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Recognizing Focal Liver Lesions (FLL) using Fuzzy C-means (FCM) Algorithm and Level Set Method (LSM)

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Abstract: Liver cancer is one of the real death factors on the planet and furthermore known as hepatic tumor; it is a disease which begins in the liver, and not from another organ which at last goes to the liver. At the end of the day, there might be tumors which begin from elsewhere and wind up in the liver - those are not (essential) liver malignancies. By chance discovered central liver sores are a typical finding and an explanation behind referral to hepatobiliary benefit. They are frequently found in patients with history of liver cirrhosis, colorectal tumor, by chance amid work up for stomach torment or in an injury setting. The medical image segmentation and tumor detection process is done by following the three significant steps. The first step is to obtain clusters utilizing Fuzzy-C-Means(FCM) algorithm. Using FCM algorithm collecting data points and indicating the centroid then collect the number of centroids in the given images. Second step is to process and section a given medical image using level set method. The third step is to calculate area of segmented image and classify type of result.

Keywords: FCM, LSM, ZLS, AUC_G, AUG_I

I. INTRODUCTION

Liver disease is one of the significant demise factors on the planet and furthermore known as hepatic malignancy; it is a growth which begins in the liver, and not from another organ which at last goes to the liver. As it were, there might be tumors which begin from elsewhere and wind up in the liver - those are not (essential) liver diseases. Diseases that start in the liver are known as essential liver tumors. Liver disease involves harmful hepatic tumors (developments) in or on the liver. The most widely recognized kind of liver growth is hepatocellular carcinoma (or hepatoma or HCC), and it tends to influence guys more than females. Early discovery and precise introduction of liver malignancy is a huge issue in functional radiology. Liver injuries allude to those anomalous tissue cell that are found in the liver.

Harmful tumors might be recognized by screening high hazard patients or by chance on an imaging investigation of the mid-region performed for another reason or might be distinguished in light of side effects, for example, stomach torment.

In patients, who experience the ill effects of more progressed hepatocellular carcinoma, weight reduction, intermittent extreme torment and other summed up manifestations may happen. The determination of hepato cell cancinoma is regularly made by liver imaging tests, for example, stomach ultraround and CT check in blend with the estimation of blood levels of aiphafeto protein. As indicated by studies], it was discovered that measurably, the hepatoma, a threatening tumor is generally more coarse grained, while the hemangioma, a generous tumor, has more homogeneous surfaces, however the surface distinction in these two sorts of malady pictures may not be effortlessly seen by human eyes. Moreover, the hemangioma for the most part has higher dim level force and differentiation than hepatoma.

II. LITERATURE REVIEW

G.- J. Liu et al., "Constant differentiation improved ultrasound imaging of central liver injuries in greasy liver," Clin. Imag., vol. 34, no. 3, pp. 211–221, 2010.

Constant differentiation improved ultrasound (CEUS) utilizing second-era ultrasound differentiate operators (UCAs) had broadly utilized as noninvasive methodology for identification & portrayal of central liver injuries (FLLs) in clinical practice. Upgrade examples of various types of FLLs on CEUS had very much depicted in typical liver parenchyma, & CEUS demonstrative execution of FLLs in ordinary liver parenchyma had significantly enhanced contrasted and customary dark scale ultrasound, with 85–96% general precision in separating dangerous FLLs from amiable ones & 81–88.5% general exactness in portraying particular FLL.

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III.MODEL AND FCM ALGORITHM , LEVEL SET METHOD

A. Our Model

The process of defining system architecture, components, modules, interfaces and data to a specified requirement is known as System Design. The system design is considered as the advantage of developing a product. System analysis, system architecture and system engineering is overlapped with each other. The product development is mainly considered with the marketing, design, and manufacturing of each product.

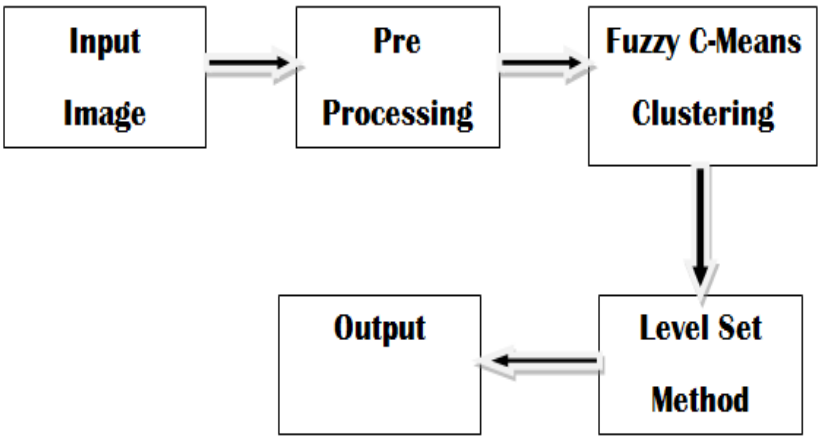

Fig 1: Block diagram of recognizing focal liver lesions

- Fuzzy C-Means (FCM) Algorithm

Step -1: Using the below equation,arbitrarily initialize membership matrix.

$$\sum_{j=1}^{c} \mu_j(x_i) = 1i = 1,2,\dots\dots\dots k$$

Step -2: For calculate Centroid, using below equation

$$Cj=\frac{\sum_i[[\mu_j(x_i)]]^m x_i}{\sum_i[[\mu_j(x_i)]]^m}$$

Step -3: To calculate the dis-similar between data points & itsCentroid using Euclidean distance.

Step- 4: For update new Membership matrix,

$$\mathbf{D_i=\sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}}$$

$$\mu_j(x_i) = \frac{[\frac{1}{d_{ji}}]^{\frac{1}{m}-1}}{\sum_{k=1}^{c}[\frac{1}{d_{ki}}]^{\frac{1}{m}-1}}$$

Where,' m' is fuzzification parameter.

Range of 'm' is always [1.25,2]

Step 5: Now go to step2, until and unless the centroids are not changing.

- Fuzzy C-Means (FCM) worked examples

X	Y	C1	C2
1	5	0.7	0.2
2	6	0.8	0.3
3	7	0.9	0.1
4	9	0.3	0.7
5	4	0.2	0.8
6	8	0.5	0.5

Step 1: To Set membership matrix

$$\sum_{j=1}^{c} \mu_j(x_i) = 1i = 1,2,\dots\dots\dots k$$

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Step 2: Find a constraint using the equation

$$\mathbf{C_j}=\frac{\sum_i[\,[\mu_j\,(x_i)]]^m x_i}{\sum_i[\,[\,\mu_j(x_i)]]^m},\frac{\sum_i[\,[\mu_j(y_i)]]^m y_i}{\sum_i[[\mu_j(yx_i)]]^m}$$

$$C1 = [\frac{1*0.7^2+2*0.8^2+3*0.9^2+4*0.3^2+5*0.2^2+6*0.5^2}{0.7^2+0.8^2+0.9^2+0.3^2+0.2^2+0.5^2},\frac{5*0.7^2+6*0.8^2+7*0.9^2+9*0.3^2+4*0.2^2+8*0.5^2}{0.7^2+0.8^2+0.9^2+0.3^2+0.2^2+0.5^2}]$$

$$C1=\frac{6.26}{2.32},\frac{14.93}{2.32}\quad C1=(2.69,6.43)$$

Similarly to calculate $C2=\frac{6.91}{4.52},\frac{9.78}{4.52}$

C2 = (1.52, 2.16)

Step 3: Find the distance $\mathbf{D_i=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}}$

Now compute Centroid 1:

(1,5)(2.69,6.43) = √(1.69)2+(1.43)2 =2.21 and

(2,6)(2.69,6.43) =0.81 and (3,7)(2.69,6.43) = 0.64

(4,9)(2.69,6.43) =2.88 and (5,4)(2.69,6.43) = 3.35

(6,8)(2.69,6.43) = 3.66

Now compute Centroid 2:

(1,5)(1.52,2.16) = 2.88 and (2,6) (1.52,2.16) = 3.31

(3,7)(1.52,2.16) = 5.06 and (4,9)(1.52,2.16) = 7.2

(5,4) (1.52,2.16) =3.9 **and** (6,8) (1.52,2.16) =7.3

Cluster 1		**Cluster 2**	
Datapoint	**Distance**	**Datapoint**	**Distance**
(1,5)	2.21	(1,5)	2.88
(2,6)	0.813	(2,6)	3.31
(3,7)	0.64	(3,7)	5.06
(4,9)	2.88	(4,9)	7.27
(5,4)	3.35	(5,4)	3.93
(6,8)	3.66	(6,8)	7.36

i-first datapoint , and j – first cluster

Cluster 1: $\mu_{11=}(1/d_{11})^{\frac{1}{2}-1}/(1/d_{11})^{\frac{1}{2}-1}+(1/d_{21})^{\frac{1}{2}-1}$

$=(\frac{1}{2.21})^1(1/2.21)^1+(1/2.88)^1=1.347$

To calculate the remaining Clusters $\mu_{12=1.302}$, $\mu_{14=1.137}$, $\mu_{15=1.254}$, $\mu_{16=1.135}$

Cluster 2:

$$\mu_{21=}(1/d_{21})/(1/d_{12})+(1/d_{21})$$

=1.114

Now the remaining clusters $\mu_{22=0.547}$, $\mu_{23=0.324}$, $\mu_{24=0.451}$, $\mu_{25=1.106}$, $\mu_{26=0.633}$

X	**Y**	**C1**	**C2**
1	5	1.347	0.114
2	6	1.302	0.547
3	7	1.197	0.324
4	9	1.137	0.451
5	4	1.254	1.106
6	8	1.135	0.633

Step 5 : Continue this process, until every iteration should get the same centroids.

Centroid : Any point x has an arrangement of co-proficient giving the level of being in the kth group wk(x). With fluffy c-implies, the Centroid of bunch is mean of eachfocuses, weighted by their level of having a place with the group:

$$ck=\frac{\sum_x w_k(x)^m x}{\sum_x w_k(x)^m}$$

The following image shows that, the data set from the previous clustering, but now fuzzy c-means clustering is applied. First, a new threshold value defining two clusters may be generated. Next, new membership coefficients for each data point are generated based on clusters centroids, as well as distance from each cluster Centroid.

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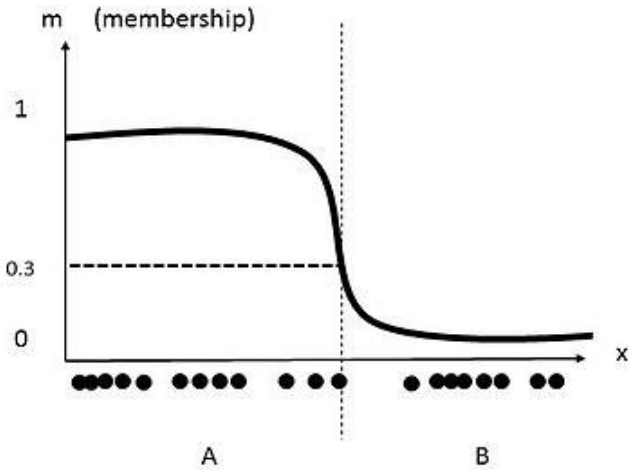


B. Level Set Method (LSM)

LSM are a theoretical system for using level sets as an instrument for numerical inspection of surfaces & shapes. Gain of a level set model is which one may accomplish numerical estimations with curves & surfaces on stable Cartesian structure without having to parameterize these articles this is known as the Eulerian approach. Moreover, level set strategy makes it easy to take after shapes whichalter topology, for example when shape parts in 2, makes gaps, or turnaround of these operations. Every these make a level set method incredible apparatus for demonstrating time-differing objects, alike to development of an airbag, or drop of oil gliding in water.

The Level Set Equation

In a event which the bend Γ moves in ordinary earing with speed ν,then level set capacity ψ fulfills a level set condition $\frac{\partial \varphi}{\partial t} = \upsilon|\nabla\varphi|$

Here, |.| is the Euclidean standard, & t is time. This is an incomplete difference condition, specifically Hamilton–Jacobi condition, &mayilluminated numerically, for instance by utilizing limited contrasts on Cartesian network.

Implicit contours

Evolving surface (∅) rather than front (C) was planned, & front is characterized to be everyfocuses where surface had no stature (∅=0). Front is then characterized certainly as zero level set ∅=0. Figure underneath demonstrates how form is extricated from advancing surface.

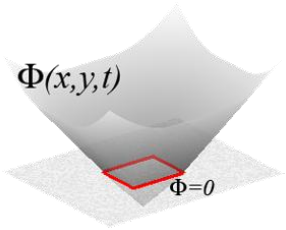
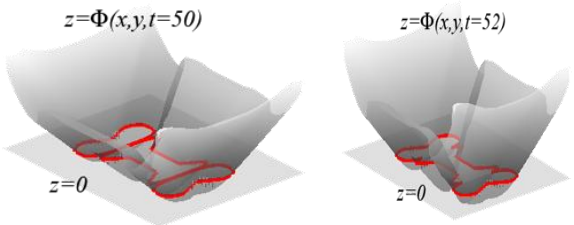


Fig2 : **Where zero level set of surface is square**

At a point when surface develops, glasses may show up, they may later restricted, or vanish. Zero level set shows shapes splitting& converging as delineated in figure beneath where plane at z=0 speaks to a guide of our valley. Crossing point of surface ∅ with plane makes understood form. Combining & spliting are here dealt with actually by surface movement.



(a) t=50, starting of merging (b) t=52, end of merging

Fig3: Evolving front in red is known by taking zero level set of surface ∅.

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Give us a chance to take a gander at the math behind this thought. A point x=(x,y) having a place with a front develops after some time so that x(t) is its position over the long run. Whenever t, for every point x(t) on front a surface haveby definition no stature, in this manner

$$\emptyset(x(t), t) = 0$$

Example: An expanding circle for a Level Set representation of circle

$$\emptyset(x, y) = \sqrt{x^2 + y^2 - r}$$

– Setting F=1 causes the circle to expand uniformly
– Observe $\nabla\emptyset = 1$ everywhere
– We obtain $\frac{\partial\emptyset}{\partial t} = -1$
– Explicit solution: $\emptyset(x, y, t) = \sqrt{x^2 + y^2} - r - t$

meaning the circle has radius r+t at time t

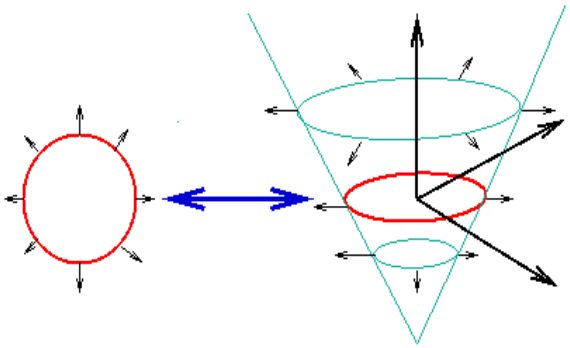

Fig4 : identify the Circle.

Two Formulas For Computation Of Area Under Curve

The calculation of the region under the bend (AUC) is a much of the time utilized technique in endocrinological look into and the neurosciences to include data that is contained in rehashed estimations after some time.

Contingent upon the idea of the examination, it fills an assortment of various needs. In clinical trials, AUC mayutilized to screen a impacts of particular solution over a time for testing. In endocrinological thinks about, AUC is utilized to gauge ultradian& circadian changes of hormones, & to evaluate general discharge over particular era. In pharmacological investigations, AUC is helpful to assess measurement/reaction connections (Ghizzoniet al., 1994; Maes et al., 1994; O'Brien et al., 1996).

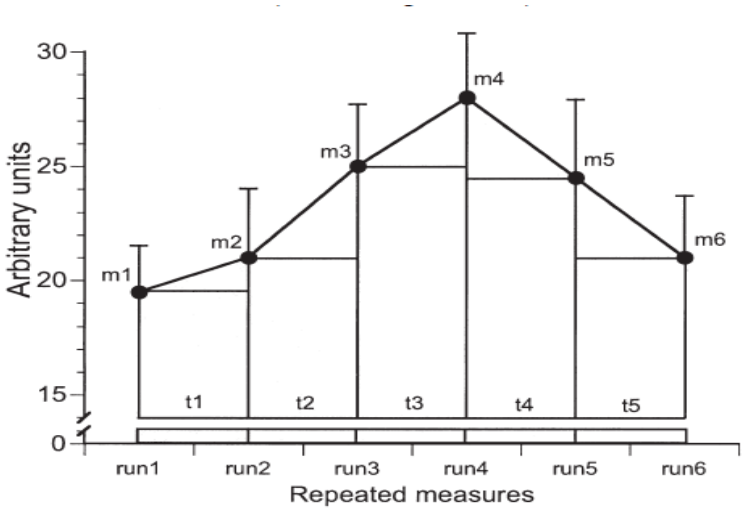

Fig. 5. Time course of a artifical dataset with 6 estimations; triangles & rectangles show organization of region under bend concerning ground (AUCG). m1 to m6 mean single estimations, & t1 to t5 mean time interim between estimations. Note that in spite of fact that in this illustration, the time interim between the estimations is indistinguishable for all perceptions, singular time interims can fluctuate contingent upon the investigation.

As it computes region under bend regarding the ground, it had named AUCG.

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AUC_G= (m2+m1).t1 /2 + (m3+m2).t2 /2 +(m4+m3).t3 /2 + (m5+m4).t4 /2+(m6+m5).t5 /2 with t1 to t5 meaning separation between a estimations & m1 to m6 speaking to single estimations.

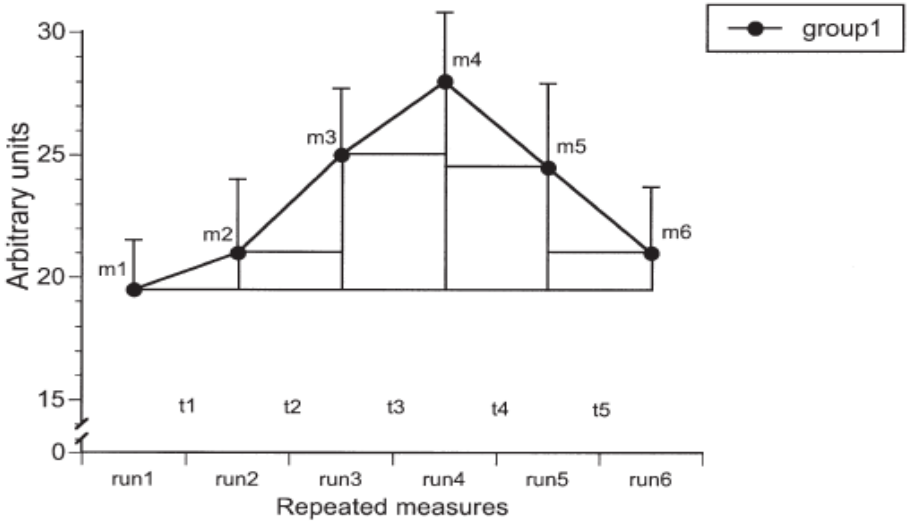

Fig6: AUC_I

$$AUC_I = (\sum_{i-1}^{n-1} . \frac{(m_{(i+1)}+m_i)t_i}{2}) - m_i \sum_{i-1}^{n-1} . t_i$$

$$AUC_I = (\sum_{i-1}^{n-1} . \frac{(m_{(i+1)}+m_i)}{2}) - (n-1).m1$$

Given the case that the rehashed estimations demonstrate a more grounded diminish than increment after some time, the consequence of this recipe could wind up noticeably egative, since it depends on the reference to the primary esteem.

C. Results

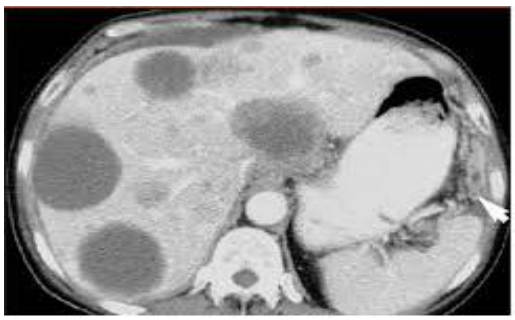

Fig 7 Liver Image

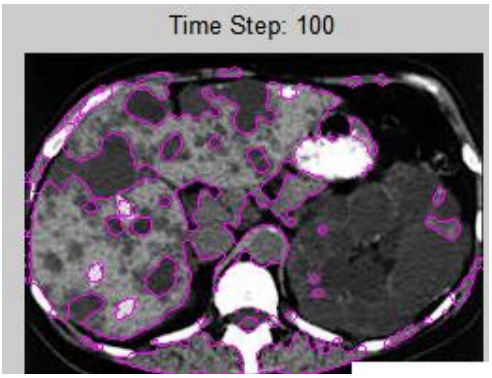

Fig 8: Damaged area in an image

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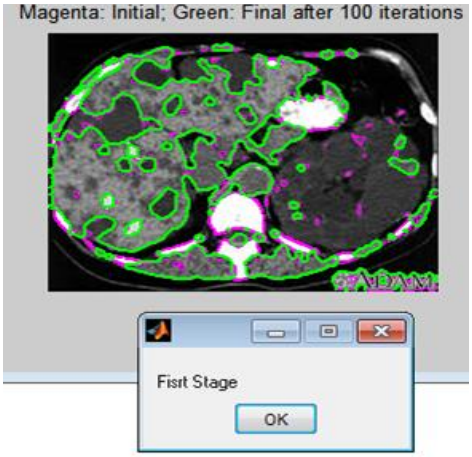

Fig 9: Identifies damaged area in an image

IV. CONCLUSION

The medical image segmentation and tumor detection process is done by following the three significant steps. The first step is to obtain clusters using Fuzzy-C-Means algorithm. The second step is to process and segment the given medical image using level set method. The third step is to analyze area of segmented image and classify type of result. Imaging modalities ought to be utilized carefully to spare cost yet to get the most elevated affectability conceivable. Perceiving Focal Liver Lesions(FLL) is quick, possible, safe, practical and has an expanded affectability in achieving the analysis.

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