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AUTOMATED CLASSIFICATION AND SEGREGATION OF BRAIN MRI IMAGES INTO IMAGES CAPTURED WITH RESPECT TO VENTRICULAR REGION AND EYE-BALL REGION

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Abstract
Magnetic Resonance Imaging (MRI) images of the brain are used for detection of various brain diseases including tumor. In such cases, classification of MRI images captured with respect to ventricular and eye ball regions helps in automated location and classification of such diseases. The methods employed in the paper can segregate the given MRI images of brain into images of brain captured with respect to ventricular region and images of brain captured with respect to eye ball region. First, the given MRI image of brain is segmented using Particle Swarm Optimization (PSO) algorithm, which is an optimized algorithm for MRI image segmentation. The algorithm proposed in the paper is then applied on the segmented image. The algorithm detects whether the image consist of a ventricular region or an eye ball region and classifies it accordingly.

Keywords:
Brain MRI Images, Automation in MRI, Ventricular Region, Eyeball Region

1. INTRODUCTION

In this fast moving world most of our daily life activities are being computerized. Medicine is one of the fields, being automated at a constant pace. Automation in this field will increase accuracy and efficiency.

Automatic detection of brain tumor is one of the trending and challenging technologies, being evolved in the field of medicine[1]-[4]. In this technology mostly MRI images are used. Segregation of the brain MRI images into images captured with respect to ventricular regions and eye ball regions aids in easy classification of tumor, based on the location of the tumor region. Different types of tumor are present in different regions of the brain, among which some are visible in MRI images of brain captured with respect to ventricular region while some are visible in MRI images of brain with respect to eye ball region. Hence segregation of the images at the initial level of detection of diseases proves helpful. The work in the paper deals with the pre-processing that is to be performed on the image before applying the algorithm for the classification of the images [5], the algorithm that is used in identifying whether the image consists of an ventricular region or an eye ball region, the steps involved in the segregation of the images and the impact of the classification.

2. RELATED WORK

The first step to be performed is segmentation of the given brain MRI image [5]. There are a lot of algorithms to perform segmentation [6]-[8]. Particle swarm optimization (PSO) algorithm is an efficient algorithm to segment brain MRI images [9]. It is an algorithm based on population based optimization. The algorithm uses a number of particles that constitute a swarm moving around in the image looking for the best solution [10]. The performance of each particle, i.e., how close the particle is from the global optimum, is measured using a fitness function which depends on the optimization problem. Each particle *i* flies through the *n*-dimensional search space and maintains the information of its current position, the personal best position of the particle and the current velocity of the particle [11]. In the algorithm each particle in the image adjusts its movement according to its own movement as well as the movement of the other particles. Each swarm maintains its global best position while each particle maintain its individual best position. Initially, the swarm is initialized from the solution space. Then the fitness of each particle is evaluated. The individual particle best and global best are updated using the formulae given below (Eq.(1), Eq.(2)). Then the velocity and the position of the particles are updated using the formulae given below (Eq.(3), Eq.(4)). The steps are repeated until the optimization condition is achieved.

If f denotes the fitness function, then the personal best of particle (i) at a time step(t) is updated as:

$$p_i(t+1)=\begin{cases} p_i(t) & \text{if } f(x_i(t+1)) \geq f(p_i(t)) \\ x_i(t+1) & \text{if } f(x_i(t+1)) < f(p_i(t)) \end{cases} \quad (1)$$

$$gbest \in \{p_0(t), p_1(t), ..., p_m(t)\} = min\{f(p_0(t), f(p_1(t)), ..., f(p_m(t)\} \quad (2)$$

where, *gbest* is the position of the particle global best.

The velocity of the particle *i* is updated using the equation,

$$v_i(t+1) = wv_i(t) + c_1r_1(p_i(t) - x_i(t) + c_2r_2\, gbest - x_i(t)) \quad (3)$$

The position of the particle i is updated using the equation,

$$x_i(t+1) = x_i(t)+v_i(t+1) \quad (4)$$

where, w is the inertia weight

c_1 and c_2 are the acceleration constants

r_1 and r_2 are random numbers in the range [0,1]

3. PROPOSED ALGORITHM

The proposed algorithms are applied on the segmented brain MRI images to classify them.

3.1 ALGORITHM TO DETECT THE PRESENCE OF EYE BALL REGION IN THE GIVEN BRAIN MRI IMAGE

a. The segmented image is received as an input.
b. The image is then complimented. [Complementation of the image is necessary since at each step the isolation of the required region is done in white. Complementation is especially performed on trans dark fluid images].

c. The complemented image is then converted to a binary image with a high threshold value.
d. The complemented image is tested for the presence of circles whose radius lie between the minimum and maximum value arbitrarily fixed based on the resolution of the test image.
e. The radius and centre of all the circles present in the image are found and are taken into consideration.
f. The circles are tested for their presence in the upper region of the image.
g. Overlapping among the identified circles is tested [occurs when the eye ball is slightly elliptical]. This is performed by considering two circles at a time, on all combinations, by comparing their centre and radii.
   i. *if*, $d > r_1 + r_2$
   ii. *then* the circles do not overlap
   iii. *else*,
   iv. the circles overlap.
   v. where,
   vi. d is distance between c_1 and c_2.
   vii. c_1 is the centre of the first circle.
   viii. c_2 is the centre of the second circle.
   ix. r_1 is the radius of the first circle.
   x. r_2 is the radius of the second circle.
h. Finally, if the number of circles present in the image is exactly equal to two, then the given input image has an eye ball region.

If the image does not have an eye ball region then we move on to test the image for the presence of ventricular region in the brain MRI image. The eye ball region in the image is encircled and shown in the Fig.1.

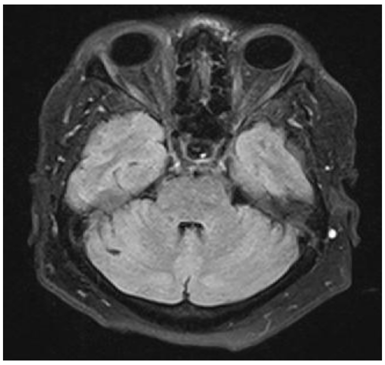

Fig.1(a). Original Segmented Image

Fig.1(b). Eye ball Detected image

3.2 ALGORITHM TO DETECT THE PRESENCE OF VENTRICULAR REGION IN THE GIVEN BRAIN MRI IMAGE

a. The segmented image is received as an input.
b. The image is then complimented. [Complementation of the image is necessary since at each step the isolation of the required region is done in white. Complementation is especially performed on trans dark fluid images].
c. The complemented image is then converted to a binary image with a high threshold value.
d. Using the binary image, the number of objects in the image is calculated. Four connectivity is used and the region is considered as an object only if it occupies more than 100 pixels.
e. The centroid for all the objects is calculated.
f. Distance between the centroid of each and every object is calculated.
g. The minimum distanced object is found and these are the ventricular regions. The ventricular regions are isolated and separately shown (Fig.2).

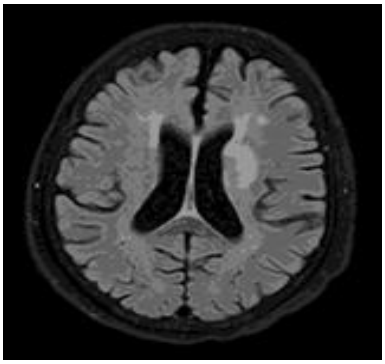

Fig.2(a). Original segmented image

Fig 2(b). Intermediate image

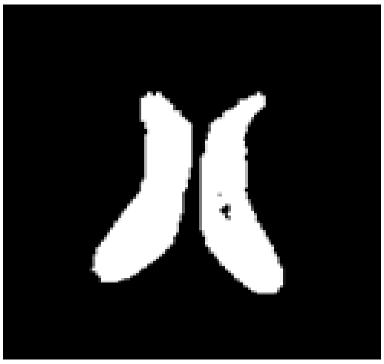

Fig.2(c). Ventricular region detected image

4. WORKING OF THE SYSTEM

The system deals with the segregation and classification of the given brain MRI images into images captured with respect to ventricular region and images captured with respect to eye ball region. Brain MRI images that are to be classified and segregated are provided as input to the system. The system gets the input one by one and performs the operations on each image. The system performs segmentation of the image using PSO algorithm. The segmented image is checked for the presence of eye ball region by applying the above proposed algorithm for detection of eye ball region, on the image. If the image does not contain an eye ball region, then is tested for the presence of ventricular region by applying the above proposed algorithm for the detection of ventricular region. The images that contain eye ball region are placed in a separate folder while the image containing ventricular region are placed in another folder.

The complete working of the system is shown in the flow chart given below (Fig.3).

5. CONCLUSION

The proposed system is a step taken towards automation in the field of medicine. This system aids in analysis of brain MRI images. It helps automatic diagnosis of diseases in brain. This system can be used as an initial step in automatic detection of diseases, such as tumor, in brain MRI images.

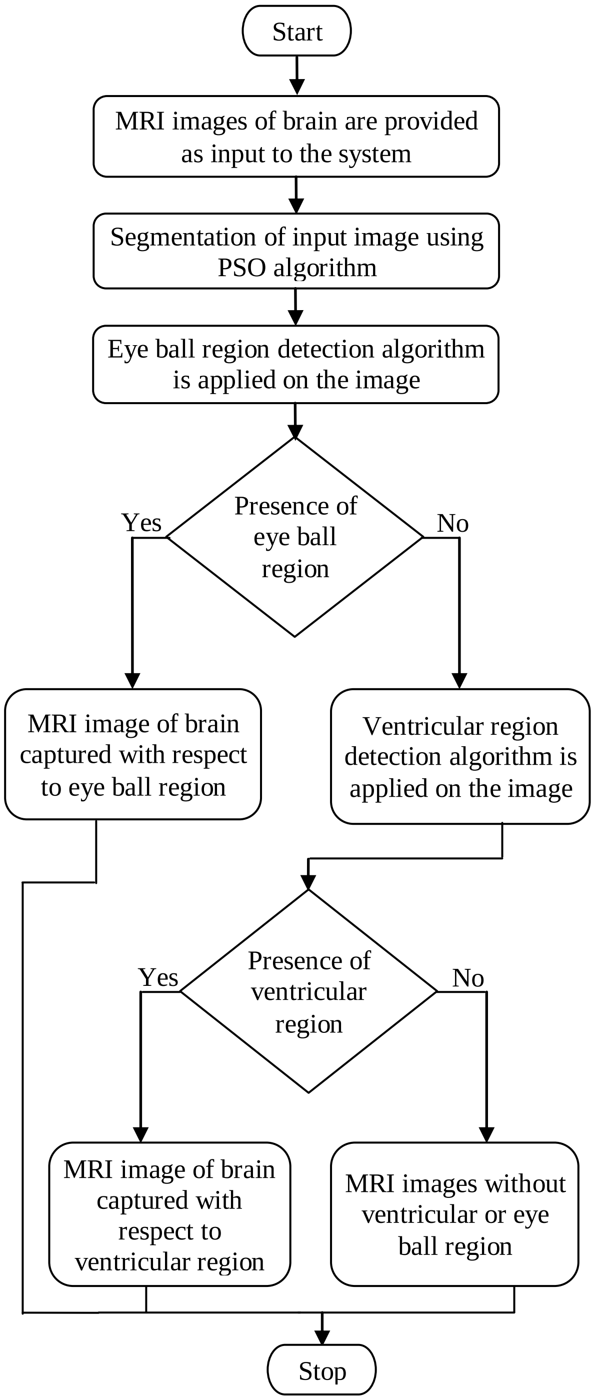

Fig.3. Flow Chart

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