

Background:

- Understanding the complex relationship between the breast thermal contrast and the underlying factors is important in thermogram-based breast cancer detection.
- Thermal modeling of the breast must account for the deformation also.
- Dynamic thermal imaging provides extra characterization to the breast physiology and pathology.

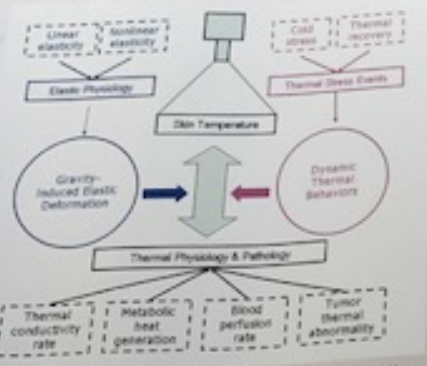


Figure 1: Diagram of the breast thermogram modeling. Elastic deformation (blue) and dynamic thermal stress (pink) have been taken into account.

Methods:

- We used finite element method (FEM) for both elastic and thermal properties modeling of the breast.
- We also examined the dynamic thermal behaviors during cold stress and thermal recovery.

References:

1. Head, J.F., et al. *IEEE Eng Med Biol Mag.* 2002, 21(6): 80-85. 2. Dusan M. J *Biomech Eng.* 1988; 11(4):269-76. 3. Ng, E.Y.K, et al. *J.Eng. Med.* 2001,215(1):25-37. 4. Ohashi, et al. *IEEE Eng Med Biol Mag.* 2000,19:42-51. 5. Rao, S.S., *The Finite Element Method in Engineering.* 1999. 6. Lewis, R.W., et al. *Fundamentals of the Finite Element Method for Heat and Fluid Flow*, 2004

Results:

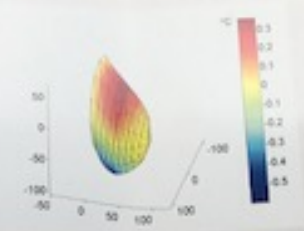


Figure 2: Breast surface temperature alteration caused by gravity-induced breast deformation in standing-up posture.

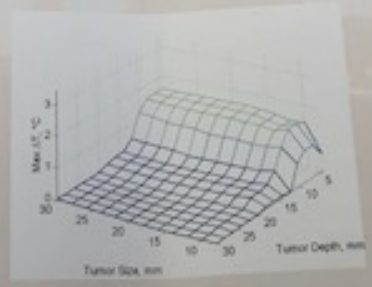


Figure 3: An overall relationship between tumor-induced thermal alteration and tumor geometry is plotted as a function of tumor size and depth.

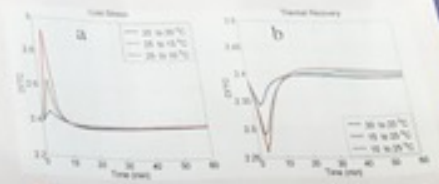


Figure 4: Time courses of deformation-induced thermal contrast (DITC) index of skin temperature in (a) cold-stress, and (b) thermal-recovery procedures.

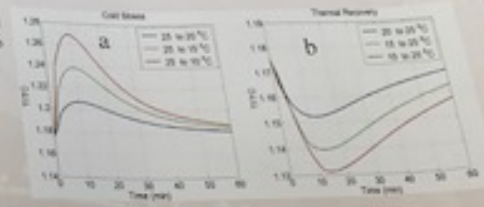


Figure 5: Time courses of tumor-induced thermal contrast (TITC) index of skin temperature for tumor depth of 10mm in (a) cold stress, and (b) thermal recovery.

Discussion and Conclusion:

- Both gravity-induced deformation and tumor exert substantial impacts on the breast temperature distribution.
- Deformation-induced thermal contrast (DITC) and tumor-induced thermal contrast (TITC) have different spatial distributions on breast surface.
- Dynamic DITC and TITC exhibit different temporal patterns during the thermal stress events.
- These results can help better separate the tumor-induced thermal contrast on the breast surface from the background of other thermal contrast sources.