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Brain Region Segmentation using Low MSE based Active Contour Model and Convolutional Neural Network

Ayushi Sharma[1], Sachin Jain[2]
[1]Research Scholar, Sunder Deep Engineering College, Ghaziabad, India, subydewan@gmail.com
[2] Assistant Professor, Sunder Deep Engineering College, Ghaziabad, India, sachincs86@gmail.com

ABSTRACT

The brain region segmentation techniques are a major concern for researchers. The input in these are taken from MRI images, which are then fed on neural network-based algorithms in recent times. Many neural network-based techniques are developed earlier with high accuracy but the error is not much reduced. In this paper, a method is proposed with low mean square error in convolutional neural network by adding active contour model-based process for snake segmentation with currently existing CNN technique. The benefit for which is calculated as it shows very low Mean Square Error and high sensitivity with nearly similar accuracy and specificity. The software coding is performed using MATLAB software and results are using the test image. The main performance metrics taken into consideration are accuracy, sensitivity, sensitivity and mean square error. The proposed algorithm proves to be beneficial in terms of all parameters. The mean squared error is reduced and sensitivity is also improved.

Key words : Brain Region, Segmentation, CNN, Neural Network, Active Contour Model.

1. INTRODUCTION

Brain region segmentation is an important field of study, several methods in image processing are developed by researcher. Segmentation is the most important method for the image processing in the medical sector [12]. This paper focuses on CNN based techniques and proposes a new technique with combination of Active Contour Model. The MR images are first given to pre-processing venture to improve the nature of image for division. Right now, Local Mean Filter is utilized for image denoising which computes weighted normal of pixels and discovering comparability with the objective pixel. It comprises of four stages[1]. Figure 1 shows the stream graph of existing system. There are two phases: pre-processing and division by means of Convolutional Neural Network (CNN).

A CNN is not quite the same as the conventional back proliferation neural network on the grounds that a BPN chips away at removed handmade image highlights though, a CNN works legitimately an image to separate helpful, and vital highlights for division. A CNN comprises of various convolutional layers, pooling layers and completely associated layers followed by one order layer [2]. At the point when the size of the image is given as contribution to the CNN include maps are delivered by convolving the image with the channels [3]. Each guide is sub-tested regularly with mean or max pooling layers. Sub testing rate as a rule differs from two to five. After the convolutional layers, there might be any number of completely associated layers. The usage steps are input age, developing the profound network, preparing the profound network and extricating the educated highlights. CNN should be possible in three different ways [4]. The main strategy is to fabricate and prepare the CNN to acquire highlight [5]. The subsequent technique is to use "off-the-rack CNN highlights" without retraining the CNN. The third technique is to utilize CNN in adjusting the outcomes got utilizing profound learning model. In each concealed layer one convolutional layer and one pooling layer are available trailed by one completely associated layer [11]. It consolidates all the highlights learned by the past layer over the image to recognize the bigger example.[6]– [10], Figure 1 shows existing CNN method.

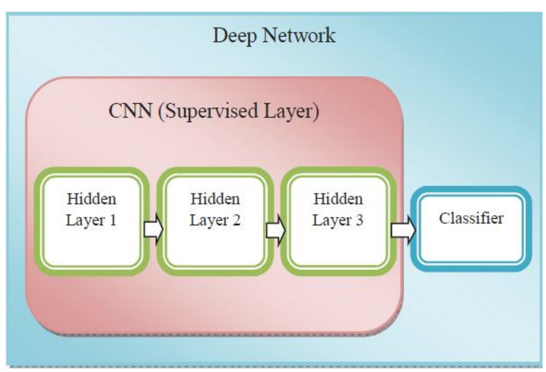

Figure 1: Internal layers of CNN [1]

2. IMPLEMENTATION

In this section, the proposed work is explained. the idea of proposed work is to make a new algorithm by applying active contour model in snake segmentation method for initial segmentation process and then applying CNN to improve the specificity and mean squared error. In the further sections, active contour model segmentation process is obtained and convolutional neural network is explained with final algorithm and flowchart. And further results are presented for both only existing convolutional neural network and proposed one with active contour model and CNN. The results will be analyzed in the following images shown in Figure 2.

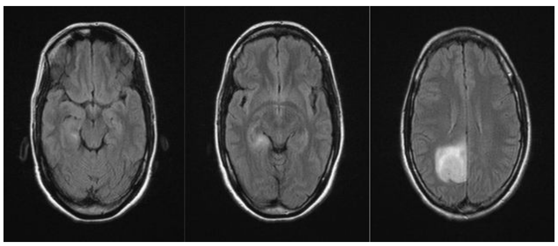

Figure 2: Input Images from MRI

In the above Figure, for this paper, the first image is input 1, the second is input 2 and the third one is input 3.

2.1 Algorithm for Proposed Work

- Input images using user interface. MRI images are added.
- Image is converted to gray scale for processing work.
- Noise removal is performed using Gaussian filter
- Snake segmentation process is initiated by defining vector parameters such as mu and lambda.
- Firstly, edge detection using Gaussian filter and gradient calculation on color map is defined.
- Applying active contour model using minimization mex to define the texture features.
- Calculation of inside and outside means using the ACM model.
- The output image acquired using the above process is the tested for CNN further.
- Using NLM, is applied for noise removal further.
- Applying CNN model by semantic segmentation technique in MATLAB.
- Final output images are taken for analysis for performance metrics such as Accuracy, Specificity, Sensitivity and mean squared error.
- In Figure 3, the block diagram for flow chart of proposed algorithm is shown.

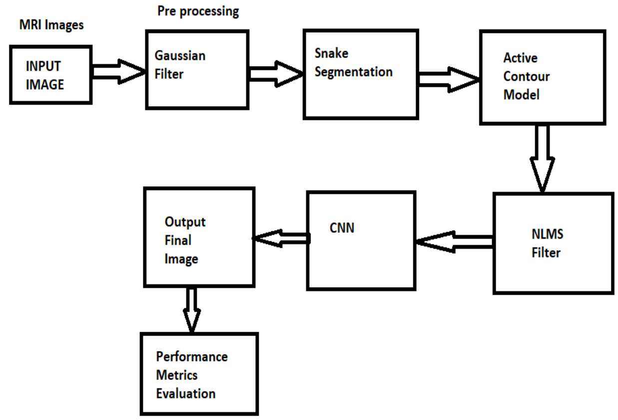

Figure 3: Proposed Algorithm Flowchart

3. RESULTS

In this section, results obtained in MATLAB software processing are shown in the form of initial input images, pre-processing images and final outputs. The proposed technique is ACM (Active Contour Model) and Convolutional Neural Network combined also abbreviated as ACM-CNN in this paper.

In this section, proposed technique is tested on the input images. In Figure 4, input 1 is given for ACM part.

Figure 4: Input 1 detected for Snake Segmentation ACM

Figure 5 is showing the output of input 1 in ACM stage. Now this image is given to CNN in next part.

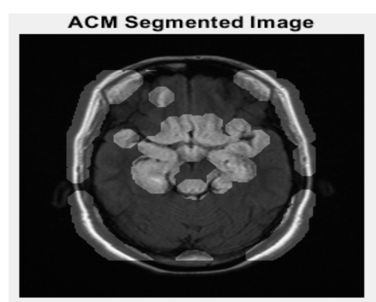

Figure 5: Input 1 ACM Output

In Figure 6 the ACM output is now input to CNN, which gives the final detected regions

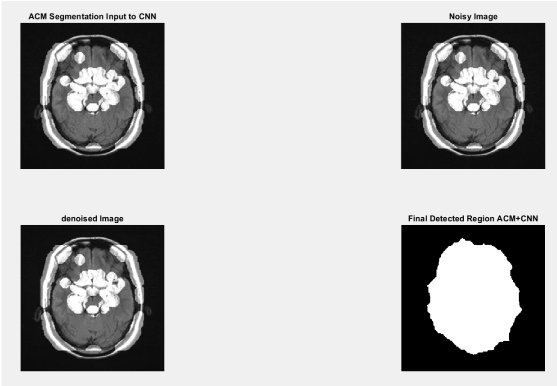

Figure 6: Input 1 CNN Final Step Output

Fig. 7 is the final output for input image 1, which shows greater region than the previous existing technique.

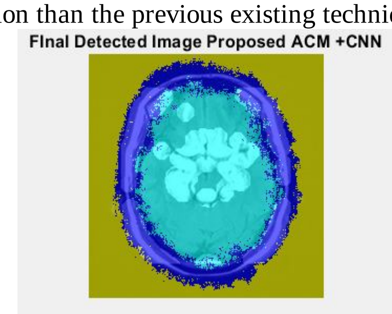

Figure 7: Input 1 ACM-CNN Final Detected Output

In Figure 8, input 2 is given for ACM part.

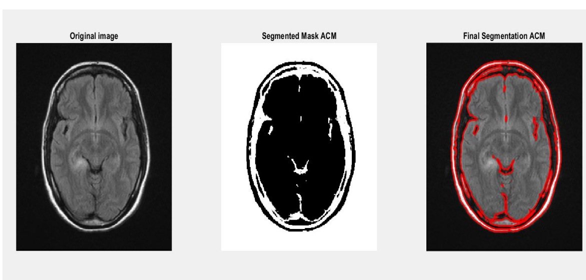

Figure 8: Input 2 detected for Snake Segmentation ACM

Figure 9 is showing the output of input 2 in ACM stage. Now this image is given to CNN in next part.

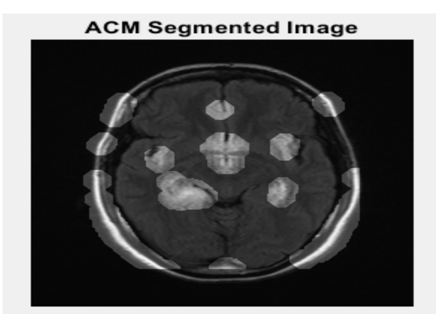

Figure 9: Input 2 ACM Output

Figure 10, shows the CNN output stage for ACM output in previous stage.

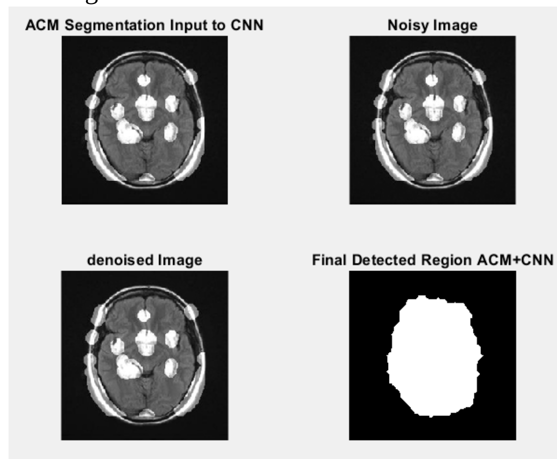

Figure 10: Input 2 CNN Final Step Output

Figure 11 shows the final output for input 2 in ACM CNN technique or proposed technique.

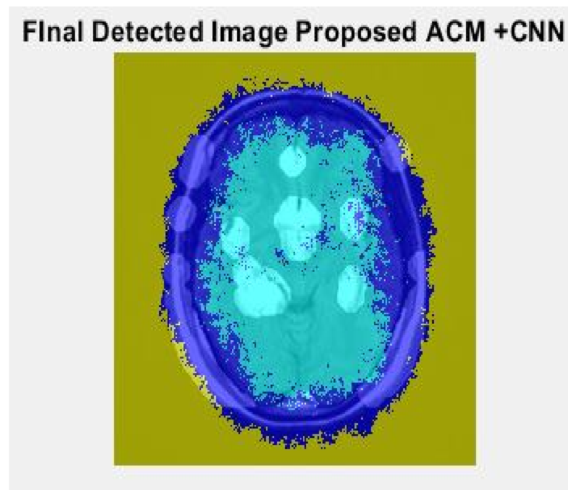

Figure 11: Input 2 ACM-CNN Final Detected Output

In Figure 12, input 3 is given for ACM part.

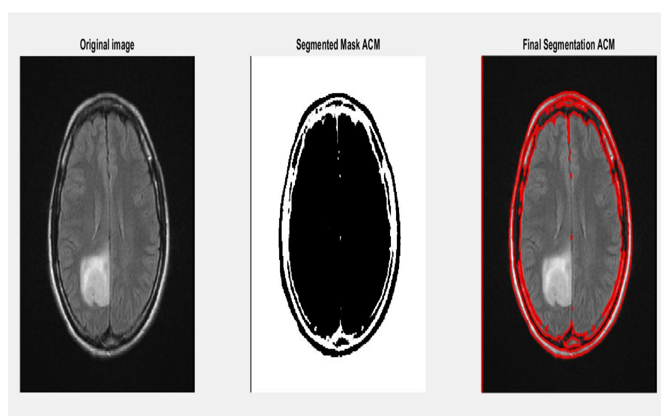

Figure 12: Input 3 detected for Snake Segmentation ACM

Figure 13 is showing the output of input 3 in ACM stage. Now this image is given to CNN in next part.

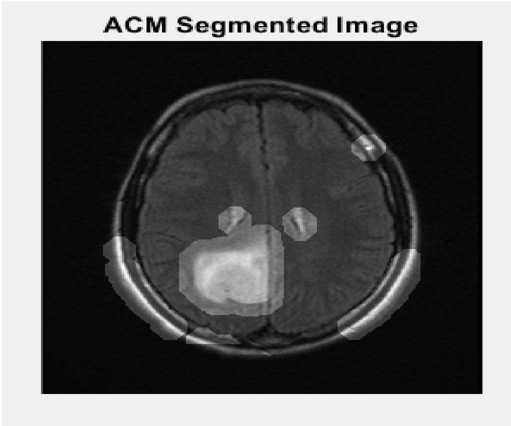

Figure 13: Input 3 ACM Output

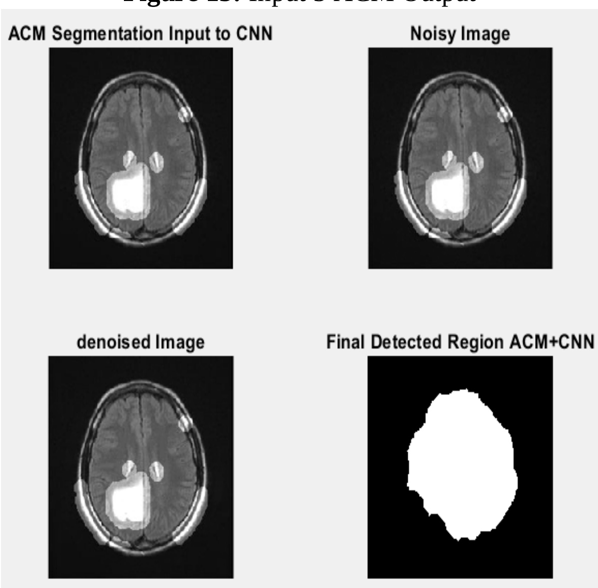

Figure 14: Input 3 CNN Final Step Output

In Figure 14, input 3 CNN stage output is shown. And in Figure 15 input 3 final detected region is shown.

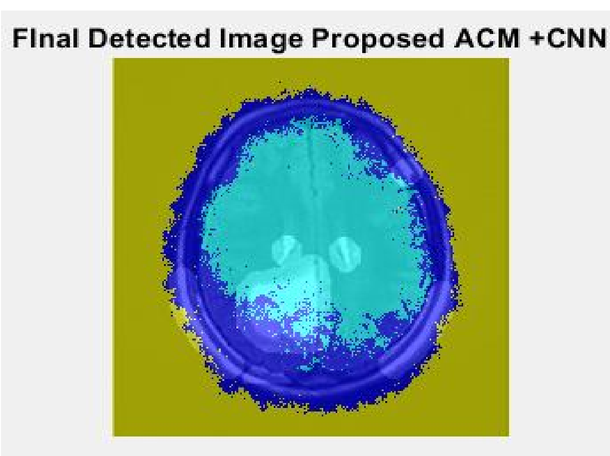

Figure 15: Input 3 ACM-CNN Final Detected Output

The two techniques are compared in this section by the following parameters:

- Accuracy (%)
- Specificity (%)
- Sensitivity (%)
- Mean Squared Error

In table 1, the output comparison table for CNN and ACM CNN proposed are shown: here average of all inputs are taken.

Table 1: Comparison table for CNN and ACM-CNN proposed work

	Average Accuracy %
CNN	95.33
ACM+CNN(Proposed)	95.33
	Average Specificity %
CNN	97.33
ACM+CNN(Proposed)	95.33
	Average Sensitivity %
CNN	91
ACM+CNN(Proposed)	94
	Average MSE
CNN	0.00013325
ACM+CNN(Proposed)	1.80E-05

In Figure 16, average accuracy graph is shown, which is same for both techniques.

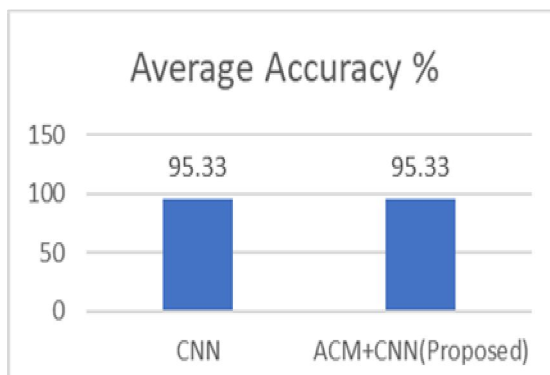

Figure 16: Average Accuracy Graph Comparison

In Figure 17, average sensitivity graph is shown, which is higher in proposed algorithm.

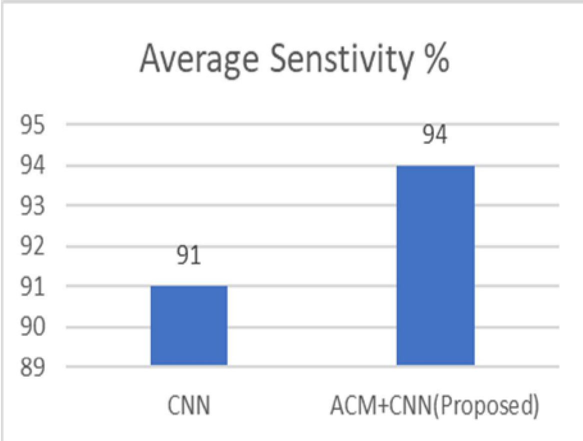

Figure 17: Average Accuracy Graph Comparison

In Figure 18, average specificity graph is shown, which is almost same in both algorithms.

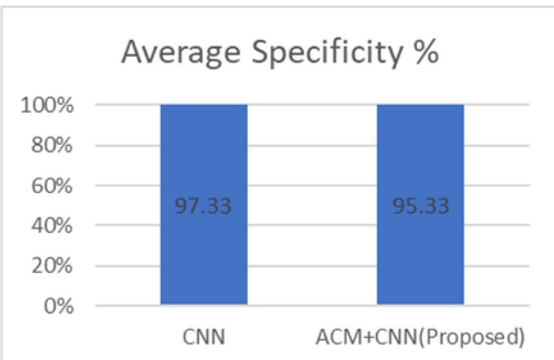

Figure 18: Average Specificity Graph Comparison

In Figure 19, average mean squared error is shown, which is lowest in proposed algorithm.

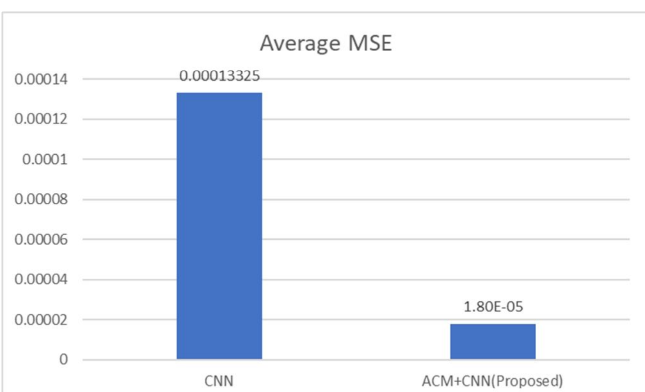

Figure 19: Average Mean Squared Error Graph Comparison

4. CONCLUSION

In this paper, implementation of active contour model with convolutional neural network is proposed and named as ACM-CNN technique for brain region detection. The proposed work proves to be beneficial in terms of high sensitivity and mean squared error. Rest parameters are comparable to CNN technique, which is the latest best technique. Hence, improvement in CNN is achieved by adding active contour model simulation in the input images. The technique also structures the brain region into inner and outer means, for proper edge detection for brain region, which is then passed though the CNN function for further processing and noise cancellation through NLMS noise filter

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