

Hybrids Otsu Method, Feature region and Mathematical Morphology for Calculating Volume Hemorrhage Brain on CT-Scan Image and 3D Reconstruction

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Abstract

Hemorrhage in the brain is a process of pathological culture from the tissues of the brain with the strength of the external mechanical, which cause physical disorders, cognitive function, and psychosocial support. Brain bleeding can cause was bruised, network torn, bleeding and brain damage or death. Segmentation techniques can be done with the Scanner computed tomography images (CT-scan) to detect the abnormalities or bleeding of the brain which occurs in the brain. This research describes the taking of an area of the brain bleeding on each image slice CT-scan and reconstruction 3D, to visualize the image of the 3D and calculate the volume of the brain bleeding. Extraction of bleeding area of the brain is based on a hybrids of Otsu algorithm, morphological features algorithm algorithm and an area of bleeding. For the reconstruction of 3D area on the area of bleeding from a slice 2D is done by using a linear interpolation approach.

Keywords: CT-scan, featured region, Otsu, morphology, volume area, incision brain injury

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1. Introduction

With the increasing number of transportation vehicles with an affordable cost for the community especially motor vehicles accessible two, resulted in an increase in the number of traffic accident in Indonesia. Similarly, increasing the number of labor, industry contribute to the increasing number of occupational accidents. An accident can occur because of the activities of the sport, distribution hobby hunting and so on. The accident on the cause 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 [1]. From all cases of brain injury according to data traffic Police of West Sumatra in Indonesia in 2014 around 49% caused by motorcycle accidents. The brain injury most often found at the age of 15 to 24 years, and two times greater in men than women [2].

According to TBI Recovery Center (2006), Tbi traumatic injury (TBI) is bleeding brain caused by the trauma on the head. If there is a trauma on the brain, but the skull is not damaged, TBI is known as a closed head injury. This can happen, for example, if a person in a car accident or motor and head stuck on the steering wheel and not broken the bones of the skull. Traumatic brain bleeding including the fourth stage of the leading causes of death in developed countries [3]. Most patients can survive on TBI lightweight, TBI and TBI weight suffer persistent neuropsikologis problems.

When this has been developed much medical image acquisition technology equipment, one of them is the technology that is often called CT scan. CT Scan (Computed Tomography Scan) is a procedure that is used to get the picture of the various small area of the bones including the skull of the head and the brain. The Image of the results of the acquisition or recording CT Scan can be designed to clarify the suspicion that strong about the abnormalities occur in the brain, for example: image lesion from the tumor, haematoma and abscesses, bleeding on the brain and vascular changes in the form of malformations, rose revelation undergo vascularisation and myocardial. The equipment scanned CT system consists of three parts, namely: Acquisition System Image, Computer System and control, Operating Station and

the station observers [19]. CT Scan work in image acquisition system there is in the frame of the tube from the engine and is part of the system that directly deal with patients. The Scanner consists of a light source of x, collimator, detector systems and the data acquisition [1, 3].

The acquisition of the image of the CT Scan of the brain usually done in the form of 2 dimensions (2D) recorded in the form of slice (sliced) with a certain distance between a layout similar to the one against the other slice. On each image slice to represent the state of the brain on the slice position. Visual inforasi representation is a variation of the intensity of the color or the level of keabuan from slices of the brain and other objects (when), as shown by the Figure 1(a) shows one slice image of normal brain and Figure 1(b) is a slice of the brain is not a normal image and the white area in the brain is an area of bleeding [4].

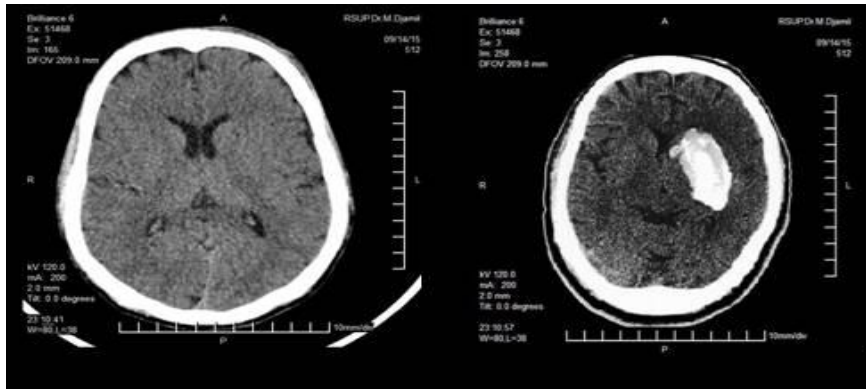


Figure 1. (a) The Image of the Brain Normal, (b) The Image of the Brain there is Bleeding

According to Basavaprasad B, Ravi M [5] In the subsidy debate explain the understanding of the image in the input is an image of the output and is the standard description of an image. Some important applications from the processing of the image in the field of science and technology, remote sensing, features extraction, face detection, expected, optical character recognition, finger print detection, sorting optical drive, argument reality, microscope imaging, lane route,, medical image processing, and though the morphological image. Kou Z, Wu Z, Tong KA, Holshouser B, Benson R, Hu J, Haacke EM [6], In the subsidy debate said MRI and applications in identifying the bleeding brain have shown the potential for the detection of the bleeding of the brain and can improve the detection of the bleeding of the brain and the results of the optimal prediction [5, 6].

According to Gajdhane AV, Deshpande LM [7] a detection system bleeding brain using image processing used for classifying on the bleeding brain on CT Scan. With the MATLAB implementation by making the procedure. In the image processing procedure, such as the process of pre-processing, segmentation and feature extraction done in detail. Produce a more accurate image of the processed using various techniques of segmentation and enhancements. Joseph RP, Singh CS, Manikandan M [8] in the subsidy debate explain the segmentation of the image of the brain with MRI using this method the algorithm K-mean with clustering with the morphological filtering to avoid misclustered areas of which will eventually formed after segmentation of the image of the brain with an MRI to detect tumor area [7, 8].

Vijaya G, Suhasini A, Priya R [9] explained in the paper The scientific rigor cancer detection Scheme consists of four stages. They, preprocessing segmentation feature extraction and classification,. Four levels is used in image processing to improve the tumor precise identification [9]. The end result of this paper is to find a cancerous tumor as are benign (or) malignant. According to Akanji OA, Akinola RA, Balogun BO, Akano AO, Atalabi OM, Akinkunmi MAN, Awosanya GOG [10], confirm the robustness CT scan in detecting both intracranial skull cavity and additional skull lesions in patients with head injury, which is the most common cause, while the lesion is most often cerebral contusion.

Tan in the subsidy debate Tan, SIM Card KS, Tan CK, Chong AK [11] to do research on the improvement of the quality of the CT images of the brain with the aim 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 [11]. 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 [13].

The next research (Wenan Wenan C, Smith R, Ji SY, Esponsible KR, Najarian K [15]), in this research suggested that the 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 the segmentation and identify the bleeding arrhythmia brain. The latest research about brain bleeding is done by the Sela [14] proposed algorithm Neuro Fuzzy and extraction ROI for medeteksi and identify and measure the area of the brain abnormal bleeding with different locations vary in the form of the image of a CT scan of the brain 2D [12, 14]. This research suggests the topic of resource extraction in the area of the brain bleeding in each image slice CT scan, reconstruction form of 3D area bleeding and counting their volume.

2. Research Method

Diagram block from the whole process of the system can be described as in the Figure 3. The Image of the brain that is used in this program is the image of the brain results from CT-Scans brain bleeding. The process on the diagram of the most important system consists of the selection of the pieces of heavy bleeding, enter the area border bleeding, bleeding detection and counting the volume. The method or sequence of research done in this research is described in the Figure 3. This research consists of 6 stages namely:

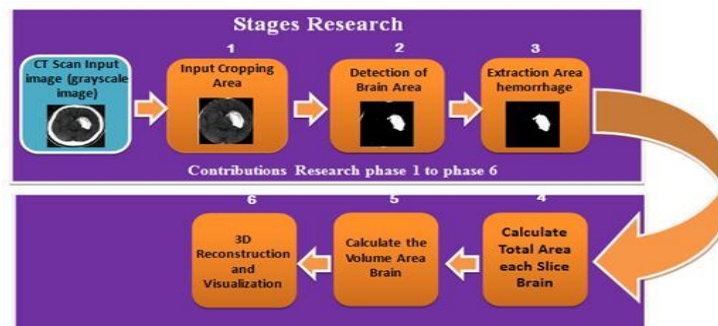


Figure 2. The Method Developed

2.1. Otsu and Feature Region Method

Otsu method published by Nobuyuki Otsu. This method of determining the value of the threshold with how to distinguish the two groups, namely the object and the background that has the part that rests on each other, based on histogram (see Figure 3) [16].

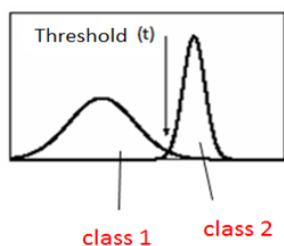


Figure 3. The Determination of the Value of the Threshold to Obtain Optimal Results



Figure 4. (a) Representation of the Region with the Approach of Ellipse Shape, (b) Representation of the Region with the Approach of Square Form

The principle of Otsu method described below. First of all, probability value of the intensity of the histogram is calculated through the formula as follows:

$$p(i) = \frac{ni}{N}, p(i) \geq 0, \sum_1^{256} p(i) = 1 \quad (1)$$

The method feature region of an object is represented as a region with Ellipse shape approach. Figure 4. shows a region from the white pixels that direpsentasikan with Ellipse shape approach. In the Figure 4. visible blue line indicates the firebrand presidents of major and minor firebrand presidents and white point as the foci of the Ellipse shape [17].

2.2. Mathematics Marfologi Method

The morphology method mathematics is a branch of image processing which is very useful to analyze the form in the image. Matlab has many tools for morphology binary form in the box image processing equipment; most of which can be used to grayscale or monochrome documents at morphology also. The Theory of morphology of mathematics can be developed in many different problems. We will adopt one of the standard method that uses the operation on the set of points [15, 18].

Two underlying operations namely dilasi morphology and erosion. Two other operations that are very useful in the processing of the image is the opening and closing formed through two basic operations.

(a) **Opening:** Smooth lines and the form of the object, eliminating the parts that narrow, and eliminating.

(b) **Closing:** Tend to smooth lines form but the reversal of the opening, rejected the pieces of narrow and long bay and thin, removes small hole and fill the gap on the lines of the form (contour).

3. Results and Analysis

3.1. The First Phase Input Cropping Area

Cropping process aims to eliminate unnecessary noise outside of the object of research, determine the image of the object of research to be analyzed and processed, and minimize original brain image size that can be easily processed and analyzed.

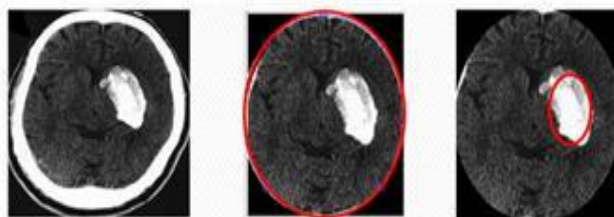


Figure 6. (a) Original image, (b) Cropping process, (c) Cropping results

The algorithm used to cropping process is ellipse shape as:

1. **Start**
2. **Read the input image**
3. **Show the input image**
4. **Calculate sum the size and intensity**
5. **Determine the midpoint of**
6. **Determine the radius of the midpoint**
7. **According coordinates and position of the ellipse will cropping**
8. **The process of cropping**
9. **View the results of cropping**
10. **Save results**
11. **Finish**

In The Figure 6(c) cropping process results from patients consists of ten slices in the brain shows no white color bleeding brain in all slices, for that done the process of detection and extraction.

3.2. The Second Phase of the Detection Areas of the Brain

The purpose of this stage is to determine which areas of the brain bleeding that is not mixed with white area boundaries are not an area that is bleeding, to distinguish between the

object to be studied and objects that are not investigated because both are white by Otsu method.

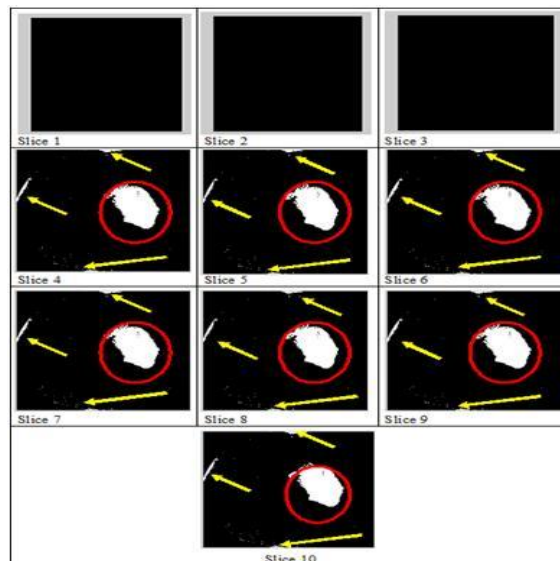


Figure 7. The results of the Detection Area of the Brain Hemorrhage

The results of the detection of the brain bleeding using Otsu algorithm is still bleeding, the image is still mixed with noise such as seen in the position of the bottom left and top (appointed the arrow with the yellow color). For that we need to do the process of separation between the image of the brain bleeding cool and not the image of the brain bleeding, the process can be done by removing the area not search using the feature extraction algorithm region.

3.3. The Third Stage of the Extraction Area of the Brain

This stage aims to throw a black dot on the image of brain bleeding from the bleeding area detection based methods Morphological (closing process).

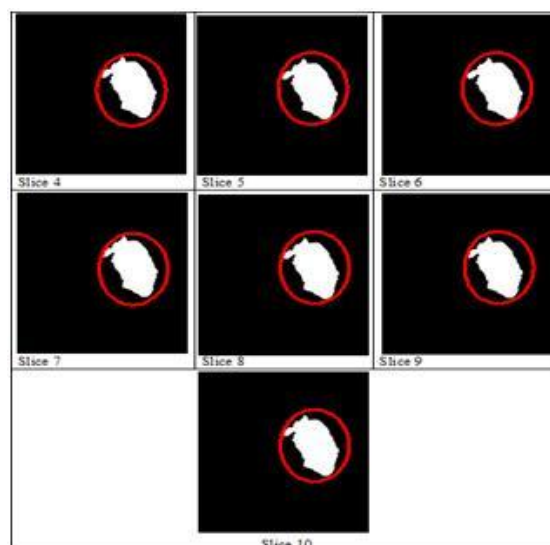


Figure 8. Results of Extraction Areas of Brain Hemorrhage

The results of the detection of the brain bleeding using Morphological algorithm, the extraction area the bleeding area detection based methods Morphological (closing process).

3.4. The Fourth Stage of Calculating the Area of each Slice Brain

The purpose of this stage is to calculate the area of a brain hemorrhage per incision that has been extracted for calculating the area of a brain hemorrhage and regionprops Bwareaopen method is used. To further carry out extensive conversion of the object in pixels into a square centimeter. Calculation of area and volume of brain hemorrhage are algorithm can be seen below.

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Start 2. Input image cropping results 3. Change the gray scale image into a binary 4. Eliminate noise area <of 8 pixels 5. Determine the area of each object and list the address and index constituent pixels, (s1 = regionprops (BW, 'Area', 'PixelList', 'PixelIdxList')); 6. Check the position of each object to k, if located on the outskirts of the image, delete the area (not the searched area) If not, do step 7. 7. Check the next area (k = k + 1), if still exists, repeat langkah 6 If not, do to 8 8. Show the end result (searched area) 9. Determine the number of the searched area and calculate the area of each area of the object as well as its position. 10. Finish | <ol style="list-style-type: none"> 1. Start 2. The sum = 0 3. Check each file incision brain; for n = 1: n 4. Change the file name of the integer i to string; filename = strcat (int2str (n), '. jpg'); 5. Read the corresponding input image file incision is found; I = imread (filename); 6. Eliminate noise area <of 8 pixels; BW = bwareaopen (I, 8); 7. Determine the magnitude of each area of each incision (object) and the mailing address and index constituent pixels, s1 = regionprops (BW, 'Area', 'PixelList', 'PixelIdxList'); 8. Calculate the total area of the whole incision, sum = sum + s1.Area; 9. If still there, repeat step 3 10. View the results of its total land area, disp (['Total Total Area:', num2str (sum)]); 11. Finish |
|--|--|

Next step Calculating Total Area Bleeding entire Slice. The its algorithm can be seen below.

3.5. The Fifth Stage of Calculating the Volume of Brain Area

The purpose of this stage to calculate the volume of the bleeding area of the brain that has been successfully calculated the area of a brain hemorrhage. To further converting the volume of objects in the bleeding area of pixels into a cubic centimeter. To calculate the area of a brain hemorrhage that has successfully segmented object is to convert the area into a pixel in a square centimeter. The image of the inputs used in this application is 512 x 512 pixels. Based on an application for DICOM Viewer, the image size of 512 pixels obtained has a length of 36.12 cm from the descriptions, the authors found that 1 cm = 14.1750 pixels and 1 pixel = 0.0706 cm². Representation of 1 square pixels would be worth 0.0050 mm². These values will be used to calculate the volume of a brain haemorrhage image area.

Algorithm of haemorrhage Entire Area Volume Slice can be seen below.

1. **Start**
2. **The sum = 0 and volcedera = 0**
3. **Check each file incision brain; for n = 1: n**
4. **Change the file name of the integer i to string; filename = strcat (int2str (n), '. jpg');**
5. **Read the corresponding input image file incision is found; I = imread (filename);**
6. **Eliminate noise area <of 8 pixels; BW = bwareaopen (I, 8);**
7. **Determine the magnitude of each area of each incision (object) and the mailing address and index constituent pixels, s1 = regionprops (BW, 'Area', 'PixelList', 'PixelIdxList');**
8. **Calculate the total area of the whole incision, sum = sum + s1.Area;**
9. **If it still exists, repeat langkah 3**
10. **View the results of its total land area, disp (['Total Area:', num2str (sum)]);**
11. **Calculate the volume of the injured area with the formula:**

$$V = \text{total pixels entire distance between incision} \cdot (\text{number of incisions} - 1) \text{ in units of cm}^3, v = ((\text{sum} * 0.5) * (n-1)) * 0.00497686157265625;$$
12. **View the results of the calculation to find the volume area, disp (['Volume Area Injury:' num2str (volcedera)]);**
13. **Finish**

3.6. The Final Stage of the 3D Reconstruction and Visualization:

3-dimensional image reconstruction is formed from two-dimensional image of a brain hemorrhage that has terdektesi perfectly resulting from the extraction process with the morphology method.

Algorithm of 3D reconstruction process as shown below.

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Start 2. Determine the input image file 3. Determine the number of incisions were reconstructed in 3D 4. Determine the coordinates Xt, Yt, Zt 5. Set Volume = 0 6. sets the input image beginning with 1 7. sets the input image file name and extension 8. Read the input image 9. Determine the size of the input image 10. Check the image of each slice to i, Specify the file name input image Read input image conversion to fractional Perform re-size the image input Show the results of re-size image | <ol style="list-style-type: none"> Determine Gsegment the input image Show with any 3D reconstruction cutlet Eliminate noise area <of 8 pixels Determine each incision area and index constituent pixels Calculate the volume of each incision area bleeding 11. If there is still next incisions, repeat steps 9 12. Calculate the total volume of the entire incision 13. Show the total volume of the entire incision 14. Perform 3D reconstruction 15. View the results of reconstruction and 3D visualization 16. Do Rotation 360o 17. Finish |
|---|---|

Table 1 shows Wide Area Measurement Results Bleeding Pixel 2 Each incision is segmented automatically.

Table 1. Wide Area Pixel

| No. | Slice No. | Total Area pixel ² |
|-----|-----------|-------------------------------|
| 1 | Slice 1 | 5,315 |
| 2 | Slice 2 | 5,315 |
| 3 | Slice 3 | 5,315 |
| 4 | Slice 4 | 5,315 |
| 5 | Slice 5 | 5,390 |
| 6 | Slice 6 | 5,390 |
| 7 | Slice 7 | 5,315 |
| | Total | 37,355 |

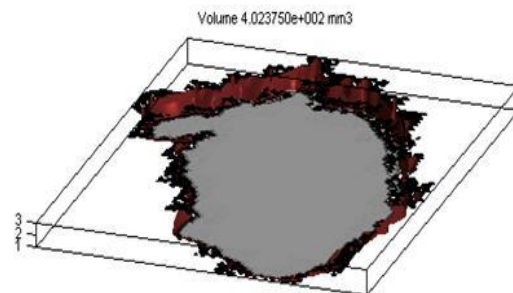


Figure 9. Reconstruction of the 3D Volume Slice Area 3 Brain Hemorrhage

Table 2 Measurement Result Shows volume area of brain hemorrhage.

Table 2. Volume area of brain hemorrhage

| No. Slice | Total Area piksel ² | Volume mm ³ | Volume Cm ³ |
|--------------|--------------------------------|------------------------|------------------------|
| Slice 1 | 5,315 | 1.32875 | 0.132875 |
| Slice 2 | 5,315 | 1.32875 | 0.132875 |
| Slice 3 | 5,315 | 1.32875 | 0.132875 |
| Slice 4 | 5,315 | 1.32875 | 0.132875 |
| Slice 5 | 5,390 | 1.3475 | 0.13475 |
| Slice 6 | 5,390 | 1.3475 | 0.13475 |
| Slice 7 | 5,315 | 1.32875 | 0.132875 |
| Total | 37,355 | 9.33875 | 0.933875 |

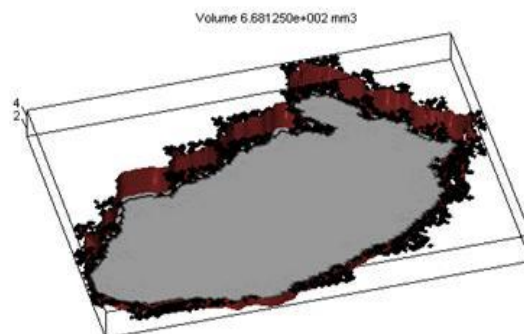


Figure 10. Reconstruction of the 3D Volume 5 Area Hemorrhage Brain Slices

Results 3D reconstruction of images 14 images 15 and 16. The images can be seen that consists of 7 incision bleeding of the brain which has an area of 37,355 pixel² bleeding and had bleeding volume 0.933875 9.33875 mm³ or cm³.

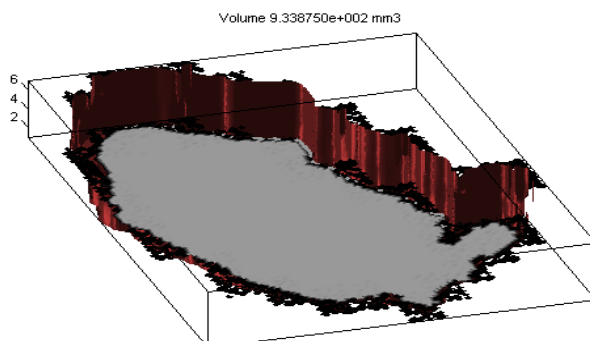


Figure 11. 3D reconstruction Hemorrhage Brain Area Volume 7 Slice

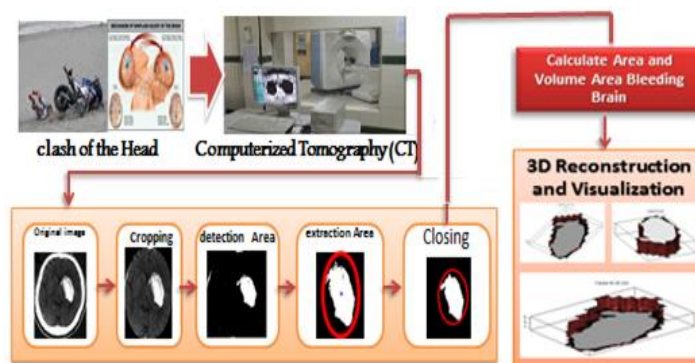


Figure 12. Diagram Overall Detection, Extraction and 3D Reconstruction

Results of calculating the volume of a brain haemorrhage image area with the formula: total pixels entire distance between Slice Slice * (number of Slice - 1), total pixels: 37,355.00 pixels², the distance between Slice: 0.05 cm, the amount Slice: 7, volume: 0,933 875 cm³, the execution time: 5 seconds. Overall detection, extraction and reconstruction can be illustrated in Figure 12, the results of this study can help the physicians and radiologists to analyze images from the CT scan results, so that a doctor and radiologist is not one of interpretation in detecting and diagnosing brain hemorrhage CT-results scan. In the end, different decision-making between physicians or radiologists can be overcome.

4. Conclusion

This research provides a method for segmentation, extraction and 3D reconstruction image of the incision. Merger Otsu method, feature region and Morphological can generate several things including:

1. Algorithm cropping elliptical proposed models can accurately separate area of the skull and the brain from other areas in the image of a CT scan. These results greatly facilitate and accelerate the process of extraction of hemorrhage in the brain area.

2. Combined Otsu method, the search and removal of objects as well as the area of mathematical morphology is very effective in segmenting and extracting areas of bleeding in the brain. Otsu algorithm is used to detect and Segmentation areas of brain hemorrhage and other areas that have a high intensity value. Search algorithm is developed to determine the position and area of each white area of Otsu algorithm results. Removal algorithm is used to identify and eliminate areas that are not part of the area Hemorrhage, so what is left is only the bleeding

area. Mathematical morphology algorithm used to cover parts of the bleeding area lost by previous processes.

3. The area and volume calculation algorithm can calculate the area of a cerebral hemorrhage per slice and the volume of the entire slice through 3D reconstruction bleeding area. 3D reconstruction algorithm used brain hemorrhage area is referring to the algorithm linear interpolation between two adjacent slices. For example in the case of test images that result for obtained an area of bleeding between 3.227 to 5.598 square pixel and total area = 37,355.00 pixel² of the total slice. Volume area after a brain hemorrhage in get to convert from cubic centimeter to square pixels, so that the volume of the hemorrhage area = 5.5773 cm³.

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