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Kidney stone detection Using Improved EM-Algorithm on MATLAB

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Abstract: *The Kidney stones are one of the most common disorders of the urinary tract. Kidney stone problem occurs as a common problem to every men and woman in Malaysia, due to nature of living. A kidney stone termed as renal calculi is a solid piece of material that forms in a kidney when substances that are normally found in the urine become highly concentrated. The ultimate aim of medical image segmentation is to reduce the amount of time a radiologist needs to spend for looking at an image to identify the portions of renal calculi. Therefore, in the view of addressing aforementioned problem, three renal calculi segmentation methods namely Effective Segmentation of Renal calculi using Multilevel thresholding Using EM (Electromagnetism-like Algorithm) Outer Regions based new Enhanced Multi-Level.*

Keywords: *PSNR, MSE, EM Algorithm..*

1. Introduction

The Kidney stones are one of the most common disorders of the urinary tract. Kidney stone problem occurs as a common problem to every men and woman in Malaysia, due to nature of living. A kidney stone termed as renal calculi is a solid piece of material that forms in a kidney when substances that are normally found in the urine become highly concentrated. Renal Calculi stone may occur in the kidney or travel down the urinary tract. The size of the stone varied from smaller, medium and larger size like golf ball, as per the diagnosis, if in early stages not diagnosed, growth is to higher. When the size of the stone is smaller, it may pass on its own, causing little or no pain during urination. A larger stone may get stuck along the urinary tract (which is the body drainage system to remove the waste) and can block the flow of urine, causing severe pain or bleeding. The urinary tract includes two kidneys, two ureters, a bladder, and a urethra. The kidneys are two bean-shaped organs, each about the size of a fist. In daily routine, the two kidneys process about 200 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra water. The urine flows from the kidneys to the bladder through tubes called ureters. The bladder stores urine until releasing it through urination. When the bladder empties, urine flows out of the body through a tube called the urethra at the bottom of the bladder.

The rest of research paper is design as follows. The overall previous work is described in Section II. Section III describes the methodology used for proposed work. Result analysis describe in section IV. Finally, Section V describes the future Scope and *VI* conclusion of paper.

2. Literature Review

Navratnam, Sujata, Siti Fazilah 2016 [1] The most common problem in the daily lives of men and woman is the occurrence of kidney stone, which is named as renal calculi, due to living nature of the people. These calculi can be occurred in kidney, urethra or in the urinary bladder. The proposed work is based image acquisition, image enhancement, segmentation, feature extraction and classification, whereas in initial stage, ultrasound of kidney image is diagnosed for the presence of renal calculi stone and its level of growth measured in sizes.

Moore, Christopher 2015 [2] Reduced-dose computed tomography (CT) scans have been recommended for diagnosis of kidney stone but are rarely used in the emergency department (ED) setting. Test characteristics are incompletely characterized, particularly in obese patients.

Mansouri, Mohammad 2015 [3] Dual-energy computed tomography (DECT) is based on obtaining 2 data sets with different peak kilovoltages from the same anatomical region, and material decomposition based on attenuation differences at different energy levels.

Viswanath, Kalannagari 2014 [4] The abnormalities of the kidney can be identified by ultrasound imaging. The kidney may have structural abnormalities like kidney swelling, change in its position and appearance. These energy levels are trained by Multilayer Perceptron (MLP) and Back Propagation (BP) ANN to identify the type of stone with an accuracy of 98.8%.

Cunitz, Bryan, 2014 [5] Kidney stones have been shown to exhibit a “twinkling artifact” (TA) under Color Doppler ultrasound. To improve the overall performance of TA as a diagnostic tool, Doppler output parameters were optimized in vitro.

Botsikas, Diomidis 2014 [6] To investigate the added advantage of IV furosemide injection and the subsequent urine dilution in the detection of urinary calculi in the excretory phase of dual-source dual-energy (DE) computed tomography (CT) urography, and to investigate the feasibility of characterising the calculi through diluted urine.

Ibrahim, El-Sayed 2016 [7] In this study, kidney stones of varying composition and sizes were imaged using both UTE MRI as well as the reference standard of computed tomography (CT), with different surrounding materials and scan setups.

Ganesan, Vishnu 2016 [8] To determine the sensitivity and specificity of ultrasonography (US) for detecting renal calculi and to assess the accuracy of US for determining the size of calculi and how this can affect counselling decisions.

Viswanath, K., and R. Gunasundari 2016 [9] In recent years, there is an increase in the count of individuals suffering from kidney abnormalities. These energy levels are trained by multilayer perceptron (MLP) and back propagation (BP) ANN to identify the type of stone with an accuracy of 97.8 % and real time implementation is done using Verilog on Vertex-2Pro FPGA.

Brisbane, Wayne, Michael R. Bailey 2016 [10] Kidney stone imaging is an important diagnostic tool and initial step indeciding which therapeutic options to use for the management of kidney stones.

Mandel, Neil S., Ian C. Mandel 2016 [11] This manuscript reviews the requirements for acceptable compositional analysis of kidney stones using various biophysical methods. High-resolution X-ray powder diffraction crystallography and Fourier transform infrared spectroscopy (FTIR) are the only acceptable methods in our labs for kidney stone analysis.

Kaplan, Adam G 2017 [12] A comprehensive stone center can effectively manage complex urinary stone disease with the right tools. A collaborative team that includes a Urologist, a Nephrologist, a Dietician and a mid-level practitioner is optimal.

3. Frame Work of Research

The implementation of such algorithm can be summarized into the following steps:

Step 1: Read the kidney image I and if it RGB separate it into I_R, I_G and I_B. If the I is gray scale store it into I_{Gr}. c =1; 2; 3 for RGB kidney images or c = 1 for gray scale kidney images.

Step 2: Obtain histograms: for RGB kidney images h^R, h^G, h^B and for gray scale kidney images h^{Gr}.

Step 3: Calculate the probability distribution using Eq. (4.3) and the histograms.

Step 4: Initialize the EM parameters: $Iter_{max}$, $Iter_{local}$, δ, k and N.

Step 5: Initialize a population S^c_t of N random particles with k dimensions.

Step 6: Compute the values ω_i^c and μ_i^c. Evaluate S_t^c in the objective function j(S_t^c) Eqs. (4.10) or (4.16) depending on the thresholding method.

Step 7: Compute the charge of each particle and the total force vector

Step 8: Move the entire population S_t^c along the total force vector.

Step 9: Apply the local search to the moved population and select the best elements of this search based on their objective function values.

Step 10: The t index is increased in 1, If t ≥ $itel_{max}$ or if the stop criteria is satisfied the algorithm finishes the iteration process and jump to step 11. Otherwise jump to step 7.

Step 11: Select the particle that has the best $x_t^{B^c}$ objective function value.

Step 12: Apply the thresholds values contained in $x_t^{B^c}$ to the kidney image I

4. Result Analysis

Table 5.1 various output parameters of EM algorithm including intensity, PSNR, MSE, Fitness and time

Kidney Image	Intensity	STDR	MEANR	PSNR	fitness	Time
image 1	101.5	0.01	16.27	21.62	16.27	6.01
image 2	99	0.01	16.72	20.25	16.72	7.82
image 3	148	0.07	17.63	12.76	17.66	7.29
image 4	81.5	0.02	16.84	22.36	16.85	8.23
image 5	86	0.04	15.8	17.09	15.81	5.09
image 6	119	0.08	17.15	18.04	17.19	6
image 7	147	0.16	16.99	20.09	17.07	5.22
image 8	114	0.03	16.6	24.18	16.6	6.96

Fig 5.1 Input ultrasound kidney image

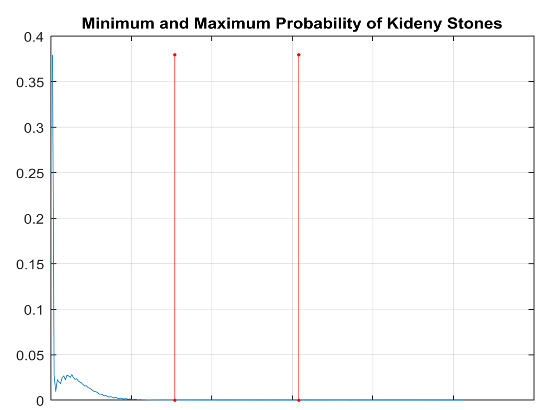

Fig 5.2 Minimum and Maximum Probability of Kidney Stones this is the range in which we search for kidney stone, stone usually falls before the minimum range.

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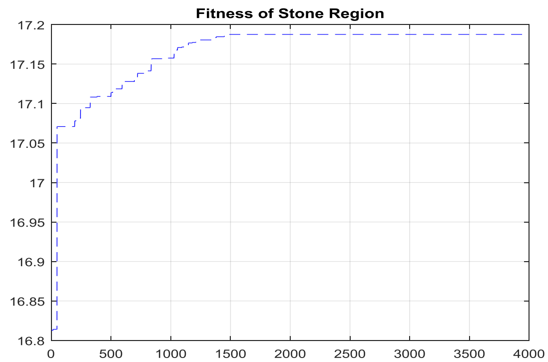

Fig 5.3 Fitness of each stone region is identified using EM algorithm

5. Conclusion

The ultimate aim of medical image segmentation is to reduce the amount of time a radiologist needs to spend for looking at an image to identify the portions of renal calculi. Therefore, in the view of addressing aforementioned problem, three renal calculi segmentation methods namely Effective Segmentation of Renal calculi using Multilevel Thresholding Using EM (Electromagnetism-like Algorithm) Outer Regions based new Enhanced Multi-Level Segmentation and Region Indicator using Entropy have been proposed in this work. The EM algorithm works very well to isolate speckle noise and identifies the stone regions more effectively than previous works.

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