INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Diagnosis of Heart Disease using Image Processing by Hybrid Cuckoo Algorithm

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Abstract: Heart disease is the major leading cause of death in most countries; hence the study of heart disease becomes crucial in today's world. Investigating and identifying this disease requires a lot of diagnosis and prediction which comes with high cost. In order to overcome this problem we need to prognosticate in earlier stages of the disease. This study is important because of the urgency in the need for a diagnosis of the disease. The image processing by the hybrid cuckoo algorithm (HCA) is presented here to diagnose and detect the disease in a more faster and efficient manner. The X-rays provided by angiography is preferably used for the diagnosis of the coronary artery disease (CAD) using image processing.

Keywords: Heart disease, Hybrid Cuckoo Algorithm, Diagnosis, X-ray, Angiography, Coronary Artery Disease.

I. INTRODUCTION

Obtaining true imaging is a crucial step in any diagnosis and it immensely assists the surgeon hence imaging plays a very important role in this study. If the imaging is disturbed or unstable it may create a bad impression on the individual. The techniques such as "interventional radiology" and "angiography" are carried out. "Interventional radiology (IR) signifies the range of techniques which depends on the radiological imaging guidance such as x-ray fluoroscopy, CT, ultrasound etc" (wikipedia). Many IR procedures begin with inserting a needle through the skin until the target. Such needle placement or insertion of the catheter (Figure 3) is performed under the "fluoroscopic guidance" here. This procedure requires skills such as manipulation of needles, fine use of catheter tubes and also interpretation of diagnostic image. These interventional techniques are quite complex and would require teams inclusive of doctors, nurses and skilled technologists to perform this procedure together.

For such interventional techniques, the most suitable example would be "angioplasty". Sometimes a blood clot in the arteries can instantly form or get worse resulting in a heart attack. In such situations "angioplasty" opens the congested blood vessel and reinstates the normal flow of blood into the heart.

Such image guided techniques would eventually replace the requirement of anaesthesia and surgery in many cases. And also for many such surgeries, the surgeon will require better imaging and high proficient diagnosis. Hence by using image processing with HCA the true imaging can be formed. The canny edge detector assists in detecting the blockages of cardiac and watershed image processing algorithms that are implemented on FGPA [1].

Here we use angiography images for image processing since it is considered to be more accurate method.

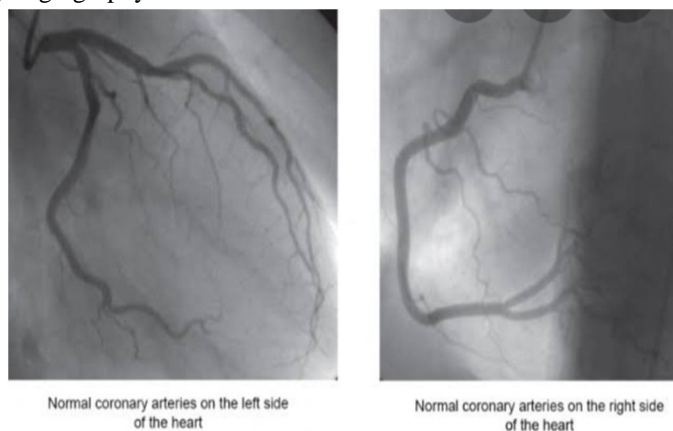Figure 1 below shows the coronary angiography.

Normal coronary arteries on the left side of the heart

Normal coronary arteries on the right side of the heart

Figure 1: Coronary angiogram of the heart.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

Cardiovascular diseases are the primary cause of mortality and morbidity. Figure 2, shown below indicates the typical cardiovascular disease is coronary artery disease.

The "variant" filtering is considered as the best preprocessing method in which each pixel is replaced by an average of 3×3 neighbour having the least variance value [2].
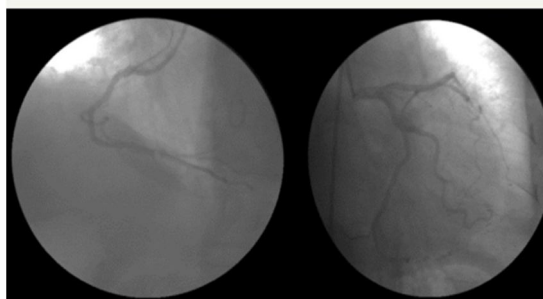

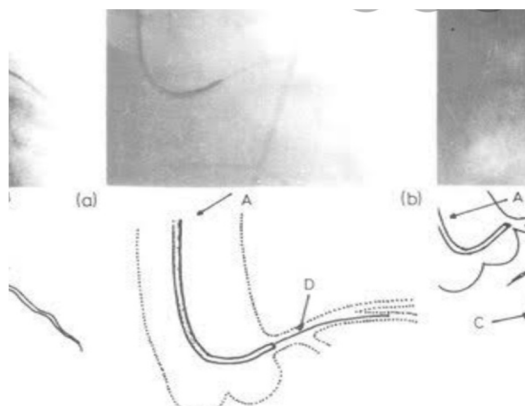Figure 2: Frames of coronary angiology

Figure 3: A coronary angiography catheter.

II.   LITERATURE SURVEY

In paper [3], "Heart disease diagnosis using image processing by cuckoo algorithm", 2018 – The heart disease is diagnosed using the image processing technique by the cuckoo algorithm. The algorithm used in this research is a bio-inspired algorithm. This technique showed speed and accuracy better than edge detectors. But the algorithm used has less speed of execution than the hybridized cuckoo algorithm.

In paper [4], "Hybrid decision tree fuzzy rule based classifier for heart disease prediction using chaotic search algorithm", 2017 – The heart disease is predicted by chaotic search algorithm. In this research it is proved that the efficiency of its classification of heart disease prediction provides accurate results than other classifiers. But the algorithm involved in this is quite complex.

In Figure 4, the graph for accuracy prediction of heart disease is shown. It compares various accuracy results in evaluation matrix [4].
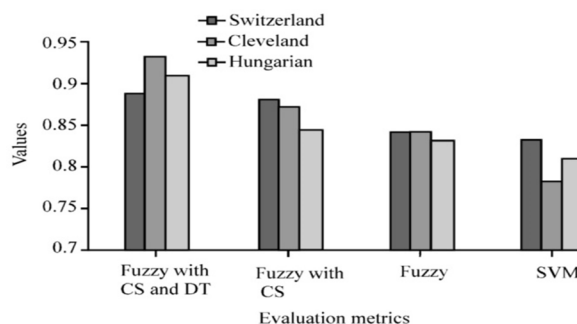

Figure 4: Graph of accuracy comparison result

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In paper [1], "Design and implementation process algorithms for cardiac blockage detection on FGPA and and by means of canny edge detector and watershed processing algorithms", 2016 – The proposed system facilitates in the detection of "cardiac blockage". The result obtained by using the canny edge detector is less efficient than any other cuckoo algorithm for detecting the edges.
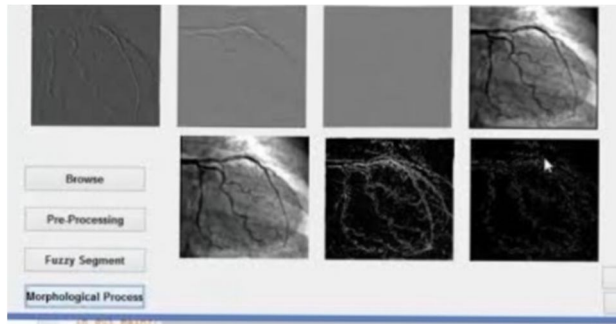

Figure 5: Blood vessel segmentation in angiogram.

III. HYBRID CUCKOO ALGORITHM

The HCA uses a new hybridization method where the entire population is divided among two groups. One group uses the cuckoo algorithm [CA] and the other uses the adaptive cuckoo algorithm, which are bio- inspired algorithms. It is observed that HCA results in better solution than CA and ACA [4].

Let Gr1 and Gr2 be two groups with n1 and n2 nests respectively.

$Gr1 = \sum_{i=1}^{ns_1} Y_i$ where ns_1 = round (N÷2)

$Gr2 = \sum_{i=1}^{N} Y_i$

A. Procedure

The HCA

Begin

Let Fitness function be f(Y), Y= $(Y_1,...,Y_i^D)$

Generation, t=1

For i=1 to N do

Initialize N nests with Y_i solution randomly using Y_i= lb+ (ub-lb)*rand (D), where lb and ub are lower bound and upper bound of optimization function.

Calculate the fitness (f_{max})

End For

Determine the best nest and fitness (f_{max})

While (maximum no. Of generation not reached)

1) Divide the N nests into two groups Gr1 and Gr2 with n1 and n2 nests respectively
2) For n1 cuckoos in Gr1, generate new solution using $Y_i(t+1)= Y_i (t)+\alpha.$Lèvy$(\lambda)$
3) Levy $(\lambda)= \beta.S,$
4) where β=factor that is used to control the step length algorithm
5) $S=u.|v|^{-1/\lambda}$
6) where u and v are taken from the normal distribution
7) For n2 cuckoos in Gr2,
8) Generate new sol using $Y_i(t+1)= Y_i(t)+$randn.Step$_i(t+1)$
9) where Step$_i(t+1)=(1/t)^{|bf(t)-fi(t)|/|bf(t)-wf(t)\backslash|}$
10) f(t) is the fitness value over generation t,
11) bf (t) is the best fitness over generation t.
12) wf(t) is the worst fitness over generation t.
13) Combine Gr1 and Gr2 cuckoos together to form N nests
14) Evaluate the fitness for the cuckoo f_i
15) Select a nest among N (say j) randomly

If ($f_i < f_j$)

    $Y_j = Y_i$ $f_j = fi$

  End if

Consider fractions, Ea of worst solutions are deleted and newer solutions are constructed.

Retain the best solution.

Evaluate and rank the solutions and search for the best current f_{new}

If $f_{new} < f_{max}$

    $f_{max=} f_{new}$

End

Increment the generation by $t = t+1$

End while

End.

IV.IMPLEMENTATION

The HCA for the image processing:

The algorithm involves following steps-

1) Step 1: Conversion of angiogram image into matrix form, each value of the image pixel is in the range of 0-255 gray-scale.

2) Step 2: Apply the non-linear variant filtering.

3) Step 3: Application of the noise reduction method.

4) Step 4: Obtaining the histogram sample and equalization.

5) Step 5: The process has to be repeated.

6) Step 6: The angiogram to be detected using HCA for optimizing the edges.

7) Step 7: To obtain the best result repeat the process.

8) Step 8: Apply optimization and update the parameters of the HCA.

9) Step 9: The above process must be repeated.

The output images will show the edges of angiogram of blood vessels using this algorithm to be more efficient than the other edge detection like canny edge detection.

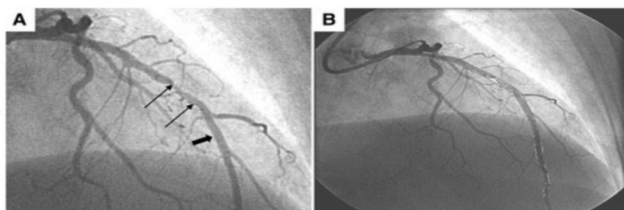Hence this algorithm can be developed to diagnose the heart disease efficiently.

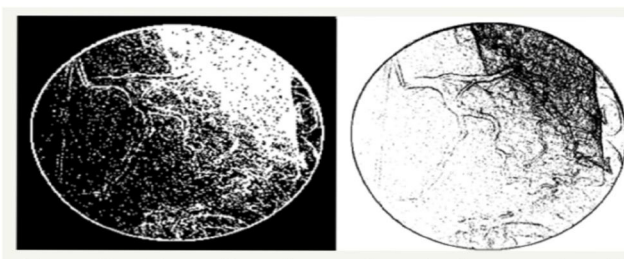Figure 6: Coronary angiogram before and after digital processing.

Figure 4: Edge detection and negative edge detection

The Figure 4 above shows the result of one cardiac frame. Using this method one can yield improved results [3].

V. APPLICATION AND FUTURE WORK

The proposed system provides very good accurate results in diagnosis of the heart disease. The image guided technique would replace the requirement of general anaesthesia and sometimes also surgery. Faster detection and diagnosis of the disease before surgery. The proposed algorithm assists in faster execution and shows better accuracy in the outcomes. If any disease is predicted through this procedure, various suitable precautions and treatment can be suggested as a future implementation.

VI. CONCLUSION

The HCA shows a significant improvement in the execution time and also efficiency. The proposed approach starts with preprocessing which removes noisy data in the image effectively. It results in a highly effective detection and diagnosis of blockage of arteries (blood vessels). Enhancement in the quality of the image by using the various preprocessing steps, filtering, noise reduction and HCA. Thus the hybridized CA outperforms the other algorithms with greater accuracy.

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