Identifying Tumors in MRI's with Fuzzy C-Means Algorithm

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***Abstract*—This document is intended to prove the use of the Fuzzy C-Means algorithm in identifying tumor regions in MRI's.**

I. Introduction

Magnetic resonance imaging (MRI) of the body uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of the inside of your body. It may be used to help diagnose or monitor treatment for a variety of conditions within the chest, abdomen, and pelvis [1], and for this experiment, the brain. The goal is to use image segmentation algorithms, in this case Fuzzy C-Means, to successfully separate the pixels correlating with a tumor region from the rest of the given scan.

II. Introduction to Fuzzy C-Means Algorithm

Fuzzy C-Means is a clustering algorithm that permits one piece of data to belong to one or more clusters [2]. Fuzzy C-Means is based on the following function:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_v^m \|x_i - c_i\|^2 \tag{1}$$

where m is a real number greater then 1 and u_{ij} is the degree of membership of x_i in the cluster j, x_i is the i^{th} of d-dimensional measured data, c_j is the d-dimension center of the cluster, and $\| * \|$ is any norm expressing the similarity between any measured data and the center [2]. The "Fuzzy" piece of this algorithm slightly modified the above equation in order to allow a single data point to belong to multiple clusters instead of just one.

III. Implementing Fuzzy C-Means

Implementing Fuzzy C-Means via Matlab is an efficient method of making use of this algorithm, using the built in $[centers, U] = fcm(data, Nc)$ method, where data is a $N * P$ matrix of data to be clustered, and Nc is the number of clusters to create. The result of this method is centers, a matrix of Nc rows containing the coordinates of each cluster center, and U, the Fuzzy partition matrix, returned as a matrix with Nc rows and Nd columns. Element $U(i, j)$ indicates the degree of membership of the j^{th} data point in the i^{th} cluster. Each cluster taken from this method contains a portion of the original MRI scan, highlighting a certain part.

Inspecting each image, the tumor regions visible to the eye are clearly much more red then the rest of the image. Using this knowledge alongside the newly partitioned images, taking the subimage with the highest average red value, we can conclude that that image is the cluster with the tumor highlighted.

IV. Experimental results and discussions

Applying a single image from the MRI scan, shown below.

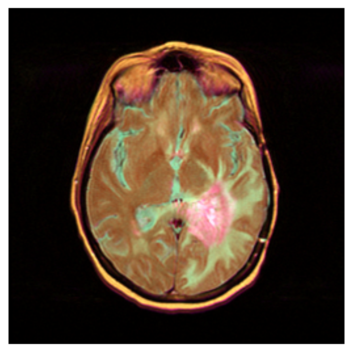

Fig. 1. Original MRI

to the Fuzzy C-Means algorithm, it was successfully able to identify and highlight the tumor region visible in the original scan, shown below.

Fig. 2. Highlighted Tumor

On some runs using this algorithm, it was unable to find the tumor. In the number of times testing this against the given MRI images it was able to find the tumor more times then not, especially with a higher cluster count.

V. Conclusion

Using Fuzzy C-Means to identify and highlight tumor regions in MRI's was a success. Being able to identify such regions is incredibly important and could possibly help to save the lives of those suffering from such tumors.

References

[1] https://www.radiologyinfo.org/en/info/bodymr

[2] https://matteucci.faculty.polimi.it/Clustering/tutorial_html/cmeans.html