Comparison between removing Noise Algorithms Method and Algorithms Bank Method using Data Science in Measuring Liver Volume using MRI Modality

Amir Mohamed Elamir
IBN Sina University

Khalda F. Ali
Taif University

ABSTRACT
Many of the cases in liver functions need to benefactors that organ. Measurement of the liver demands optimal attractive, accurate and faster. The mapping non-geometric soft organs in the human body applying algorithms bank method to reach the measuring liver volume with high accuracy, decreasing the error rate and more fasting. In the accomplishment of the objectives of this paper represent in developing a platform for measuring the liver volume. The analysis method of this paper divided into four phases regarding data science, phase one is image source, Phase two software application and development, Phase three template prototype implementation and measurement, Phase four examine the liver volume measurement with Gold standard reading. The framework describes in three layers, technique layer, image layer, and application layer. To make sure the declining of mistake and access to the value is zero or equal to zero, use one of the Artificial Intelligence techniques, which is the Artificial Neural Network. The template is a method to measure liver volume, which uses the template to gauge the volume of the liver automatically preferably of using the manual as the handbook used the Gold standard method.

Keywords
Data science, computer graphics, enhancement boundary, the gold standard, segmentation, remove noise, Algorithms Bank

1. INTRODUCTION
Measuring liver volume moved in various phase's time, each of these phases has been the achievement. Measuring liver volume needs to propose an integrated method to be achieved to resolve the non-geometric liver volume, leading into consideration building template, which used to be the liver volume measuring with more accuracy, less rate error. The present study was intended to improve the liver volume measurement method for better accuracy and time efficiency in liver segmentation. The precision and time efficiency of the proposed algorithm method for liver segmentation corresponded with those of the 2D and 3D region developing method implemented Am Suk (2014). Computer graphics and visualization liver removal from hepatic MRI images are challenges because the liver regularly abuts many organs of a similar density. The one objective of the purposes of this paper was to develop a computer-aided measurement of liver volume in hepatic MRI using data science.

II. method

The method accompanies how to achieve the objectives. The objectives represent in four phases. Each phase describes Henderson (2017) separately. These phases design the first stage an image; the get image from the main origin (ultrasonography), these origins are MRI. The second phase designs in image manipulation Singh (2017); remove the noise, enhance the image and segmentation. The third phase is template prototype; which creates a model, compare an image with the template and restore an image as a template, Kenji Suzuki (2018) the fourth phase measuring the liver volume by the template. Figure 1 shows the method phases.

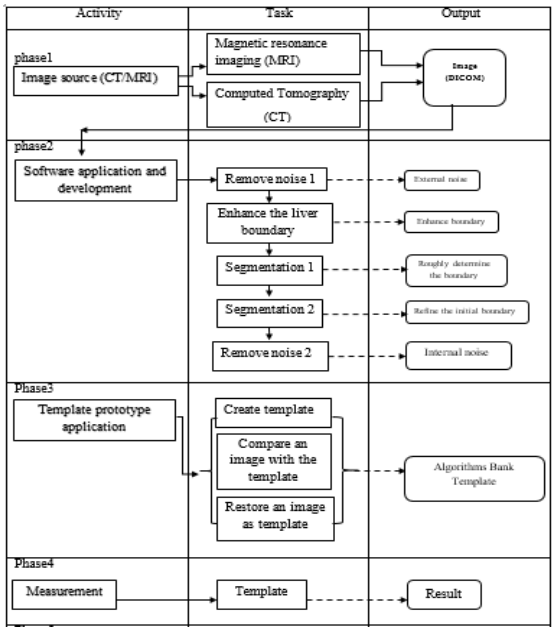

Figure1. Method phases

1.1 Phase1
The Magnetic Resonance Imaging (MRI) are origins of the technique used in the field of medical imaging; several different causes applied in the field of medical imaging. The image can be converted to Digital Imaging and Communications in Medicine (DICOM) from MRI modality, then the image has become (DICOM EXTENSION), the Dicom image can be examined and manipulated in the second phase, that is the software application and improvement.

1.2 Phase2
This phase represents the one of main part focusing in this paper Ananthi (2018). The software employment and development phase include four stages are as follows uses the algorithms bank. Remove the external noise; which applies the Anisotropic diffusion filter. The Anisotropic diffusion filter eliminates the Portal vein and liver edge. Enhance liver edge, which uses two filter algorithms to enhance the liver edge; those filters are A scale specific gradient magnitude refine and Gaussian filter. Segmentation, which involves two parts, part one works Fast marching algorithm, in this segment gives the roughly determine liver lines, part two uses Geodesic Active Contour algorithm and Level-set algorithm, in this part gives the refine initial boundary. Remove internal noise Uma (2018), which uses impulse noise to remove impulse noise. Figure 2 shows the phase2 steps such as algorithms, stages, and the effects.

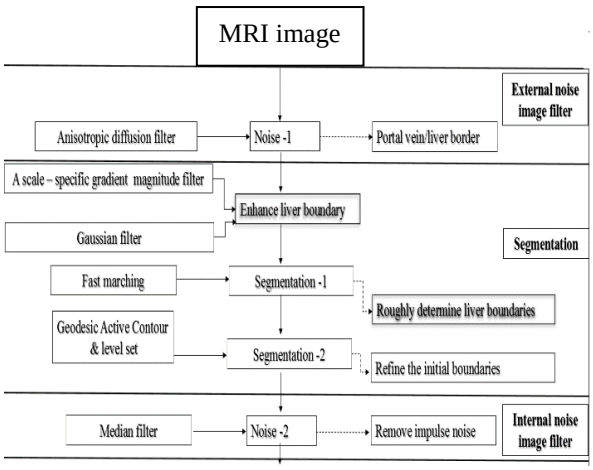

Figure 2. Bank algorithm's stages and the effects

1.3 Phase3

In this phase describes the configuration templates that measured by the image taken from MRI. This phase comprises three stages; create measurement template, compare the image with the measurement template and storing image as a template. The measurement template designs the manual measurement after changed to auto measurement by this staging, this stage follows by subsequent stage which is comparing the entrance new image with the suitable template to obtain the measurement with more precision and no error rate. The third stage saves the image as a model if the last image has no template before and use it as a template. Figure 3 shows the template prototype application.

1.4 Phase4

In this phase is matched results extract within the prototype implementation with the effects of manual (Gold standard), "A gold standard is an approach that is considered to be accurate for determining the presence of an irregularity or the parameter estimated," where identify the accuracy rate and error rate.

2. ALGORITHMS BANK MATHEMATICAL FRAMEWORK

Algorithms bank mathematical model framework is the compiled for each of the seven algorithms applied in this paper, wherever the mathematical framework shows the activity algorithm's name and formula when performed across this context Etehad (2017). The next table indicates that table Seven Algorithms formula and activities.

Table 1. Displays the Activity, Algorithms, and Formula

ACTIVITY	ALGORITHM	FORMULA
Remove noise	Anisotropic Diffusion	$\frac{\partial I(x,y,t)}{\partial t}=div[g(\lvert\nabla I(x,y,t)\rvert)\nabla(x,y,t)]$
	Median filter	$\propto(x,y,z)=\begin{cases}1: if\ (x,y,z)=0\ or\ l-1\\ 0: otherwise\end{cases}$
Enhance liver boundaries	A scale –Specific Gradient magnitude	$f(x)=\frac{1}{1+e^{-(x-\beta)/\alpha}}$
	Gaussian filter	$G(x,y,z)=\frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2+z^2}{2\sigma^2}}$
Segmentation	Fast marching	$\frac{d\psi}{dt}$ - F (p)$\lvert\nabla\psi\rvert$, where the ψ(p, t=0) =I
	Geodesic Active Contour & level set	$\frac{d\Psi}{dt}$ = -αA (p). $\nabla\Psi$- βF (p) $\lvert\nabla\Psi\rvert$ + γZ (p) k$\lvert\nabla\Psi\rvert$

3. PROTOTYPE APPLICATION

Regarding the prior method and mathematical framework, it was created software program doing the method phases. The software application can use to fulfill four functions, which functions remove the DICOM image noise, enhancement DICM image edge, DICOM image segmentation and liver volume. The user can choose one modality DICOM image either CT or MRI, then can be manipulated by the previous functions. Figure 3 displays the main application screen.

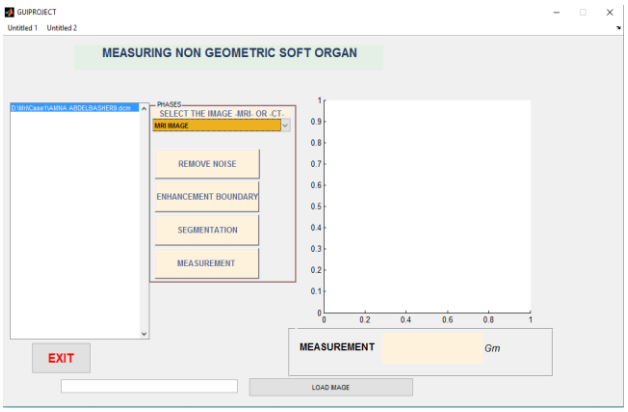

Figure3.Main screen model form

The main screen prototype form allows the user to select the image to be prepared, where there are two alternatives either CT image or MRI image in Dicom extension. Following determining the image, the employment starting with the first phase, this phase raises the noise, in this phase practices two algorithms, median filter algorithm, and Anisotropic diffusion algorithm. Figure 4 displays the two algorithms effect.

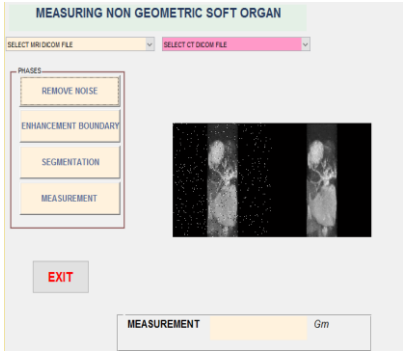

Figure4. Remove the noise from the median filter and anisotropic diffusion algorithm

The Scale-specific gradient magnitude filter algorithm and Gaussian filter algorithm applying enhancement boundary in the second phase. Figure 5 illustrates the enhancement boundary by are A scale specific gradient magnitude filter and Gaussian filter.

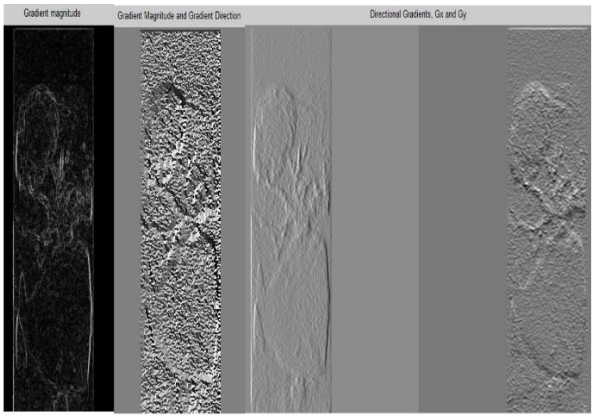

Figure5. Represents the effect of A scale – specific gradient magnitude filter and Gaussian filter in the liver image

Fast marching algorithm, Geodesic Active Shape algorithm, and level set algorithm to apply in segmentation phase. Figure 6 displays the segmentation phase.

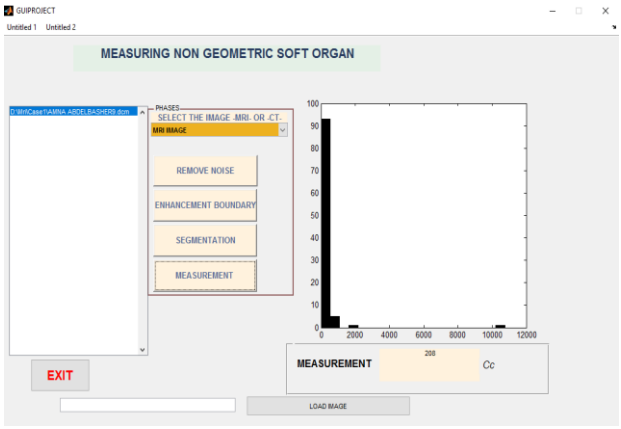

Figure 6. Demonstrates the Segmentation Phase

Measurement phase defines the measurement liver volume according to the previous phases, the prototype application determines the liver region and calculates, then compare the result with Gold standard using the artificial neural network following histogram displays black color for the liver area and identified the liver measurement. Figure 7 illustrates the liver area.

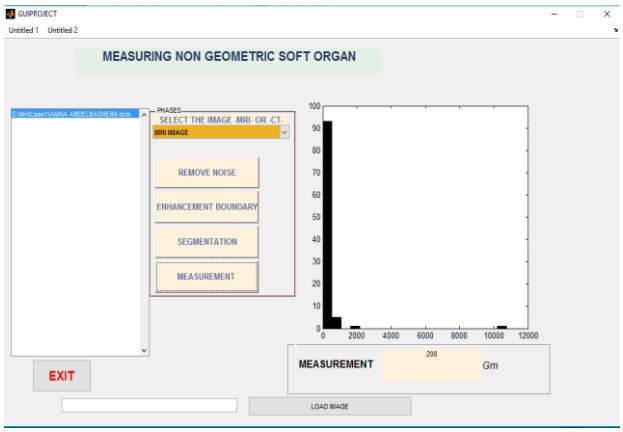

Figure7. Displays Measurement Liver Volume

When implemented the removing noise method and Algorithms Bank method, the system gave the results in table1. In table1 shows the comparison between removing noise method and Algorithms Bank method, the comparison includes the two parameters, accuracy and error rate. The source of this case from the MRI modality, from this modality, has ten representative images, six male, and four female, the age ranging between 42 and 55 years. The comparison results between two methods represented in the following table1.

Table 1 The comparison results between removing noise algorithm method and algorithm bank method in data science

Gender	Age	Removing noise algorithm method		Algorithm bank method	
		Accuracy (100%)	Error rate (100%)	Accuracy (100%)	Error rate (100%)
Male	45	99.40	3.60	99.7	3.2
Female	50	99.20	3.70	99.6	3.2
Male	40	99.40	3.60	99.8	3.1
Male	55	99.50	3.60	99.8	3.1
Female	55	99.50	3.60	99.7	3.2
Female	49	99.40	3.60	99.7	2.9
Male	44	99.30	3.80	99.8	3.1
Male	52	99.20	3.60	99.7	3.1
Male	40	99.40	3.60	99.8	3
Female	42	99.50	3.60	99.8	3.1

In table1, the high accuracy value using Remove noise method is 99.5, this value repeated three times, while that the high accuracy value using the Algorithms Bank is 99.8, this value repeated five times. For the error rate, the lowest error rate value using the Remove noise is 3.6, this value repeated eight times, while that the lowest error rate using Algorithms Bank is 3.0, this value repeats one time.

To present the data in table1 using the bar chart, diagram, figure 8 illustrates the data in columns. In figure 8 displays also the comparison between removing noise method and Algorithms Bank Template method using MRI modality source, this comparison regarding accuracy and error rate with two factors, age, and gender.

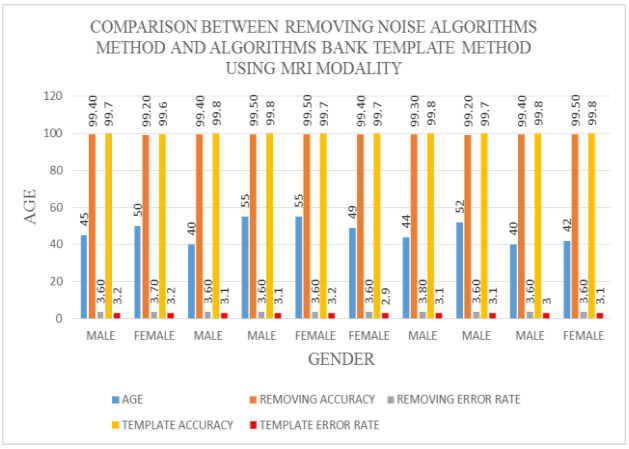

Figure8. Comparison between Removing Noise Algorithm Method and Algorithm Bank Method

In figure 8, the bar chart illustrates the number of six male and four female cases under the studying the measuring liver volume, the age of the male and female between 40 years to 55 years. Each case the chart illustrates four figures, that figures are age, measuring liver volume by removing noise method, measuring volume by the Algorithms Bank method and the two

error rates by the previous methods. In table2 calculated the average results from the two approaches, these methods Removing noise and Algorithm bank method. The table displays the comparative average for age, accuracy and error rate.

Table 2 Illustrates the common comparison results between Removing Noise Algorithms Method and Algorithm Bank method

		Removing Noise algorithm method		Algorithm Bank method	
	Age average	Accuracy Average (100%)	Error rate Average (100%)	Accuracy average (100%)	Error rate average (100%)
Average	47	99.38	3.63	99.74	3.10

4. CONTRIBUTION

In this article constructed a new method that uses algorithms bank, which included seven algorithms. Theses algorithms divided into four phases, which uses to obtain the measurement liver volume in high accuracy and reduce the error rate rather than removing noise method. The algorithms bank method contains the most accurate algorithms. These algorithms have split into the phases; it based on a specific target. This objective represents the next source until reach the nearest measurement equal to the actual volume of the liver organ while reducing the error ratio. The prototype application divided into sub-application, each sub-application represents one phase, and the phase determined specific algorithms according to the previous studies have demonstrated their efficiency in this aspect. The removing noise method describes a part of this study to achieve the real destination. Through this study, the Algorithm Bank method framework was developed to provide the most accurate algorithms to measure the liver volume. This method can raise the level of accuracy and reduce the error rate. The data science clarifies comparison the data in accuracy and reduce the error rate between removing noise algorithms and an algorithms bank method.

5. REFERENCES

[1] Am Suk Oh et al. (2017). "Design and Implementation of Standard DICOM Interface Module International Journal of Bio-Science and Bio-Technology" Vol.6, No.2 (2018), pp.141-146.

[2] Book. Encyclopedia of Diagnostic Imaging. Albert L.Baet. Springer reference. 2017.

[3] Etehad Tavakol M, Ng EYK. (2018). "Breast thermography as a potential non-contact method in the early detection of cancer: a review." J Mech Med Biol 13: 1330001; doi:10.1142/S0219519413300019.

[4] Gurpreet kaur, Rajdavinder Singh. (2018) Image Enhancement and It is Techniques- A Review, 2014. International Journal of Computer Trends and Technology (IJCTT).

[5] Gurpreet kaur, Rajdavinder Singh. (2018). Image Enhancement and Its Techniques. International Journal of Computer Trends and Technology (IJCTT) – Volume 12 number 3 – Jun 2018.

[6] Henderson JM, Heymsfield SB, Horowitz J, Kutner MH.(2018) "Measurement of liver and spleen volume by computed tomography. Assessment of reproducibility and changes found following a selective distal splenorenal shunt. Radiology 2018; 141: 525-527 [PMID: 6974875]

[7] Kenji Suzuki, (2017), "Computerized Liver Volumetry on MRI Using 3DGeodesicActiveContourSegmentation"http://www.ajronline.org/doi/abs/10.2214/AJR.13.10812.Jan 2015.

[8] Mussarat Yasmin, Muhammad Sharif, Saleha Masood, Mudassar Raza and Sajjad Mohsin. (2016). Brain Image Enhancement - A Survey. World Applied Sciences Journal 17 (9): 1192-1204, 2012 ISSN 1818-4952 © IDOSI Publications, 2012.

[9] R. Sharmila and R. Uma.(2017). "A New Approach to Image Contrast Enhancement using Weighted Threshold Histogram Equalization with Improved Switching Median Filter," International Journal of Advanced Engineering Sciences and Technologies (IJAEST), 7(2), pp. 38-43, 2018.

[10] Rafael C. Gonzalez and Richard E. Woods (2018), "Digital Image Processing," 3rd edition, Prentice Hall, 2018.

[11] V.P.Ananthi, P.Balasubramaniam, C.P.Lim. (2014)."Segmentation of gray scale image based on intuitionistic fuzzy sets constructed from several membership functions". PatternRecognition47(2014)3870–3880.

[12] www.medicalresourcelinks.com/tac.html (2019).