CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

In Active thermography, a stimulus is applied to a target to cause the target to heat or cool in such a way as to allow characteristics of the target to be observed when viewed by thermal imagery. By understanding the expected thermal properties of the target’s surface and subsurface, adaptive thermography might provide a possible solution to one’s need. (Michael Sharlon 2008). The clinical tests were performed using active dynamic thermography in the oncology Surgery Clinic, Medical University of Gdansk for women with breast cancer. Halogen lamps were as external heating source and sequences of thermograms were recorded during the cooling phase. While the Static thermogram analysis showed hot spots and significant asymmetries in temperature distribution at quadrants of the left and right breast, active dynamic thermography detected pathological changes at the right-upper quadrant of the breast (Mariusz Kaczmarek and Antoni Nowakowski 2004).

The results of the experiments conducted in our laboratory with phantom models also show that the proposed active thermography method by external irradiation for early detection of breast carcinoma may lead to the development an improved thermal imaging method. In the following section we discuss the inference of our research work.
A method of obtaining an active thermo gram by irradiating the patient’s breasts using an external source and allowing the breasts to cool naturally before taking the thermo gram is proposed. The proposed method increases the temperature difference between the normal and the cancerous breasts tissues and that by enabling the early detection of breast carcinoma. The techniques used to obtain an active thermo gram are Conductive heating, FIR irradiation, Micro wave irradiation, Hybrid irradiation, Micro wave double and multiple irradiation and Hybrid multiple irradiation. The FIR irradiation technique increased the temperature difference between the normal and cancerous breast phantoms to 2°C after heating and cooling processes for 1°C temperature difference between the normal and cancerous breast phantom before heating and cooling processes. It was found that in the FIR irradiation method, the temperature difference between the normal breast phantom and the cancerous breast phantom was not increased during heating and only the cooling process increased the temperature difference between them. Hence there was only a nominal elevation in the temperature difference between the normal breast phantom and the cancerous breast phantom by the FIR irradiation technique.

Micro wave single irradiation technique produced 4°C temperature difference between the normal and cancerous breast phantom after heating and cooling processes for 1°C temperature difference between the normal and cancerous breast phantom before heating and cooling processes. It was observed that in the Microwave single irradiation method, the temperature difference between the normal breast phantom and the cancerous breast phantom was increased during both the heating and cooling processes. Hence there was a considerable elevation in the temperature difference between the normal breast phantom and the cancerous breast phantom by the Microwave single irradiation technique.
In Hybrid irradiation, the phantom models were first irradiated by a FIR source and after a cooling period they were given Microwave irradiation. The second cooling period followed the Microwave irradiation. The FIR irradiation step increased the temperature difference between the normal breast phantom and the cancerous breast phantom only nominally where as the following microwave irradiation increased it to a greater level. The FIR irradiation step increased the temperature difference between the normal and cancerous breast tissues to 2°C after heating and cooling processes for 1°C temperature difference between the normal and cancerous breast phantom before heating and cooling processes. The following Microwave irradiation step increased it further. Hence Hybrid irradiation technique produced 5.75°C temperature difference between the normal and cancerous breast phantom after second heating and cooling processes.

In Microwave Double irradiation method, the phantoms were given a microwave irradiation first. After a cooling period, the second irradiation from the same microwave source was given and this was followed by the second cooling period. The first irradiation increased the temperature difference between the normal and cancerous breast phantom after heating and cooling processes to 4°C for 1°C temperature difference between the normal and cancerous breast phantom before heating and cooling processes. The second microwave irradiation increased it further that the Microwave Double irradiation technique produced 6.75°C temperature difference between the normal and cancerous breast phantom after second heating and cooling processes. Since the proposed Hybrid irradiation, Microwave Double irradiation methods increased the temperature difference between the normal and cancerous breast phantoms to 5.75 °C, 6.75°C for 1 °C growth of cancer, these methods would reduce the false positives in addition to early detection of the disease.
In microwave multiple irradiation technique, triple microwave irradiations were given to the phantoms. The first microwave irradiation increased the temperature difference between the normal and cancerous breast phantoms considerably and the second microwave irradiation further increased it. But the third irradiation did not elevate the temperature difference between the normal and cancerous breast phantoms and hence microwave multiple irradiation may not produce a significant increase in the temperature difference between the normal and cancerous breasts tissues.

In Hybrid multiple irradiation technique, FIR irradiation was first given and a double microwave irradiation step followed this. The FIR irradiation nominally increased the temperature difference between the normal breast phantom and the cancerous breast phantom. The following microwave irradiation increased the temperature difference further, but the third irradiation was found to be not useful. Thus the Hybrid multiple irradiation technique may not produce a significant increase in the temperature difference between the normal and cancerous breasts tissues.

Since even the third irradiation was found to be not superior to double irradiation technique, multiple irradiations by both Hybrid as well as microwave irradiation techniques, may not produce a significant increase in the temperature difference between the normal and cancerous breasts tissues.

6.2 FUTURE SCOPE

In our laboratory, phantom experimental study conducted for the proposed active thermography method has shown that the temperature difference between the normal breast phantom and cancerous breast phantom is increased by external irradiation method for various irradiation techniques. However the effectiveness of these irradiation techniques for tumors at various depths should be studied.
We are currently in the beginning stage of developing a new imaging technology for early breast cancer imaging where we have to validate our results against X ray mammography, the gold standard imaging modality. The volunteers could be chosen and screened by the proposed imaging technique and the cases of suspicion should be monitored for a period of 8 to 10 years, since the early signs of breast cancer appear in thermogram 8 to 10 years prior to the stage they appear in mammogram. After 8 to 10 years of follow up, the thermograms of the suspicious cases can be compared with mammograms for validating the results. Our future work is to test the effectiveness of these irradiation techniques for tumors at various depths and to validate the proposed method of early breast carcinoma detection using external irradiation by clinical study. Presently we are trying to establish contacts with hospitals for clinical study.