Leonardo Daniel BUITRAGO
University of Maryland College Park
BSE 4115
9636 Gudelsky Drive
Rockville (MD) 20850
USA
e-mail: Bardia.Yousefi@gmail.com

QIRT-2024-088
PANEL
ABSTRACT
PRESENTATION
PAPER

Leonardo Daniel Buitrago is a student at the A. James Clark School of Engineering of the University of Maryland College Park in Rockville (MD), USA.

Miguel MARTINEZ
University of Maryland College Park, Rockville (MD), USA
Severin VIHOSSI
University of Maryland College Park, Rockville (MD), USA
Prof. Xavier MALDAGUE, PhD, Eng.
Laval University, Department of Electrical and Computing Engineering, Québec (QC), Canada
Prof. Bardia YOUSEFI, PhD
University of Maryland College Park, Rockville (MD), USA

UNIFORM MANIFOLD APPROXIMATION AND PROJECTION FOR BREAST THERMOGRAPHY

The detection of breast cancer using dynamic thermographic imaging presents unique challenges due to the complex and high-dimensional nature of the extracted feature data or 'thermomics'. Our previous research has introduced many different techniques to deal with high dimensional dynamic thermography, which provided solution to an often struggle to encapsulate the intricate patterns in our thermographic breast images. These patterns are crucial for an accurate and very early diagnosis of breast cancer leading abnormalities (CLA) through hindering the effective application of machine learning models in identifying potential cancerous changes in breast tissue based on the thermal heterogeneity.

To continue responding to these challenges, our study focuses on introducing Uniform Manifold Approximation and Projection (UMAP) in more advanced way of extracting low-rank HD manifold matrix approximation. Such basis vectors lead to reduction of thermal images leading to extract more reliable themomics. This is the first time UMAP being used for computational thermography and its novelty lies in its sophisticated approach to dimensionality reduction, preserving not just global, but also local data structures. UMAP focuses on capturing complex non-linear relationships in the data and is much more scalable in dealing with various dataset sizes. Coupled together with its use of stochastic gradient descent to find optimal low-dimensional representation along with combining it with embedding methods such as the Gaussian and Bell to integrated basis vectors leading to predominant outcome projecting CLA heterogenous as a robust imaging biomarker. This enhances the predictive accuracy of our machine learning algorithms in early breast cancer diagnosis.

The proposed method's results indicate an enhancement of diagnostic accuracy for UMAP embeddings, yielding 80% (78,6%, 85,7%) for UMAP-Bell embedding and 79,3% (60,0%, 80,1%) for UMAP-Gaussian embedding using different binary classifiers, Naïve Bayesian and random forest, respectively. These accuracies were obtained by 10-fold cross validation paradigm evaluation. These findings suggest that UMAP techniques substantially help preserve crucial thermal patterns leading to significant enhancement of the efficacy of clinical breast examination (CBE) and enabling the early detection of breast cancer.