AUTOMATED CLASSIFICATION OF INTRACARDIAC MASSES IN ECHOCARDIOGRAPHY USING SPARSE REPRESENTATION

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Abstract:
One important responsibility in the diagnosis of cardiac sickness is the identification of intracardiac masses in echocardiograms. For the purpose of improving diagnostic precision, a new fully automated sparse representation-based classification method is introduced for the detection of intracardiac tumours and thrombi in echocardiography. To find the mass area, first a region of interest is cut. After that, the speckle is removed while the anatomical structure is preserved using a new global denoising process. Afterwards, a modified active contour model and K-singular value decomposition are used to depict the mass's contour and its associated atrial wall. Lastly, in order to distinguish between two masses, a sparse representation classifier processes the motion, boundary, and texture data. For this purpose, we gather 97 clinical echocardiography sequences.

I. Introduction

The concept of sparse representation has gained popularity in the last few years. True signals might be sparsely represented by a linear combination of few basis elements in the transform domain, according to the transform-domain techniques, which is where the sparse notion was born. The use of sparse linear combinations of an overcomplete dictionary may replace fixed and orthogonal transformations in picture description.

Sparse representation has many uses, such as in denoising, compression, classification, and regularisation for inverse problems. K-Singular Value Decomposition (K-SVD) is a common sparse representation approach that makes use of full dictionaries derived from an initial training process. One crucial challenge in the diagnosis of cardiac illness is the identification of intracardiac masses in echocardiograms. An innovative sparse representation-based completely automated classification system for echocardiography-based intracardiac tumour and thrombi detection is suggested, with the aim of improving diagnostic accuracy. Any abnormal structure inside or around the heart is known as an intracardiac mass. Thorough diagnosis is necessary for rapid excision and treatment of these formations since they cause serious cardiovascular problems. Tumours and thrombi are the two most common forms of intracardiac masses. A thrombi is a solid clump of platelets, while a tumour is an enlarged, abnormally growing piece of tissue that may move about in the body.

One such way to classify tumours is as either primary or secondary. Primary tumours of the heart are quite uncommon. They may manifest in any cardiac tissue but have their origins in the heart itself. They may or may not be malignant. Most of them are myxomas, and around 75% of them in adults are benign. Its texture is gelatinous and its form is asymmetrical. Compared to primary tumours, secondary tumours are more prevalent. They have no spiritual foundation. They begin their development in another part of the body and then make their way to the heart. Cardiac tumours may either go unnoticed or induce serious cardiac dysfunction, such as heart failure or a precipitous decrease in blood pressure as a result of pericardial haemorrhage. They restrict the ability of the left ventricle to fill. Embolisation, intracardiac blockage, and constitutional sighs are all present in the patients. There is an urgent need to remove the tumours due to the significant danger of embolisation and abrupt mortality.Ischaemic stroke patients often have intracardiac thrombi. As a result, the atrial chamber may widen, cardiac outputs might drop, and atrial fibrillation could occur. In the majority of cases, thrombolysis and heparin are used to treat thrombi. Echocardiography is often used to diagnose intracardiac masses due to its non-invasive and inexpensive nature. Echocardiography is a kind of cardiovascular imaging that makes use of conventional two- and three-dimensional ultrasonography as well as Doppler ultrasound. Echocardiography captures dynamic images of the heart using sound waves; it is also known as an echo test or heart ultrasound. The hospital is not necessary during your stay.

A visual screen displays the patient's cardiac rhythms. The detection of intracardiac masses by echocardiography greatly influences the decision-making process of medical practitioners, since various illnesses are associated with distinct treatment choices. Most intracardiac tumours, according to the echocardiography sequence, have a wide base and a small stalk. Both friable and villous surfaces are possible. Different types of internal echoes are audible. In addition to being very mobile, the tumours show continuity with the atrial wall. On echocardiography, thrombi show as thick, ovoid, stationary, and echo reflecting structures.

Despite their pathological differences, intracardiac tumours and thrombi seem to echocardiographically behave similarly. They are often taken the wrong way. Manual echocardiographic identifications are the norm in hospitals. It takes a lot of time to diagnose. Cardiologists' expertise, imaging quality, and methods all play a role in recognition. Since automated categorisation has the ability to enhance diagnostic accuracy and direct which cases should be indicated for surgery, its demand is on the rise. The use of ultrasound image analysis in computer-aided diagnosis of cardiovascular disease has been fruitful in a number of ways, including the following: utilising adaptive block matching methodologies in the study of carotid artery wall and plaque dynamics; developing fuzzy rule-based decision support systems for the diagnosis of coronary arteries; and uncovering valuable ultrasound features in the prediction of early strokes. The inferior picture quality, which includes a great deal of speckle noise, signal drop-out, artefacts, and missing contours, as well as the fact that two masses might seem identical on echocardiography, makes intracardiac mass identification a tough task. Accordingly, echocardiography thrombi and intracardiac tumour classification need a new approach.

II. Literature Survey

Yi Guo et al 2015assert that a crucial step in diagnosing heart illness is the identification of intracardiac masses using echocardiograms. To enhance the precision of diagnoses, a new completely automated classification approach is suggested for differentiating between intracardiac tumours and thrombi in echocardiography, which is based on sparse representation. To begin, the mass area is defined by cropping a region of interest. After that, the speckle is removed while the anatomical structure is preserved using a novel worldwide denoising approach. Afterwards, the K-singular value decomposition and a modified active contour model characterise the mass's shape and its associated atrial wall. Lastly, a sparse representation classifier processes the motion, boundary, and texture characteristics to differentiate between two masses. In order to determine how effective it is, 97 clinical echocardiography sequences are gathered. With a sensitivity of 100% and a specificity of 93.02%, our suggested technique outperforms existing state-of-the-art classifiers. The accuracy is

96.91%. Cardiologists may find our technique useful in their clinical practice since it explains how to categorise intracardiac tumours and thrombi in echocardiography.

Parisa Gifanial 2016 Interpreting real-time echocardiographic images accurately when the myocardium and valves are undergoing minute, transient movements is a difficult problem. Temporal super resolution (TSR) is helpful for showing the rapidly moving structures, and a faster frame rate video could make this easier to see. Using sparse representation and temporal information, we describe a new framework that optimises TSR enhancement of echocardiographic pictures. This technique aims to improve the accuracy of studies of moving structures by increasing the frame rate of echocardiographic recordings. The suggested approach begins with the extraction of time-related data from intensity variation time curves (IVTCs) evaluated for every pixel. Based on what we knew about the time signals and a set of functions that were already known, we created two types of dictionaries: low-resolution and high-resolution over complete. A small number of prototype atoms from the low-resolution dictionary may be used to characterise the IVTCs as linear combinations. To determine the sparse signal coefficients, we used the Bayesian compressive sensing (BCS) sparse recovery approach. In order to build fresh sparse coefficients matching the high-resolution dictionary, we retrieved the active atoms and sparse coefficients from the low-resolution dictionary. An updated IVTC with more samples was built using the predicted atoms and the high-resolution dictionary. Finally, we were able to rebuild the original echocardiogram video with additional frames by inserting the new IVTC signals into the original IVTC places. The suggested approach avoids blurring objects in motion and blocking artefacts without training low-resolution and high-resolution dictionaries or requiring motion estimation.

O. Michailo vichet al 2002 Utilising harmonic frequencies caused by tissue and echo-contrast chemicals has led to significant advancements in the quality of ultrasound imaging over the last several decades. Myocardial perfusion determination stands out as the most significant use of harmonic imaging, which has quickly gained traction due to its many benefits. Proper extraction of the information contained in the higher harmonics of the received signals is necessary for their successful use. Linear filtering is a popular technique for removing harmonics. The fact that axial resolution is inversely proportional to the contrast agent's detectability is one of its key drawbacks. This work presents a new nonlinear method for extracting the harmonic components from radio-frequency pictures that have been received. It is shown that convex optimisation can efficiently execute the harmonic separation. The separation is done without any impact on the picture quality. The ideas of sparse signal representation in over full signal bases form the basis of the approach. An clearly defined variant of the sparse signal representation is provided, which is particularly well-suited to the issue at hand. Through a battery of virtual and computational tests, the innovative method proves capable of obtaining "un-masked," second (or higher) harmonic pictures.

III. Methodology

To identify intracardiac tumours and thrombi in echocardiograms, this technique proposes a new approach. The innovation of this technique lies in the use of the kernel collaborative area based classification algorithm, which sets it apart from previous methods. The process includes breaking down the frame, automatically selecting ROIs, despeckling the whole image, segmenting intracardiac masses, extracting features, and finally, classifying the results. The video consists of several frames. Codes written in MATLAB are used to transform the recorded video into still images. When cardiologists diagnose a patient, they get echocardiography sequences. In order to analyse the movement of the intracardiac mass, the echocardiographic sequences are first separated into successive frames. Typically, an echocardiography sequence lasts about three or four seconds. This is a 39 fps frame rate. There are 480 × 640 pixels in each deconstructed frame. Not only does an echocardiogram show the scanned area, but it also shows labels and words that convey information about the patient and the scanning transducer. These letters and labels don't move at all, unlike a heart that beats in two consecutive frames. After two consecutive frames are subtracted, all static information is deleted, leaving just the sector scanned zone that contains the moving heart. Next, a rectangle enclosing the sector is located once the profile of the area scanned by the sector is recognised. Lastly, the scanned area is preserved for further study by cropping the original picture.

IV. Proposed Method

To identify intracardiac tumours and thrombi in echocardiograms, this technique proposes a new approach. The innovation of this technique lies in the use of the kernel collaborative area based classification algorithm, which sets it apart from previous methods. Phases such as frame decomposition, automatically selecting ROIs, despeckling on a global scale, segmenting intracardiac masses, extracting features, and classification are all part of it. In order to get a fine position with half the size of sub windows, the uniform sub windows are first searched in a coarse position. Once the intensity distributions of all the remaining subwindows are identical, the loop terminates. The chamber is often located close to the heart's centre in an echocardiogram taken from a short axis perspective. In order to pinpoint the exact location of each chamber, the precise position requires computing the Euclidean distance from each subwindow to the heart centre. This process eliminates unnecessary windows that are too far away.

V. Block Diagram

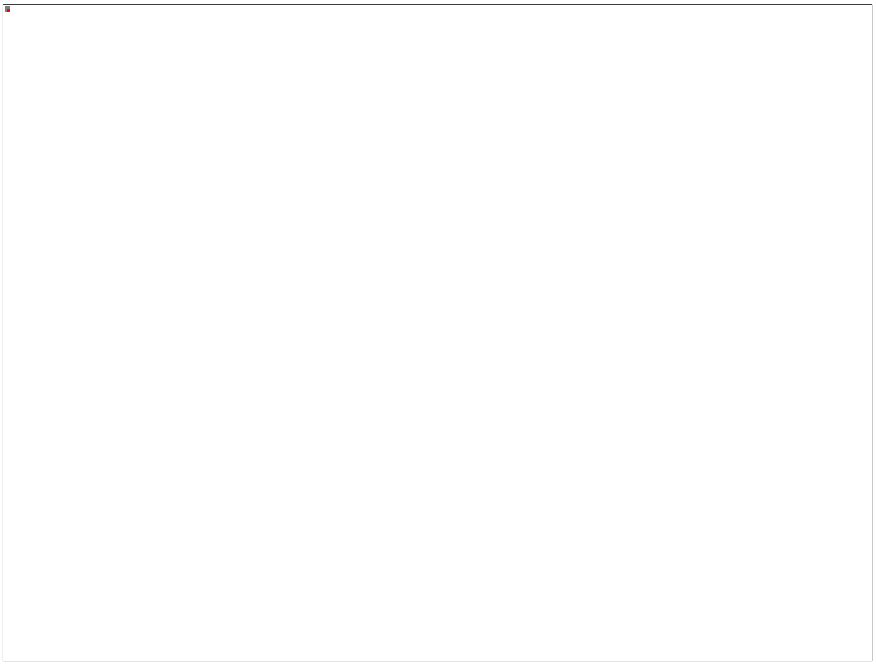

Fig. 1 Block Diagram of Workflow for the proposed classification method

VI. Conclusion

This research presents a novel approach to echocardiography-based intracardiac tumour and thrombi categorisation. Thanks to an automated coarse-to-fine technique, the mass area in ROI is perfectly delineated. Better noise attenuation and edge enhancement are achieved by the denoising process, which preserves the key cardiac features. The mass is segmented using the SLIC approach. We get quite near to the hand drawn outlines with our discovered ones. The suggested approach has nine elements that allow cardiologists establish a diagnosis before surgery. These features include the original features picked by the cardiologist, additional features with improved accuracy, and easy implementation. The method also serves as a realistic performance baseline for future study.

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