DETECTION AND EXTRACTION OF BRAIN HAEMORRHAGE ON THE CT-SCAN IMAGE USING HYBRID THRESHOLDING METHOD

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ABSTRACT

Brain bleeding can occur because of the outbreak of the blood vessels in the brain which culminated into haemorrhagic stroke or stroke due to bleeding. Haemorrhagic Stroke occurs when there is a burst of blood vessels result from some trigger factor. Segmentation techniques to Scanner computed tomography images (CT scan of the brain is one of the methods used by the radiologist to detect brain bleeding or congenital abnormalities that occur in the brain.
This research will determine the area of the brain bleeding on each image slice CT-scan every patient, to detect and extract brain bleeding, so it can calculate the volume of the brain bleeding. The detection and extraction bleeding area of the brain is based on the hybrid thresholding method.

Keywords: CT Scan, Hybrid Thresholding, Volume, and Incision area Brain Injury

I. Introduction

With the increasing number of transportation vehicles with an affordable cost for the community especially motor vehicles accessible two resulting in the increasing number of traffic accident in Indonesia. Similarly, increasing the number of labor, industry contribute to the increasing number of occupational accidents. Besides that an accident can occur because of the activities of the sport, distribution hobby hunting and so on. The accident resulted in many victims suffered broken bones brain injury, bleeding of the brain and other diseases. The brain injury is one of the most causes that cause the death of the man. According to Shepard from FCA 1998 .[1] . Haemorrhage in the brain can be caused by two things namely trauma and non-trauma. Clash of hardware in the head because of trauma or accident can cause bleeding in the thorax the head or in the brain. 6). Bleeding brain recounted the existence of the history of previous trauma, then the possibility of that happening is bleeding non-brain trauma. This bleeding can occur because of the outbreak of the blood vessels in the brain which culminated into haemorrhagic stroke or stroke due to bleeding. Haemorrhagic Stroke occurs when there is a burst of blood vessels result from some trigger factor. Two types of blood vessels are vulnerable burst (low) obtained in the case of aneurism and malformations arteriovenosa (AVM): [7].

Other causes of haemorrhagic stroke is : [7][4].
1. Drinking drugs diluent routine blood, such as aspirin and warfarin
2. Drugs such as cocaine
3. Cancer of the brain

Haemorrhagic stroke is divided into 2 :
1. (intraserebral bleeding in the brain). Generally intraserebral bleeding induced by chronic high blood pressure where the early symptoms are headache and more often occurs at the age of > 60 years. Chronic high blood pressure can weaken the blood vessels and makes it easier to crack. Accumulation of proteins called amyloid

angiopati can also cause bleeding. Bleeding intraserebral generally fatal especially for those with high blood pressure. More than half of the people who have extensive intraserebral bleeding died in a few days.

2. *Subarachnoid hemorrhage* . Subarachnoid bleeding is bleeding that fills the cavities subarachnoid namely between cavity layers in (parameter) and middle layer (arachnoid matte) which is part of the membranes that surround the brain (meninges). The most commonest pathogens are broken aneurisms. Generally broken aneurisms cause headache sore that come suddenly and followed by the loss of consciousness. 35% people died when bled subarachnoid because the extent of bleeding.

CT technology Scan there are some weakness on is such as the emergence of artefact (image that should not be there but recorded). This usually arise because patients move during the recording, patients using dental amalgam patches or false joint from metal, or network conditions specific body, Interpretation wide area and the volume of the brain bleeding is done by a specialist doctor radiology, because it is expected to see the unseen by the eyes and still mix between the bleeding area, the object of the skull head and layers of the brain other parts. [11].

The time needed to analyse from the acquisition until the image analysis between 15-60 minutes, while patients need quick action and accurate in determining the volume and extensive bleeding stopped for maintenance if could not experience death. CT Scan will only show the possibility of a disorder the structure of the brain invisible, then smooth changes in the difficult network identified. Even the structure of the brain in areas of the brain and back bars head not so good visualizers due to the thickness of the wall of the skirt of bones. [11].

The changes that striking (eyes) will be easily detected, such as the brain bleeding or disruption of the growth of the tissues of the brain, because the change is very smooth. (specialist doctors radiology. [11]. To analyse the image of the brain required reading per special slice slices indicated the bleeding brain, then the result in the total manually to calculate the wide or the volume of bleeding area manually by a specialist doctor radiology to be given to the specialist doctors nerves.

To overcome some of the weakness of the CT Scan needed innovations needed to help law enforcement diagnosis image CT. The development of science have digital image processing allows the computer to detect any traumatic brain injury or bleeding of the brain by searching for the features that are often present on the brain. The specific features that have been obtained can be made training data on the ***machine learning*** so that later the system is able to determine the type of injury based on its characteristics and extensive calculations and the volume of the brain bleeding area.

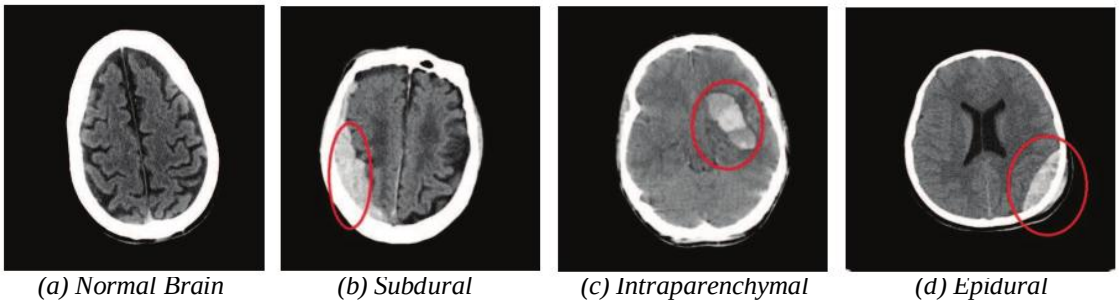
II. Literature Review

Traumatic brain injury is a pathological process of brain tissue that is not degenerative or congenital, but rather due to external mechanical force, which causes physical disorders, cognitive function, and psychosocial. These disorders can be permanent or temporary and accompanied by the loss of or change in level of consciousness. [12]. According to Zasler et al [12], brain injury is divided for :

1. Congenital brain injury is a brain injury are genetically and birth trauma.
2. Acquired brain injury (ABI), namely brain injury traumatic and non-traumatic brain injury. On

More serious traumatic brain injury can result in bruises, torn tissue, hemorrhage and other brain damage that can lead to long-term complications or death.[12].

Image classification normal brain and brain hemorrhage three types as shown in Figure ure 1. The images was published with the permission of the M. Jamil Hospital Padang.



(a) Normal Brain *(b) Subdural* *(c) Intraparenchymal* *(d) Epidural*

Figure 1. Image Brain Normal and 3 type image Brain Hemorrhage

Several studies have been conducted by previous researchers, research first accurate detection of the ideal middle titi to determine the extent of bleeding obtained in determining the category of brain injury in three classes, namely class I, II and III. [14].

Further research on medical image segmentation using Otsu's method iterations to clarify between the object and the background image of the brain. [15]. Determine the segmentation of brain tumor know how much area and large classification according to the area of tumor in its formation. To measure the area of a brain tumor can be determined by how much the area and classification according to the size of the tumor area of the slice. [17]. according to Utasi [16] The percentage of pixels representing fluid that significantly brain hemorrhage results from segmentation Fuzzy c-mean methodTo clarify the parts of the brain with a clear edge and this process requires a fairly short time in just seconds with edge detection method of brain Laplacian of Gaussian (LOG) method. [17].

Tan in the subsidy debate [8] do research on the improvement of the quality of the image of CT brain with the purpose to clarify the contrast between the part of the brain through the dye with the help of histogram algorithm. This research has not been oriented toward the detection of brain injury. Karuna and Joshi [3] do research about area segmentation brain tumors by using texture analysis: angular second moment (ASM), contrast , inverse difference moment (Homogeneity), dissimilarity and entropy. Gillebert [2] in the research proposed a lgoritma *a utomated delineation* that automatically can describe myocardial and brain bleeding on stroke (brain injury) CT image.

Further research to identify and extract the image of the brain from the image of CT Scan for classifying brain bleeding and not bleeding brain with classification method the algorithm k -means that examined by Sharma . 5).

Next article from Xuguang [10] In research suggested Selection Algorithm Slice *(Slice Selection Algorithm),* this research proposed algorithm for upgrading the estimation center line with SSA to p encarian full symmetrical position is based on the anatomical features in the detection of brain bleeding. The results of this research with multi-stage algorithm is evaluated on 3313 CT slices of 70 patients and accuracy of 96,9%.

The next research Wenan [9], in paper proposes ICM and MASP algorithm to compare both the algorithm to analyze traumatic brain bleeding. The results focus on the automatic processing the image of the brain CT -Scan for segmentation and identify the bleeding arrhythmia brain.

Other research Srimini [6] proposed algorithm *Neuro Fuzzy* and *ROI extraction* to detect and identify and measure the area of the brain abnormal bleeding with different locations vary in the form of the image of CT Scan of the brain 2D.

III. Research Method

The method or sequence of research done in this research is described in the Figure 2. This research consists of 6 stages namely :

1. The first phase of the *cropping* area : input *cropping process* aims to eliminate noise that does not need to be outside the research object, determine the image of the object of the research will be analysed and processed and minimize the size of the image of the original brain in order to easily in though and analysed.
2. The second stage of the detection areas of the brain : the purpose of this phase is to determine the areas of the brain bleeding in order not to mix with the limit white area is not an area that bleeding, to distinguish between the object that will be examined and the object that is not examined because the same white colour.
3. The third stage extraction areas of the brain : this stage aims to throw away the black spots on the image bleeding o not from the results of the detection area bleeding.
4. The fourth stage count area each slices / pieces of the brain : the purpose of this stage is to calculate the area of the brain bleeding per slices have detection to perform the calculation area bleeding from the brain. For the next wide conversion object in pixels into square centimetres.
5. The fifth stage of the count the volume of the brain area : the purpose of this stage is to calculate the volume of the brain bleeding area has been successfully calculated area bleeding from the brain. For the next area volume conversion object bleeding in pixels into cubic centimetres.

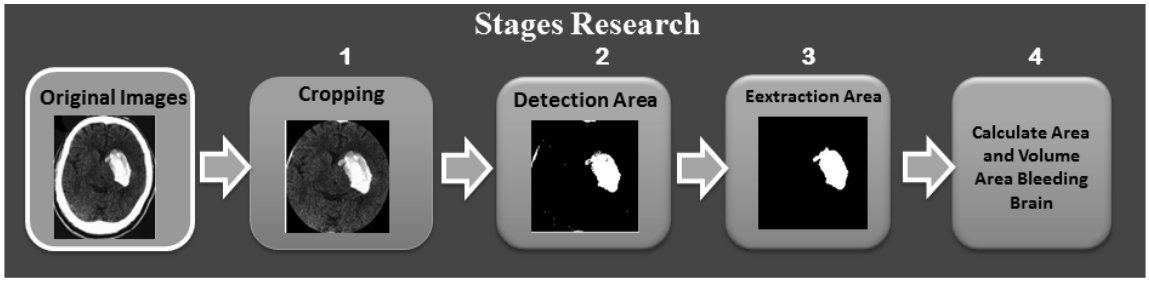
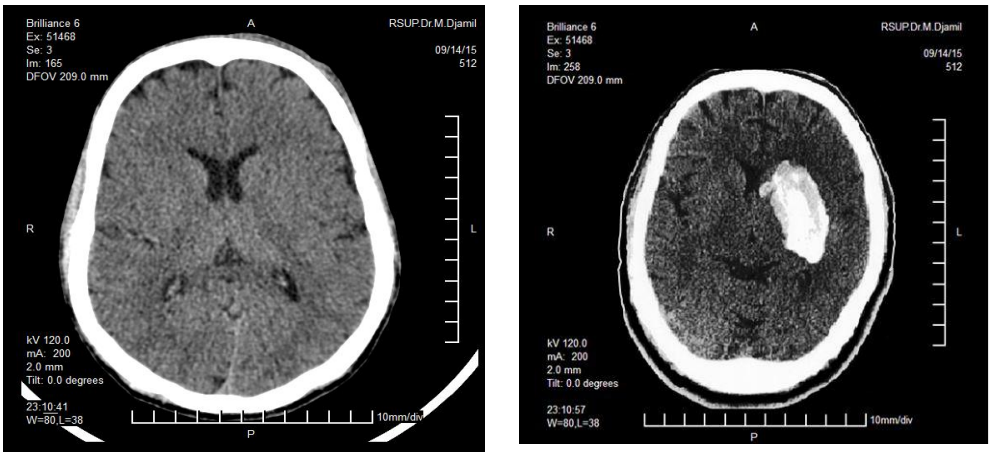


Figure 2. Stages Research

3.1. Inputs Images from the CT Scan (Image of their Grayscale)

Inputs image from the CT Scan in the get from the image of the brain that has been saved in the electronic media (hard disk) that will be used in processing the image. In this research is the image that will be known , trained and tested are the results of the CT scan of the original from Center Hospital M. Jamil Padang without discuss his acquisition process . Figure ure 3 (a). The original image normal brain and (b). Image genuine that is white in the brain is a brain bleeding.



Source : Public Center Hospital DR. M. Djamil Padang West Sumatra, 2015
Figure 3. (a). The Image of the brain Normal, (b). The Image of the brain Bleeding

A. Cropping Input Area

Figure 2. (a) is the image of the original brain from Center Hospital DR. M. Djamil Padang, West Sumatra, in the image of the brain is much noise such as visible around the ellipse from Fugure 2. (a) there that is white and black so that affect the research object. For that we need to do cropping Delete noise that does not need to be outside the research object, D etermine the image from the object of the research that has been analyzed and processed increase image size genuine brain in order to easily in though and analyzed.

To be able to cut (crop) Fugures with the functions provided by Matlab, some property of the image must be in the know first. The properties of the property is : the position of the column of the upper left corner of the area that is not in the crop, Y : the position of the line from the upper left corner of the area that is not in the crop. The Delta x : the width of the area that is not in the crop, The Delta y : high in crop that would area

Four such property can be depicted in Figure ure 4. The functions provided by matlab that can be used to crop the Figure ure is imcrop.

Imcrop usage example can be seen in Figure 6. (a) is the image of the beginning, and Figure 6. (b) is the image cropping results.

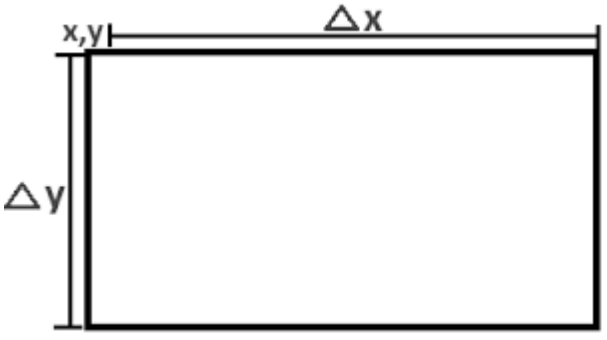


Figure 4. The properties for Cropping Area

The algorithm 01: Process Cropping Ellipse shape:

1. **Read the input image A=imread('Patients 1/Slice 05.bmp');**
2. **Show input image figure(1), imshow(A);**
3. **count the size and intensity jumlan [M, N, L] = size(A);**
4. **determine the central point of the ellipse (x,y) c = hotfixes(size(A) / 2);**
5. **determine the radius of the central point (y-firebrand presidents, x-firebrand presidents) r_sq = [80, 105] .^ 2;**
6. **main step and coordinates the position of the ellipse will dicrop [X, Y] = meshgrid(1:size(A, 2), 1:size(A, 1));ellipse_mask = (r_sq(2) * (X - c(2)) .^ 2 + ... r_sq(1) * (Y - c(1)) .^ 2 <= successfully met(r_sq)); the**
7. **process of cropping A_cropped = bsxfun(@times, A, uint8(ellipse_mask));**
8. **Show results cropping figure(2), imshow(A_cropped);**
9. **Save the results of cropping imwrite(A_cropped, 'Patients 1/Slices 01C. bmp')**

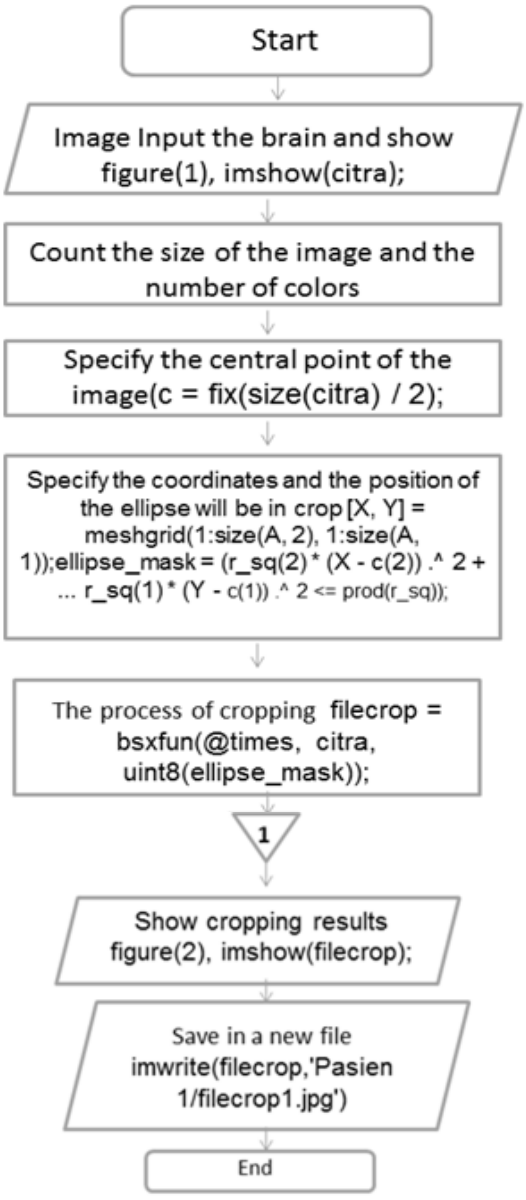
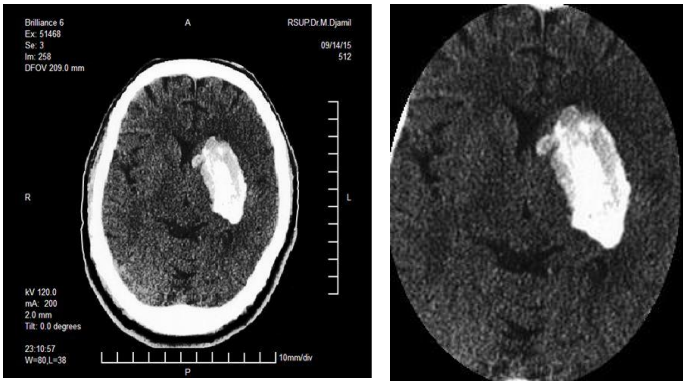


Figure 5. Ellipse shape Cropping Process Flowchart

In the Figure 5. and algorithm cropping cropping stage of the process is intended to eliminate the noise that does not need to be outside the research object, determine the image of the object of the research that has been analysed and processed and minimize the size of the image of the original brain in order to easily in though and analysed. Thus obtained a clean image from the noise that can interfere with the process of processing the image.



(a) (b)

Figure 6. (a) the image of the brain Before Cropping, (b) Image Cropping Results

3.2. Brain Bleeding Area detection

Stage area detection this bleeding perform analyse spread of white intensity including indicated bleeding so that know increased the brightness or contrast stretching and the spread of the White House , the determination of the boundaries of the separation of the object from background, the percentage of white and black composition also texture intensity to the process of the identification of the image of the brain further , determine the value of the *threshold* , determine the areas of the brain in and outside, in order not to mix with the limit shell area of the brain and Determine the value of the threshold with how to distinguish the two groups, namely the object that will be examined and the background of the object, who have part that rests on each other based on histogram.

3.3. Hybrid Image Thresholding Method

The purpose of the hybrid image thresholding methods utilize the characteristics of the image to help the process of thresholding with combining the method P-tile as the global thresholding method with the edge to retrieve information form of detect. Using the information edge detection, area object obtained the ratio is determined by the form of objects. This information is especially useful for applications that need to enhance the shape of objects in the original image. 4.

Give the value of the image I became the original image and G will be the threshold limit value that is looking, *Hybrid algorithm* Image Thresholding method is as follows: [4].

02 : The process of Thresholding algorithm with Hybrid method

```
I.  O ←EdgeMap(I)            # calculate Edge Map from I #
2.  v ← initial_Value
3.  e ← RealMax              # set e U.S. maximum real value #
4.  Loop until v = max_Value in Step increment.
5.  T ← P-tile(I,v)          #threshold I using heading P-tile method and v united states the threshold value
6.  C ← EdgeMap(T)           #calculate Edge Map from T #
7.  r ← MSE(O,C)             # calculate MSE value between O and C #
8.  If r < e                 # bear the MSE value is smaller than e #
9.  e ← r                    # replace e with MSE value #
10. G ← v                    # U.S. setv the searched value #
```

This method is simple and suitable for all types of edge detection, because only iteration in continuous time (determine the value of step by step). This method does not add more to the method of complexity P-tile and detect the edge make this hybrid approach.

In the Hybrid Image Thresholding method, we need to find the best edge to combined with edge detection methods P-tile. This method is trying to combine the method P-tile with five types of edge detection, canny, Prewitt, Roberts, Sobel and Laplacian of Gaussian (LOG). The first four is a gradient based on edge detection and the last is based on the Laplacian. In the scenario of all forms, information is required for the image with the appropriate threshold, for each scenario. According to the subjective evaluation of the results, can find that combines the method P-tile with canny edge detection produces the most stable results. This combination consistently produce image that have quality better than or equal to the other. 4.

3.4. Extraction Of An Area Of The Brain Bleeding

Based on the results of object detection of hybrid algorithm where there is still a white area that is not an area of the brain bleeding search. This means that the area is considered noise and must be removed or cleaned. -02 algorithm is the algorithm to delete an area that is not an area of the brain haemorrhage.
Figure 4 is the flowchart to eliminate white spots which is not an area of bleeding. The implementation of the algorithm in Figure 4. Produce Figure 7. Look seen in the Figure ure is that the exodus results algorithm are identical. Furthermore based on the results of this can be selected one of them both in this research done by using the hybrid algorithm.

IV. Results And Discussion

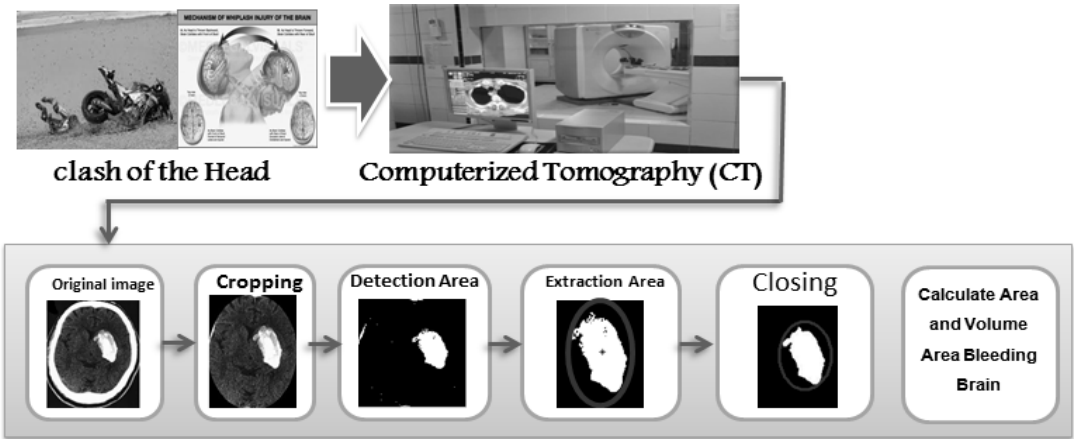


Figure 7 . The diagram of Overall Detection and Extraction

Table 1 shows the results of the calculation of the volume of the brain bleeding image area with the formula : The total pixels all slice * distance between slice * (number of slice - 1), the total pixels : 37,355.00 pixels 2 , the distance between the slice : 0.05 cm, number of slice : 10 , volume : 80,04 cm 3 , the execution time : 5 seconds . Overall detection, extraction and BRR s can be depicted in the Fugure 1 5 , the results of this research can help parties doctors and radiologists to analyze the image of the results of the CT Scan, so that a doctor and radiologists not one interpretation in detect and diagnose brain bleeding Scan CT results. In the end the decision making that is different between the doctors or experts radiology i can be resolved.

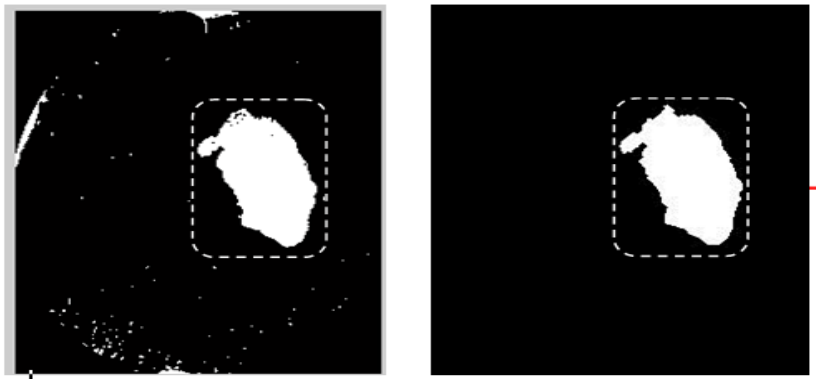
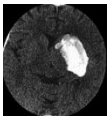
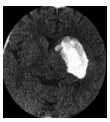
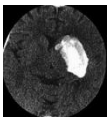
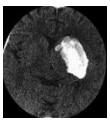
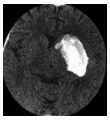
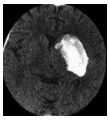


Figure 8. (a) Input Image Area Detection Results Brain bleeding (b) the image of the results of extraction of the area of the brain bleeding

Figure 8. (a) is the stage to eliminate the black spots object in area where seen that bleeding area of the brain has not been detected perfectly. This can be seen the existence of the black spots in the area of heavy bleeding, including on the main areas. The results of the bleeding area extraction has not mixed with noise such as Figure 8. (b) For that can be done the calculation area that bleeding cool, the process can be done by searching for each slice (pieces) brain every patient . The brain Slice every patient there 6-10 and not all slice slices bleeding so it needed a slice bleeding.

Table 1. The Results Of Extensive Calculations And The Volume Of The Brain Bleeding Area

The Image of A CT Scan results (cropping)	Extraction brain injury	Area pixels / Slices	Total Area All Slices	Volume Bleeding Cm 3
		5164	37.355	80,04
		5115		
		5112		
		5164		
		5115		
		5164		

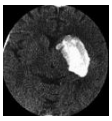
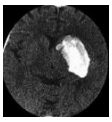
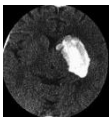
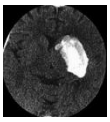
		5115		
		5164		
		5115		
		5112		

Table 2. The Level Of Testing The Accuracy Of The Algorithm With 10 Slices

Slices	Ground Truth (Number of Pixel)	Hybrid Method (Number of Pixel)	The Difference (Number of Pixel)	% of The level of Err	% Accuracy
Slice 1	5239	5164	75	2.86	97.14
Slice 2	5218	5115	103	3.95	96.05
Slice 3	5214	5112	102	3.91	96.09
Slice 4	5239	5164	75	2.86	97.14
Slice 5	5218	5115	103	3.95	96.05
Slice 6	5214	5164	50	1.92	98.08
Slice 7	5239	5115	124	4.73	95.27
Slice 8	5239	5164	75	2.86	97.14
Slice 9	5218	5115	103	3.95	96.05
Slice 10	5214	5112	102	3.91	96.09
The average			93	3.57	96.43

Table 2 shows the results of testing the level of accuracy with the method is Hybrid compared with the Ground Truth, result calculation to get the level of accuracy of ten slices by an average of 96.43%. Table 2. The results of the test calculations between the Hybrid thresholding method and Ground Truth with 10 slices is as follows: The Hybrid method of difference area bleeding slices 1 = 175 pixels, slice 2 = 203 pixels and slice 3 = 202 pixels, slice 4 = 75 pixels, slice 5 = 103 pixels and slice 6 = 50 pixels, slice 7 = 125 pixels, slice 8 = 75 pixels and slice 9 = 103 pixels and slices 10 =102 pixels, calculation error level with Hybrid method slice 1 = 2.86%, slice 2 = 3.95%, slice 3 = 3.91%, slice 4 = 2.86%, slice 5 = 3.95%, slice 6 = gained 1.92%, slice 7 = 4.73%, slice 8 = 2.86%, slice 9 = 3.95%, slice 10 = 3.91% , and the calculation of the level of accuracy of the slices 1 = 97.14%, slice 2 = 96.05%, slice 3 = 96.09%, slice 4 = 97.14%, slice 5 = 96.05%, slice 6 = 98.08%, slice 7 = 95.27%, slice 8 = 97.14%, slice 9 = 96.05%, slice 10 = 96.09%, so that the average accuracy = 96.43%.

V. Conclusions

a. The algorithm *cropping* ellipse model proposed that can separate accurately 96.43 precent of the areas of the skull head and the brain from other areas in the image of a CT scan. This result is very easy and can speed up the process of extraction of the area in the brain bleeding.
b. Hybrid thresholding object area is very effective 96.43 precent in Do segmentation and extract the area of the brain bleeding.
c. Extensive counting algorithm and volume can calculate the area of the brain bleeding per slice and volume

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References

[1] FCA, Fact sheet: TBI Traumatic Injury: selected statistics. Http://www.caregiver.org/factsheets/tbi_statsC.html , (1998)

[2] C. GillebertR., GlynW.Humphreys G.W., Mantini G., Automated delineation of stroke lesions using heading brain CT images, NeuroImage: Clinical 4 (2014) 540-548, jourual home page : www.elsevier.com/locate/ynicl

[3] Karuna M. and Joshi A. (2013), Automatic Detection And Severity Analysis Of Brain Tumors Using Heading Gui In Matlab, IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308

[4] Samopa F. and Asanoa A. (2009), Hybrid Image Thresholding Method using heading Edge Detection, IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.4

[5] Sharma B. and Venugopalan K.. (2012), Automatic Segmentation of Brain CT Scan Image to Identify Hemorrhages, International Journal of Computer Applications (0975 - 8887) Volume 40- No.10

[6] Srimani P.K. and Mahesh S. (2013), A Comparative Study of Different Segmentation Techniques for Brain Tumour Detection, International Association of Scientific Innovation and Research (IASIR) (An Association Unifying the Sciences, Engineering, and Applied Research), ISSN (Print): 2279-0047, ISSN (Online): 2279-0055

[7] T. Gong, R. Liu, L. T. Class enterprise, N. Farzad, C. K. Lee, B. C. Sexual perversity, Q. Tian, S. Tang, and Z. Zhang. (2007), Classification of CT Brain Images of Head Trauma

[8] Tan T. L., K. S. Sim card, C.K. Tan and A. K.Chong. (2008), CT Image Enhancement by Colorization for Brain Infarct Detection', Faculty of Engineering and Technology, Multimedia University, Way Ayer Keroh Long, Negeri Melaka 75450, Malaysia, and the Department of Diagnostic Imaging, Negeri Melaka Hospital, Way Mufti Haj Khalil, Negeri Melaka 75400, Malaysia

[9] Wenan Chen, Rebecca Smith, Soo-Yeon Ji, Kevin R Esponsible and Kayvan Najarian. (2009), Automated laparoscopic assisted ventricular systems segmentation in brain CT images by combining low-level and high-level egmentation template match, Published: 3 November 2009, BMC Medical Informatics and Decission making 2009, 9(Suppl 1):S4 doi:10.1186/1472- 6947-9-S1-S4, 2009

[10] Xuguang Qi, Belle, Sharad Ashwin Shandilya, Wena n Chen, Charles Cockrell, Tang, Kevin R. Ward, Rosalyn H. Hargraves, Kayvan Najarian. (2013), Ideal Midline Detection, Open the Journal of Medical Imaging, 3, 51-59 http://dx.doi.org/10.4236/ojmi.2013.32007 Published Online June 2013

http://www.scirp.org/journal/ojmi

[11] Rumah Sakit Umum Pusat Dr. M. Djamil. (2015), Buku Radiologi**,** Jl. Perintis Kemerdekaan Padang 25127 - Sumatera Barat, Telp. 0751 32373 Hunting Fax. 0751 32371, email: rsmdpdg@indosat.net

[12] Zasler N. D., MD, Douglas I. Katz, MD, Ross D. Zafonte, David B. Arciniegas, MD. (2012), Brain injury medicine: principles and practice. 2nd Edition. Demos Medical Publishing.

[13] Valadka AB, Gopinath SP, Contant CF, Uzura M, Robertson. (1998), Relationship of brain tissue PO2 to outcome after severe head injury. Critical care medicine. 1998; 26(9): 1576-1581.

[14] Sumijan, Madenda S., Harlan J. (2015), Deteksi Perdarahan Otak Manusia Pada Citra CT-Scan dengan Pengembangan Metode Otsu Sebagai Identifikasi Cedera Otak. Prosiding Seminar Ilmiah Nasional Teknologi Komputer (SENATKOM). Padang.

[15] Alvia Ferry Mandalasari (2013), Segmentasi Citra Medis menggunakan Metode Otsu dan Iterasi. Skripsi Thesis. Yogyakarta. Teknik Informatika Fakultas Sains dan Teknologi UIN Sunan Kalijaga

[16] Utasi, Á., Kiss, Á., & Szirányi, T. (2009), Statistical filters for crowd image analysis. In Performance Evaluation of Tracking and Surveillance workshop at CVPR. 2009. :95-100.

[17] Rajendran P. and Madheswaran M. (2010), Hybrid Medical Image Classification Using Association Rule Mining with Decision Tree Algorithm. Journal of Computing. 2010; 2(1). 127-136.