AUTOMATIC HEART DISEASE PREDICTION USING MODAL DECOMPOSITION AND MASKED AUTOENCODERS FOR LIMITED ECHOCARDIOGRAPHY DATABASES

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Introduction

Heart diseases constitute the main cause of international human defunction (around 18 million deaths per year [1]). Also considering the increase of available medical data, much pressure is therefore put on the health industry to develop systems for early and accurate heart disease recognition. This has motivated the development of several deep learning frameworks, mainly employing echocardiography data. However, the majority of approaches are based on Convolutional Neural Networks (CNNs). In addition, these systems typically handle a single disease, or a closely related family of them [2].

Methods

In this contribution, an automatic system based on a novel deep learning framework which analyzes echocardiography videos in real time is proposed. This system addresses two related tasks. The first one is the prediction of the time in which a heart failure happens. The second task involves the heart disease recognition. The system is composed of two stages. The first one is aimed to create a large database from different sources of echocardiography videos. This allows the training of machine learning-based frameworks, including deep learning algorithms. This stage also includes the use of the Higher Order Dynamic Mode Decomposition (HODMD) algorithm [3], for the first time to the authors' knowledge in the medical field [4] for both data augmentation and feature extraction. The second stage builds and trains a Masked Autoencoder (MAE), adapted for an effective training from scratch, even with limited databases. This designed MAE analyzes the images from an echocardiography video to automatically estimate the heart state. In addition, it also estimates the time in which a heart failure will happen.

Results

Table 1 shows the estimation time performance using Vision Transformers (ViTs), the proposed MAE, and the impact of the HODMD algorithm. The proposed MAE achieves the best results, with a lower estimation error. In addition, the HODMD algorithm further improves performance, demonstrating its potential for data augmentation and feature extraction.

Algorithm	HODMD included	Estimation error (months)	# Training images
ViT		5.44	31211
MAE		5.15	31211
MAE	×	4.65	74974

Table 1: Comparison of the estimation time performance.

Discussion

The results demonstrate that the proposed system is superior and the HODMD algorithm effective for the prediction of the time of heart failures.

References

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