Cardiac MRI Image Analysis

Rachana Khairate[1], Aditi Laroiya[2], Prof.Dr. Nitin Palan[3]

***Abstract*— The research base for analysis of medical images for automatic detection of various diseases has immensely increased over the last decade. There are a number of researchers working in this field. The primary challenges faced by them are the amount of image data and the time required for analysis. Also, in case of images obtained by the MRI machine, sometimes there is a noise induced due to the internal noise of the machine. The objective of our study is to reduce the noise induced in the input images by using noise reduction techniques, and to implement segmentation techniques. We have used Atlas Based segmentation technique for segmenting the image. We have also implemented deep learning techniques in order to automate the segmentation process.**

***Index Terms*—Deep Learning, Left Ventricle, MRI, Template Matching.**

1) INTRODUCTION

Cardiovascular System is also known as vascular system or circulatory system which carries nourishment and oxygen to body, and waste along with carbon-di-oxide from various tissues as well as from various organs of the body. The location of heart is to the middle at upper portion of the chest. About one third portion of heart lies to right of the midline of body and rest part lies to left of the midline. Heart acts as dual pump, and consists of two chambered pump on both sides that is left side and right side. The upper chambers are input for pumps and are called as Arteries while lower chambers of heart are output for pump and are called as Ventricles. Blood is carried away from heart through arteries and brought back to heart from veins. Deoxygenated blood from upper as well as lower part of body is carried to right atrium of heart through superior as well as inferior vena cava respectively. Blood leaves right atrium through tricuspid valve and enters into right ventricle, and from right ventricle deoxygenated blood leaves heart through pulmonary artery through pulmonary semilunar valves. Vessels carry blood to lungs where carbon-di-oxide is given out and oxygen is taken in and oxygenated rich blood enters heart via lungs and pulmonary veins in left atrium and through mitral valves passes to left ventricle. Then oxygenated rich blood is circulated through body through Aortic Valves and this cycles repeats. Heart serves as a pump due to its ability to contract under electric stimulus. In adults with resting state pumps about three to five liters of blood per minute.

2) LITERATURE SURVEY

We have surveyed close to 30 papers from standard journals. Out of these, we had selected 4 papers to implement as a part of the study. [1], [2], [3], [4].

Effects of caffeine intake prior to stress cardiac magnetic resonance perfusion imaging on regadenoson-versus adenosine induced hyperemia as measured by T1 mapping:[1].This work aims at the effects of coffee or caffeine based products consumed before CMR imaging are studied.T1 mapping technique is used.

Impact of the cone operation on left ventricular size, function, and dyssynchrony in Ebstein anomaly:[2]. In this paper RV and LV volumes and ejection fractions are calculated. Feature tracking is used for measuring left ventricle circumferential and longitudinal strain. The results indicate that cone operation leads to reduced tricuspid regurgitation, RV and LV stroke volume. Further, they indicate improved left ventricle basal septal strain and ventricle synchrony.

A Mesh free Representation for Cardiac Medical Image Computing: [3].In this paper two methods, namely FEM and mesh free method are used. The main problem of noise during image acquisition is solved by using Kalman filter. Results indicate that mesh free method provides better accuracy than FEM.

A combine deep-learning and deformable model approach to fully automatic segmentation of left ventricle in cardiac MRI: [4].In this paper approach was to develop fully automated LV segmentation tool from short axis of the heart. For automatic detection of LV chamber they employed convolutional networks. Deep learning algorithm is used along with the deformable model.

3) SOFTWARE DESIGN

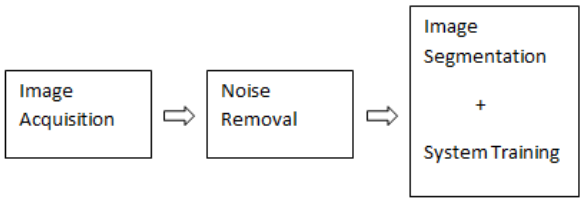

Fig.1.Detail Block

Table I. List of filters

Filter	Type of noise filtered
Median	Salt and Pepper, Poisson
Weiner	Gaussian, Speckle.
Gaussian	Gaussian.

A) Image Acquisition:

Image acquisition refers to obtaining the image by means of a camera. In this project, we shall be using the MRI images obtained from a database which is freely available online. This database is provided by Sunny Brook Health Centre, as a part of their Cardiac Atlas Project. The database consists of images of about 45 patients; some with normal heart conditions and some with abnormal conditions.

B) Noise filtering:

Mostly, in MRI images, Salt and Pepper, Speckle, Gaussian and Poisson noises are detected. These can be removed by the use of filters such as Weiner filter, Gaussian filter or Median filter.

C) Image Segmentation:

We shall use Atlas based segmentation technique for segmentation of the ventricle.

1) Template Matching.

2) Deep Learning.

D) Deep Learning:

In deep learning technique we have used segnetLayer function.segnetLayer is a deep full convolutional neural network mainly used for large number of classes.segnetLayer is also used in end to end pixel label classes. This technique helps to maintain consistency in diagnosis.

4) METHODOLOGY

A) Template Matching:

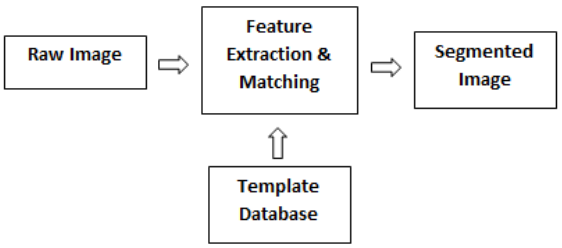

Fig.2.Block diagram for Template Matching

It is a technique in image processing, wherein small portions of an image match a template image. It is generally suitable for large data. This technique can be implemented on grayscale images. In our implementation, we provide two inputs to the Feature Extraction & Matching algorithm. We then calculate the cross-correlation or sum of absolute difference.

The first input is a set of raw images that need to be segmented. This is known as the search image. The other input is a template. The template is a part of the image that is to be searched.

Further, the center of the template is moved over each pixel in the search image and the sum of products between the pixels of search image and the template is calculated. The pixels with the highest score is considered the best position and marked in the search image.

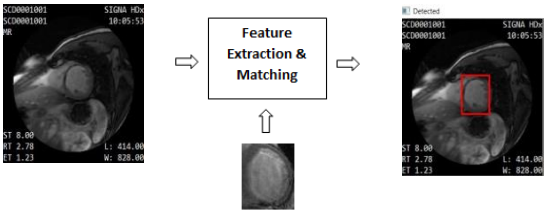

Fig.3.Results using Template Matching

B) Deep Learning:

Deep Learning is also known as deep based learning or hierarchical learning. Various architectures of deep learning such as deep neural networks can be used in various fields such as speech recognition, medical image analysis and in many more fields, which have been proven to produce results which are much more superior to human experts. Deep learning is used as a class of machine learning algorithms that can be used as supervised learning for classification and non-supervised learning for pattern analysis. We use this technique post the manual segmentation of the images in order to develop a system for automatic segmentation of the ventricle.

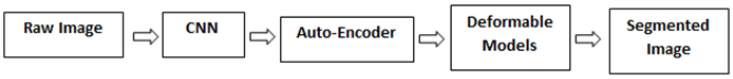

Fig.4.Block diagram for deep learning

1) Convolutional Neural Network:

The raw image is fed to the Convolutional Neural Network. The CNN passes the image through multiple layers. It first extracts the features from the image and then trains. It computes the Region Of Interest in the image.

2) Autoencoder:

Autoencoder is a type of unsupervised Artificial Neural Network. It learns and compresses the data and further reconstructs the encoded data. It is reconstructed very close to the input provided. It helps us to determine the shape of ROI.

3) Deformable Models:

Surfaces defined within an image that provide an abstract model of an object class by modelling the variability separately in shape, texture or imaging conditions of the objects in the class.

5) CONCLUSION

Atlas based segmentation is used for the segmentation of the ventricle. As template matching technique did not work for MRI images of all patients, we went ahead with deep learning technique. Accuracy of about 70 percent is achieved by deep learning technique.

6) RESULTS

6.1) Results using Template Matching:

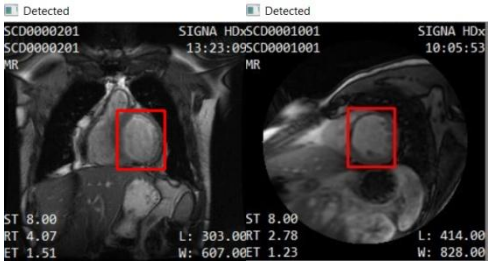

Fig.5.Template Matching

6.2) Results using Deep Learning:

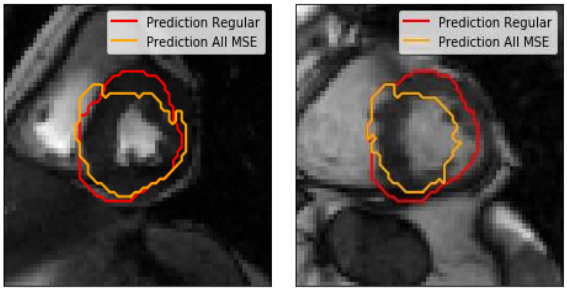

Fig.6.Deep Learning

6.3) Accuracy CNN:

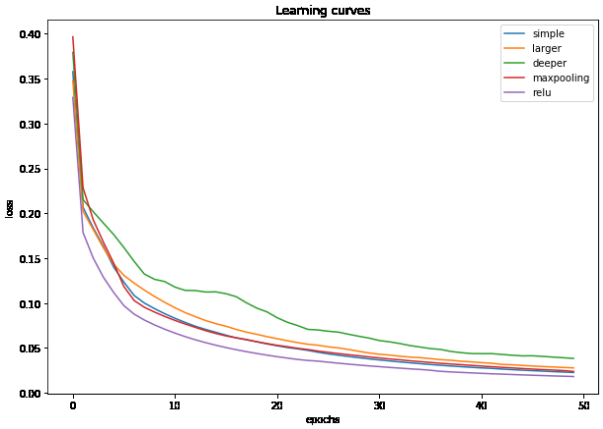

Fig.7.Accuracy CNN

7) REFERENCES

[1] R. van Dijk1,· D. Kuijpers,T. A. M. Kaandorp, P. R. M. vanDijkman,R.Vliegenthart1 · P. van der Harst1,· M. Oudkerk1," Effects of caffeine intake prior to stress cardiac magnetic resonance perfusion imaging onregadenoson-versus adenosine induced hyperemia as measured by T1 mapping",IJCI,2017.

[2] Impact of the cone operation on left ventricular size, function, and dyssynchrony in Ebstein anomaly: a cardiovascular magnetic resonance study Rebecca S. Beroukhim1,2,3* , Linyuan Jing4, David M. Harrild2,3, Brandon K. Fornwalt4,5, Abba Mejia-Spiegeler4, Jonathan Rhodes2,3, Sitaram Emani6,7 and Andrew J. Powell2,3.

[3] A MeshfreeRepresentation For Cardiac Medical Image Computing.

[4] A combine deep-learning and deformable model approach to fully automatic segmentation of left ventricle in cardiac MRI(2016).

[5] www.mriquestions.com.

[6] https://www.sciencedirect.com/science/article/pii/S1936878X15008670