Automatic Heart Disease Recognition in Limited Databases of Echocardiograms Improved with Higher Order Dynamic Mode Decomposition and Vision Transformers

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Abstract: Heart diseases are the main cause of human mortality in the world (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. The several deep learning frameworks currently available handle echocardiography data. Most of them resort to Convolutional Neural Network (CNN) technology. However, these systems are typically specialized on a single disease, or a closely related family of them [2]. In this contribution, we describe a system for automatic heart disease recognition, based on a novel deep learning framework, which analyses echocardiography videos in real time. The system comprises two stages. The first one creates a large database from different sources of echocardiography videos. This allows to train any machine learning-based framework, and especially deep learning algorithms. This 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 is aimed to build and train a Vision Transformer (ViT), adapted to be effectively trained from scratch, even with small databases. This designed ViT analyses the images from an echocardiography video to automatically estimate the heart state. The results demonstrate that the proposed system is superior and the HODMD algorithm effective in the recognition of different heart conditions, even outperforming several pretrained CNNs.

References:

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