UNIVERSITI TEKNOLOGI MARA

DETECTION OF CALCIFICATIONS IN DIGITAL BREAST TOMOSYNTHESIS IMAGES USING A NEW APPROACH OF IMAGE FILTERING

SYAFIQAH AQILAH BINTI SAIFUDIN

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Electrical Engineering)

College of Engineering

June 2023

ABSTRACT

Breast cancer is the world's second leading cause of death among cancers primarily affecting women. Calcifications are the most important subject in the early stages of breast cancer detection; thus, calcification detection is important because it leads to early treatment and increases the survival rate for breast cancer patients. Digital Breast Tomosynthesis (DBT) is the screening technique that move the device to specific angles and produced images that have been shown to improve the overlapping issue in mammogram. This is important to obtain a clearer view of calcifications. However, due to movement of device to a specific angle as well as patients' movement, blurry artefact and noises might unavoidably produce. The primary goal of this research is to propose a calcifications detection system based on convolutional neural networks (CNN) while employing a novel approach to image filtering techniques on DBT images. To overcome the unsatisfied quality of the images, this study proposed new filtering techniques for DBT image enhancement. The new filtering techniques are adaptations of Non-Linear Unsharp Masking (NLUM) and Fuzzy Weighted Median Filter (FWMF) to enhance DBT images and calcifications. Furthermore, the improved DBT images will be fed into the CNN model adapted from the previous study. Following that, the performance of both the enhancement stage and the detection process is evaluated, and finally, the radiologist performs the validation process. The proposed enhancement techniques outperformed conventional filtering techniques for both NLUM and FWMF, which produced average PSNR values of 66.39915 and 96.226764, respectively. The newly proposed Adaptive FWMF can be used to enhance calcifications, but modified NLUM can be used to enhance the entire DBT image, including the clear form of breast glands, breast fat, and ligament, according to qualitative results. The filtering techniques are then applied to the CNN model, and the mean Average Precision (mAP) and Log Average Miss Rate (LAMR) values are recorded in the results. The outcome of this study demonstrated the capability and reliability of the proposed methods particularly for radiologists, of overcoming the problems and limitations associated with the diagnosis of breast cancer disease, both in terms of the visibility of calcifications and the detection process of calcifications.

ACKNOWLEDGEMENT

First and foremost, I want to thank Allah S.W.T for being grateful for His blessing in giving me the opportunity to pursue my MSc and for successfully completing this long and difficult journey. My heartfelt gratitude and appreciation go to my primary supervisor, Assoc Prof Ir. Ts. Dr. Hajah Siti Noraini Sulaiman, and co-supervisors, Dr Muhammad Khusairi Osman and Dr Noor Khairiah A Karim, as well as Dr Iza Sazanita Isa. Thank you for your patience, ideas, and help in getting this study completed.

My gratitude goes to all the members of the Advanced Control System and Computing Research Group (ACSCRG) who were supportive, as well as all the faculty members of Fakulti Kejuruteraan Elektrik (FKE), UiTM Pulau Pinang who were both directly and indirectly involved. I could not have finished this project without their cooperation and assistance.

Finally, this thesis is dedicated to the beautiful memory of my late father,
and my lovely mother,' for having the vision and determination to educate me, for her physical and mental support, and for being understanding throughout the entire process of this study. A special thanks to my sisters, and for entertaining me, being supportive, and encouraging me in negative and stressful situations during the entire process of completing this study.

Thank you for your encouragement, ideas, and comments that have contributed to the success of this project. This victory is dedicated to each and every one of you.

Alhamdulilah.

TABLE OF CONTENTS