound Robotic Assisted Biopsy and aims to improve breast biopsy. Image modalities such as ultrasound and MRI are used to locate the lesion. MRI breast biopsy provides higher resolution images but is significantly more complicated than ultrasound guided biopsy and causes increased discomfort for the patient and increased intervention time and costs. The MURAB project aims to reduce these drawbacks using the advantages of both imaging modalities. Images of both modalities will be registered and will provide input during the robotic assisted biopsy while using real-time ultrasound guidance to guide the biopsy needle to the lesion.

The main aim of this research project is to design and implement the ultrasound scanning phase during which the breast of the patient is autonomously scanned by a LWR4+ lightweight robotic arm (KUKA industrial robots, Germany) in order to acquire 2D ultrasound images. The design and implementation in this study consists of 1) autonomous initialization of scanning using visual servoing, 2) automatic trajectory planning and 3) contact control using force feed-back to maintain a constant contact pressure between the robot probe and the patient while keeping the probe normal to the breast surface. Experiments were performed using breast phantoms.

Results showed that during initialization of the scanning motion the robot is steered to the correct start position with an accuracy of 1.6 mm. It was possible to automatically plan the trajectory, after which the robotic arm made contact with the breast phantom. The contact pressure of 5N was maintained during the full scan and the probe was kept normal to the surface with an average deviation of seven degrees. These results are promising for further implementation and fine tuning of the scanning phase using a robot arm designed for breast biopsy applications.

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## References

- [1] World Cancer Research Fund International (2012), Breast cancer statistics. <http://www.wcrf.org/int/cancer-facts-figures/data-specific-cancers/breast-cancer-statistics>
- [2] Khatib, Oussama MN, and Atord Modjtabai. "Guidelines for the early detection and screening of breast cancer." *World Health Organization. Technical Publications Series 30* (2006).