Reproducibility of Quantitative Image Texture Features in Identifying Tumor Regions in Thermal Breast Images

Nada Kamona and Murray Loew
Department of Biomedical Engineering, The George Washington University, Washington, DC;
nkamona@gwmail.gwu.edu

GW Biomedical Engineering

School of Engineering & Applied Science
THE GEORGE WASHINGTON UNIVERSITY

INTRODUCTION

- **Image textures** are perceived patterns, variations, and randomness across image pixels.

Figure 1: Examples of natural image textures

(a) (b) (c)

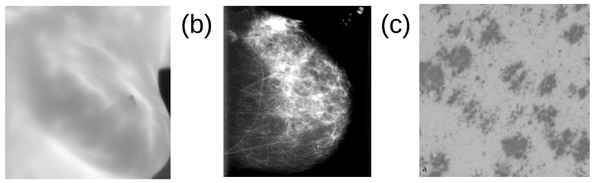

Figure 2: Examples of texture in medical images
(a) Infrared breast image, (b) mammogram, (c) microscopy of prion protein distribution.

- Imaging analysis techniques often rely on quantitative measurements of textures to quantify disease status.
- Measurements of texture are called **texture features**, and depend on spatial relationships of the pixel values.
- It is unclear if quantitative texture features are capable of distinguishing tumorous regions from healthy tissues in thermal images, and if they are robust across a range of patient characteristics.

OBJECTIVES

Investigate the ability of 39 texture features to distinguish tumor regions in thermal breast images from healthy tissues, and study their reproducibility across multiple patients. Determine the effects of grid size (area over which texture feature is computed) on the ability of a texture feature to identify tumor regions.

HYPOTHESES

- Texture measurements of a tumor region are statistically different from those of the corresponding healthy region on the other breast.
- Because cancerous and healthy tissues cool at different rates over time[3], the absolute difference of the texture measurement between the left and right breasts should be larger when compared to the absolute difference between two healthy regions.
- A **high standard deviation** over time for the absolute difference in a given area indicates a high variability between the left and right breasts and the possibility of one of the breasts having a tumor.

METHODS

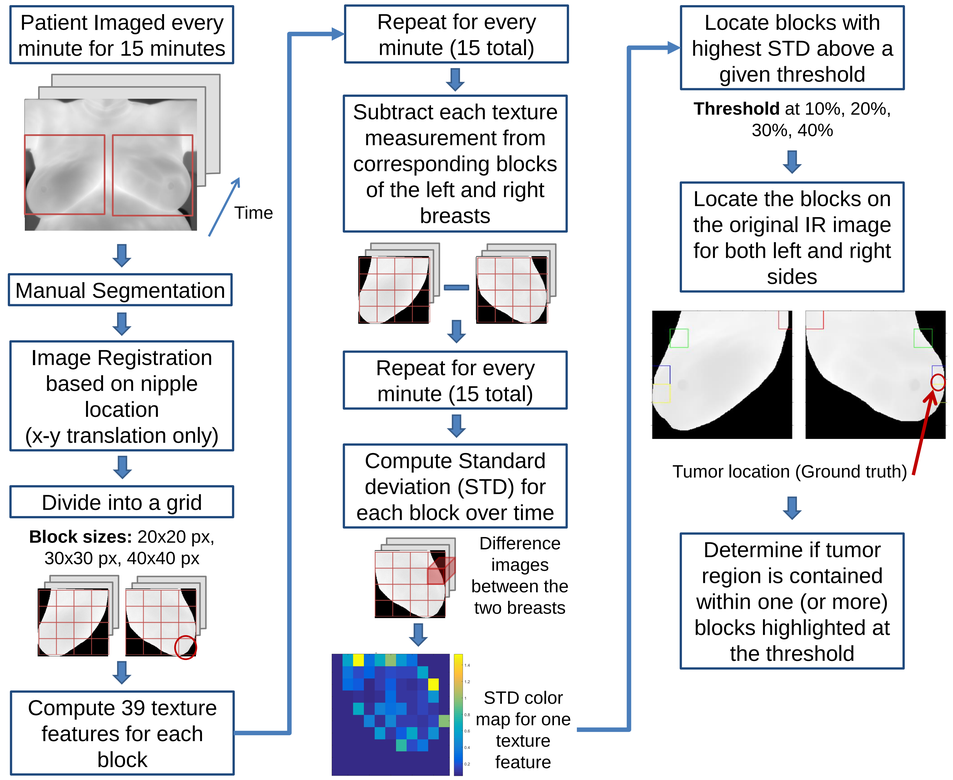

Figure 3: Developed algorithm flowchart illustrating the major steps.

39 texture features from: 1) **Gray-Level co-occurrence matrix** [1] (at quantization level = 256, and offset = 0 degrees, pixel-neighbor distance = 1), 2) **Laws' texture energy**[2] measures, 3) **first-order Intensity Histogram** measures, and 4) three other statistical measures.

RESULTS

- Each texture feature was evaluated for its reproducibility across three patients.
- Features, such as cluster shade, identified the tumor region in two patients with grid size 20 by 20 pixels, but did not succeed when the grid size was increased to 40 by 40 pixels.
- Other features, including skewness and kurtosis, identified tumorous regions in two patients when only a larger grid was used.

Table 1: Effect of grid size and threshold level on the ability of texture features to identify tumor region (Hits ROI). This is an example for *Law's Edge-Edge (EE)* texture feature tested on one patient.

Edge-Edge	Threshold			
Grid Size	10%	20%	30%	40%
20x20 pixels	No hits	No hits	No hits	No hits
30x30 pixels	**Hits ROI**	**Hits ROI**	**Hits ROI**	**Hits ROI**
40x40 pixels	No hits	No hits	**Hits ROI**	**Hits ROI**

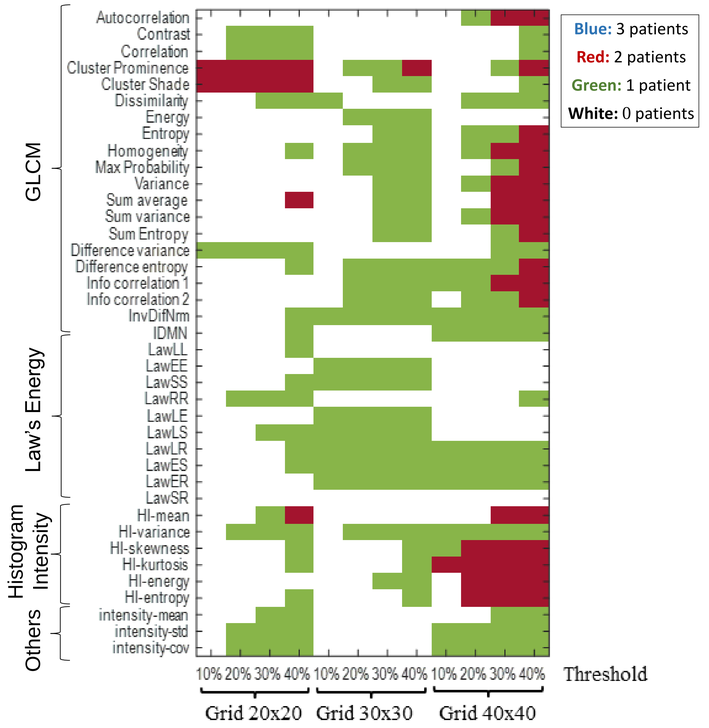

Figure 4: Ability of 39 texture features to locate tumorous regions in three breast cancer patients, across various grid sizes and threshold levels. The color codes show the number of patients with successfully identified tumorous regions.

CONCLUSION & FUTURE WORK

- We investigated the effect of grid size on the *repeatability* (within the patient) and *reproducibility* (between patients) in each of the 39 texture features to identify tumor regions in three cancer patients
- We found some features performing better at larger grid size, in contrast to others.
- To draw meaningful conclusions, future work involves testing the proposed algorithm on more breast cancer patients.
- The goal is to examine the suitability of texture features in identifying tumor regions on thermal images, and possibly to isolate a subset of candidate features.

REFERENCES

[1] Haralick, Robert M., K. Shanmugam, and Itshak Dinstein. "Textural Features for Image Classification." *IEEE Transactions on Systems*, Man, and CyberneticsSMC-3.6 (1973): 610-21. Web.
[2] Laws, Kenneth I. "Rapid Texture Identification." *Image Processing for Missile Guidance*(1980): n. pag. Web.
[3] L. Jiang, W. Zhan, and M. H. Loew, "Modeling static and dynamic thermography of the human breast under elastic deformation," *Phys. Med. Biol.*, Vol. 56, No.1, 2011, pp. 187-202.
[4] Nailon, W. H. (2010). Texture analysis methods for medical image characterisation. In *Biomedical imaging*. InTech.