Region Of Interest: A Novel Technique To Improve Medical Assistance

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Abstract: Manual segmentation, a process in which an expert transcriber makes a speech file into different parts and also names each speech file by hand, having a glance only to the spectrogram and/or waveform. This process of manual segmentation is a difficult mechanism where it cannot achieve efficient results in some of the sensitive and complicated cases. In medical imaging, there are various methods and procedures which make the medical processes easier and also very much useful for the doctor to identify appropriate cause. Medical images are produced with the help of different electronic devices. These images make the doctor's job easier in identifying the underlying problem.

Index Terms: Medical Imaging, 2D, 3D, Manual segmentation, X-rays, MRI, CT scan, ROI

1. INTRODUCTION

A picture is a 2D form of 3D environment. If it is considered as a function f(x,y) in a graphical representation [8] with X,Y co-ordinates where x as abscissa, which gives length and y as ordinate, which gives height respectively with respect to the scale of the image. An image is assumed as a two variable function on the real number set as domain and co-domain. The value of function at any point in the co-ordinate axis is referred as the intensity value and also called as the gray level [4]. Intensity value gives us the intensity of that particular point in the image. Every point on the image specifies the gray value of that position. The gray values are in between the range zero to one (black-white color contrast). [7]. In the graph, the limit of X co-ordinate and Y co-ordinate are based on the picture quality and has any real value in the above specified range. Based on the function values, we can draw a graph. By this graph, we can get detailed information of the image, which is helpful in analyzing the image. So, that we can develop the image and also implement different image processing methods. If all the intensity values are finite, it is known to be a Digital Image. In most of the cases, Medical Imaging is helpful to know the disease and provide effective medical treatment. It helps us understanding the various region of interests and also anatomical structures of the any body organ.

Medical Resonance Imaging is most popularly used technique. By using this process we can get images of the internal body parts. But due to the complex nature of the images produced by this process, it makes radiologist difficult to understand. As the image creates more disturbances, we cannot separate it or select the required part. In medical image division process, we make image into different parts and diagnose the image more carefully in case of urgency. Medical image processing comprises of many steps whereas segmentation procedure plays an important role in separating image into meaningful regions and to have a clear study of the disease. The final data obtained by this process is taken into consideration for further diagnosis and also for taking important decisions like concluding the reason for malfunctioning of the organ and also to find a better and accurate solution for the disease. In 1980's image processing tools are added to medicine and these provided the images of the internal body parts to recognize the disease. They were mostly based on the 2D image datasets. In the next era of imaging techniques, we can notice different developments in the sphere of medical imaging by application of image models and optimization techniques. In 1990's the reference images are used to study the medical imaging structures, these are the most familiar ones of that time. But by using reference images, there are many difficulties. The major troubles in analyzing the image are:

- Low quality of the images
- The noise created by the image during separation of the image.

Further, many techniques were introduced in the medical imaging field and these made the work of doctors easy to find out a solution for the disease.

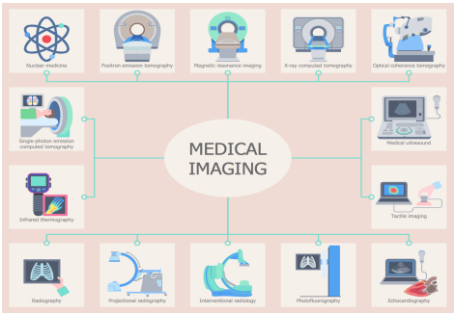

***Fig.** 1. Types of Medical Imaging*

1.1. INTRODUCTION TO MEDICAL IMAGING

As it is not an easy task to dissect a living person and to know the reason for abnormal functioning of organs we use modern techniques and methods to solve this issue. Medical imaging is a method used to scan all the internal organs of a human body and able to know the abnormalities in the functioning of any body organ. It is the process of making a visual interpretation of the interior parts of a body for medical analysis or diagnosis. This imaging technique helps doctors to know the disease and also to find a solution for the disease. These images are of two forms either two dimensional or three dimensional. Doctors are able to find out the working of the internal organs by this method; either they are functioning normal or else having any

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abnormality in functioning.The images obtained by medical scanning processes are 2D form of the internal parts of the body. In 2D medical imaging wave signals are sent into the body. These signals are received in the same plane and reflected waves give a black and white image. By this process X-rays, MRI, CT scan, etc. are done. By the methods mentioned above, doctors are able to know the problem accurately. Thus, doctors can find a proper solution and can give treatment to the patient. It is price-friendly to the patient so that many can choose this method and cure disease. But this method is not suitable in all cases due to its limitation it cannot get proper information regarding the tissues, tumors. Then doctors suggest for other advanced method to know the problem. In the present years, 3D medical imaging is widely used. This helps in improving the efficiency of the treatment and also the patient can get accurate treatment. 3D imaging technique has capabilities of reconstruction, visualization of multi dimension data. This method provides quantitative and qualitative data analysis for the doctor to identify the disease and treat the patient. It involves 3 steps fig.2.

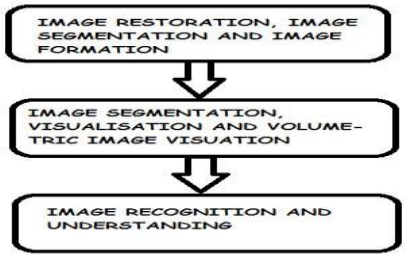

Fig. 2*. Steps in Medical Imaging*

Information regarding the disease or malfunctioning is more important for treatment. And it varies in 2D and 3D view as shown in fig. 3.

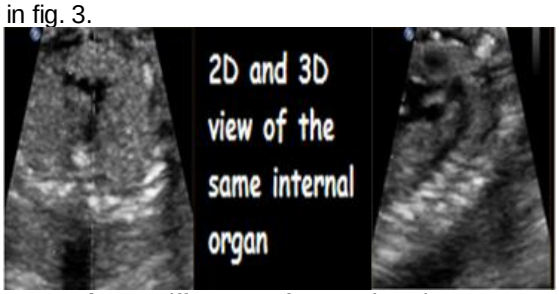

Fig. 3*. Difference of 2D and 3D image*

Image segmentation as the name suggests making the image into many parts. It is a process of separating image data into meaningful parts. It helps in further identifying the disease and also planning a solution for the disease. This also helps in identifying the functioning of different organs. Thus by this method the patient can get early and efficient treatment towards the disease. There are many types of medical imaging techniques as mentioned above namely, radiography, MRI, Ultrasound, Tomography, Echocardiography, Nuclear medicine, etc. In case of pregnant woman it is commonly used to know the growth of the baby and by this doctor can give any suggestions regarding parental care for the better development of the fetus.

TYPES OF MEDICAL IMAGING

The various types of medical imaging are described in fig.1.

MAGNETIC RESONANCE IMAGING

MRI uses strong magnets to polarize and excite the h-atoms present in water (H_2O) molecules in the animal tissues. Radio waves are used in this process. It produces a radio frequency resonant with the atoms. And also a computer is used to have detailed view of the internal organs. They are mostly used for diagnosis soft tissues and nervous system [3][8]. They do not produce any damaging radiation. MRI is mostly useful in the diagnosis of the functioning of brain. It gives us the information about the activity of the brain. In case of brain surgery, it helps in brain mapping which gives doctors clear idea to plan for the surgery.

RADIOGRAPHY

Radiography is also defined as first line investigation in the area of the orthopedics. It is based on difference in radiographic density. It uses a little amount of ionizing radiation to show the body's internal structure. It is the oldest and most frequently used method in medical imaging process. They are mostly used for in case of fractures and also any issues of tissues. But in case of soft tissues radiography cannot give the best results. As it gives best results in the area of orthopedics, radiography is widely used. Radiography has some difficulties in understanding the image due to the superimposition of the structures. And thus they are less informative.

NUCLEAR MEDICINES

Nuclear medicines technique uses radioactive substances for this technique for the analysis of the body parts. They are sent into blood, inhaled or swallowed. By using gamma rays and special cameras, computers create images of internal body parts. These cameras consist of a radio sensitive crystal they help in knowing the spreading of the radioactive substance in the body. It is used to scan different parts of the body like lungs, kidneys and also to know the metabolism of the bones. This method is not suggested for everyone it has some limitations due to radioactive substances. It gives unique data compared to that of other techniques. This technique is used to treat diseases like cancer. High dose of radiation is sent into the body of the patient, this is transmitted towards the diseased organ.

TOMOGRAPHY

Tomography is a method used to display the whole body by using x-rays or ultrasound. It used to produce images of deep internal parts of the body. It produces sectional view of the internal organs. The radiation is emitted and it helps in studying the internal parts of the body. There are different types of tomography techniques depending on the requirement doctors recommend for a particular tomography technique. This method is available at very low prices and here we do not use any damaging ionizing radiations. It is one of the mostly used techniques.

ECHOCARDIOGRAM

Echocardiogram technique is mostly used to know the condition of heart and nearby blood vessels. It is used for producing images of heart using sound waves. High frequencies of sound waves are passed into the body, they create echo by colliding with the different internal body parts. The image is an echo diagram. Echocardiogram is helpful in knowing the pumping conditions of the heart. This method gives the information related to the heart diseases and also helps doctors to decide the best solution for the problem. It tells us the health of the muscle of heart. It also helps in determining the health of the baby in the pregnant woman.

ELASTOGRAPHY

Elastography is a type of imaging test that checks liver for fibrosis and also for finding the stiffness of the tissues. It uses ultrasound for imaging process. This method calculates the elastic properties of tissue by collecting the echo from the ultrasound. Fibrosis is a condition that limits the blood flow into the liver. By this process, at the early stages of the fibrosis we can limit the situation and we can have better treatment for curing of the disease. This technique is widely used in the area of muscles and tissues. This method gives us the clear idea about the health of the tissues or muscles. It also helps in checking the functioning of the some of the important organs and glands like pancreas.

PHOTOACOUSTIC IMAGING

Photo acoustic imaging allows the pass out of the light energy from the tissues which results in a thermo elastic expansion. It is an optical imaging with high spatial resolution of ultrasound imaging. By this process we can also have a glance at the organelles of the cells. Photo acoustic imaging can be regarded as ultrasound image in which the image quality does not depend on the environment of the medium. Due to these complex specifications, we can watch the blood flow in the blood vessels, metabolism of the blood vessels and also the oxygen levels in the blood. Thus this method is most helpful at molecular level diagnosis. It is also used for cancer treatment and also variation of temperature in the body parts during treatment.

ULTRASOUND

It is a medical technique, using high frequency of sound waves. It is also known as sonography. It is something like SONOR. It allows doctor to have a clear vision of internal body organs. It does not use any radiation in this technique, thus they are safe. It sends sound waves and these are reflected back to the transducer by the tissues. And thus they produce electrical signals which are sent into the scanner, and thus it produces the image of the internal organs. In most of the cases either ultrasound or MRI is used to know the disease and also to find out a proper solution to the disease. They are helpful in getting information related to blood pressure and also the health of the tissues. It is mostly used in case of the pregnancy and also used for scanning of the sensitive organs in the human body. But it also has some drawbacks in case of diagnosis of some sensitive parts due to environmental reasons.

i). INTRODUCTION TO 2D MEDICAL IMAGING

In general, medical imaging system, we get 2D images of the internal organs as shown in fig. 4. This is widely used imaging process. The 2D images can give us information about only some of the abnormalities in case of functioning of an organ. This technique is mostly used in detecting fractures in bones and it also helps surgeon to study the actual anatomy of a patient. But here there is a constraint because it produces only a two dimensional view of an organ and it requires some imagination which in practical may not be the same. This can be overcome by 3D imaging technique [6].

Fig 4. *2D Medical Imaging*

ii). INTRODUCTION TO 3D MEDICAL IMAGING

The example of 3D imaging shown in Fig. 5, we get actual view of the internal organs of the body. It creates a 3D visualization of the internal body parts. 3D imaging establishes a more innovative opportunity to represent all medical data in a precise way. This makes the doctor to get the clear idea of the functioning of the organ and also the abnormalities. This provides more information compared to that of 2D imaging techniques and it also helps doctor to give more accurate and efficient treatment to patient. In case of MRI scan it produces many images it takes more time to sort them in an order and study them however it involves some predictions. We can overcome this by using 3D imaging technique, which gives us cross section slices of the image and these can be combined into a 3D visual area. By using 3D technique we are able to have a real time view of the internal organs. There is a lot of ease in this case for the doctors to know the reason for abnormalities in functioning of the internal organs as it does not involve any predictions [2].

Fig. 5*. An animation of 3D Imaging*

It helps doctors from committing mistakes during surgery. The 3D imaging helps in studying the organization and internal structure of every person due to individual uniqueness of the organization of the body although, organizations of all the organs are same for every person. Thus doctors are able to have a clear study of the structural and functional system of a patient before undergoing a surgery. By 3D imaging we can come to know various kinds of disorders which we are unable to find using 2D imaging process. Thus, we are able to get more efficient information by 3D imaging.

iii). DIFFERENCE BETWEEN 2D AND 3D MEDICAL IMAGES

The main differences between 2D imaging and 3D imaging are shown in fig. 6.

- The main difference between them is the dimensional view of the image as the 3D gives the real view of the image whereas the 2D image gives the apparent view of the image.

- Images produced by 2D imaging process require prediction for further treatment of the person which is not required in case of the 3D imaging.
- We can get only quantitative analysis from 2D imaging whereas quantitative and also qualitative analysis from 3D imaging.
- We can identify only some type of disorders or abnormalities in case of 2D imaging whereas in 3D imaging we can get to know various kinds of disorders
- In case of 3D we can have in depth analysis of sensitive parts which is not possible in case of 2D.
- The treatment has more perfection in case of 3D when compared to that of 3D.

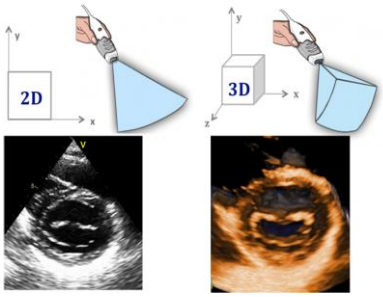

***Fig. 6**. Difference between 3D and 2D Image*

They difference in the dimensional view of the images gives a great variation at the time of the surgery because the surgery is a practical task and it should be done accurately without any errors, if any mistake is committed it risks the life of the patient. So, a surgeon must be more careful regarding this and he should have a clear idea about surgery and patient's body before performing surgery.

1.3. INTRODUCTION TO REGION OF INTREST (ROI)

In 3D imaging, to have a detailed view of a region we go with ROI shown in fig. 7. The ROI means the interested region which is considered for the medical analysis. It helps the user to select a particular region to examine and have a detailed study about that particular region. By this technique, the interested region is only viewed and it is analyzed to know the reason for malfunctioning of the organ

***Fig. 7**. An example of ROI*

2. PROCEDURE INVOLVED

The difference in 2D and 3D images make a major difference in treatment, by 3D process we can get precise information regarding the issue and the problem can be solved easily. Generally one prefers 2D imaging technique to 3D imaging technique because it is widely used and price friendly. If the doctor is unable to find disease they go for 3D. In 2D imaging we are only able to get a 2 dimensional view of a particular object whereas by 3D imaging we can get three dimensional view of an object. In case of 2D we are only able to get area of an object but in case of 3D we are able to get the volume of the object. In 3D imaging we can get to know the detailed information of the body part and doctor is able to give perfect treatment. Thus, from 3D images we can get more information than 2D images.

Step 1: Analyze the input.
Step 2: Show the input as a three Dimensional medical image.
Step 3: Select your interested area in the image which is needed.
Step 4: Create a binary image.
Step 5: Selected area is white inside the area which is not selected.
Step 6: Selected area is darks inside the area which is not selected.
Step 7: Selected area is untouched inside the image and dark outside the area.
Step 8: Display selected area.

Follow these steps carefully to get appropriate output.

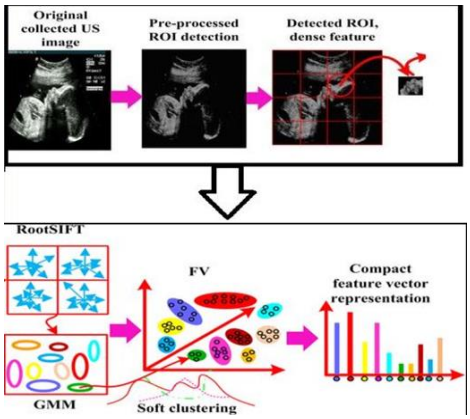

***Fig. 8**. The steps involved in selecting a ROI in 3D Medical Imaging*

The 3D form of an image, I is represented by I(x, y, z) where, I is denoted as the gray value at a particular point in the required image with respect to the three dimensional axial view, now select the region to diagnosis and apply masking technique. By using Matlab program for all comparisons which are helpful in selecting the region of interest for further medical process. By this process, we can select the required potion of image [5][9]. By using freehand tools, we can have the sketch of the diagram or selection of the part of an image in our desired way.

The tool functions as-

Where I is defined as imfreehand or imfreehand (I parent) or imfreehand (…, param1, val1 …).

Such that I = imfreehand (..., param1, val1 ...) helps in selecting a required region, with the parameters and particular points which exercises the property of the tool.

$$a \leq I(x, y, z) \leq b \text{--------} \rightarrow (1)$$

Here I (x, y, z) is the gray value at that point.
a and b are minimum point and maximum point respectively.

$$(a, b) \in \{1, 2, 3, 4, \ldots, 255\} \text{----} \rightarrow (2)$$

Let R be the ROI and H (x, y, z) was the untouched part then

$$R = I(x, y, z) - H(x, y, z) \text{------} \rightarrow (3)$$

In masking, we change the actual image 3D form into 2D form then,

$$(X\text{-}x) - (Y\text{-}y) = x_i / y_i \longrightarrow (4)$$

$$\text{Where } 0 \leq i \leq 255$$

X*Y = It is the contrast of actual Image

X_i*Y_i = It is the contrast of ROI image
x = the required region of the image that should be selected in the x-axis to get Region of interest.
y = the required region of the image that should be selected in the y-axis to get Region of interest.

$$Y = (Y_i / X_i) X + (Y - X * Y_i / X_i) \text{----} \rightarrow | (5)$$

Equation (3) is used for detecting the interested region in the given image, according to the discretion of the ROI technician and after choosing the interested region all the operations are made using the MATLAB tools for further image analysis. Thus, we evaluate the attributes and properties of the image for further data of the medical image.

3. DISCUSSIONS AND OUTPUTS

The results and discussions are based on the results obtained from the above procedure.
Input imageThe result of process depends on the contrast of the input medical image. After applying sequential procedure, it is difficult to get the data of the image, which is given initially. We get a 3D image as output by this method.

Select Region

There are different reasons for a doctor to go with ROI. ROI is used for analyzing the input data and it focuses on the selected area and gives detailed information regarding it. Here, we are able to select the required region and able to access it for further information.

Binary mask

In segmentation process, colored image is converted into binary image. This binary image will have 2 values for each point. Now, transform the existing image data into computer language format and then go by partition method [2].

Selected Region

Select the region and make it white and the unselected outside area from original form converted into binary image. In next step, make black inside and unselected outside area. The unselected outside area from actual form converted into binary image. Then make all white outside the region and untouched inside the region in original transformed into a binary form. In next step, make black outside the area and original is transformed into binary. Red dot represents centroid and green dot represents centre of mass image shown in fig. 9.

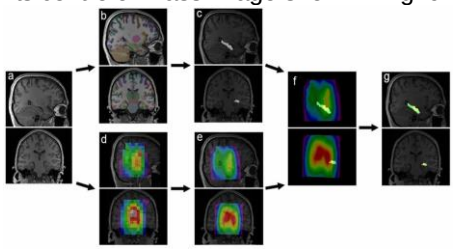

Fig. *9: ROI Technique methodology*

Interpretation on output

The steps are consequently executed in a single frame. We get the output in seconds. So that we can get to know the reason for abnormalities in the body very fast. By this we can also overcome manual errors.

4. EXPERIMENTAL EVALUATION

rinterestedregion.py - C:/Users/Admin/Desktop/rinterestedregion.py (3.6.8)
File Edit Format Run Options Window Help

```
import cv2
img=cv2.imread("km.jpg")

for i in range(30):
    contours=cv2.selectROI(img)

    x, y, width, height = contours
    roi = img[y:y+height, x:x+width]
    roi= cv2.resize(roi, None, fx= 0.6*5,
        fy= 0.6*5, interpolation= cv2.INTER_LINEAR)
    cv2.imwrite("roi.jpg", roi)
    img=cv2.imread("roi.jpg")
```

Fig. 10*. A sample code for ROI in python.*

By using cv2 module, a python code is developed to select Region of Interest in medical imaging. The command 'imread' is used to read the image. After reading the image, for further processing here we used for loop. The command 'selectROI' is used to select the interested region in medical image. From the previous command we get the return type, the return type is the various aspects of the selected region. By adjusting the image aspects, a new frame is created. This frame is allowed for further selection of interest till the loop breaks. By this way, we can select Region of which we needed to diagnose in a medical image.

5. EXPERIMENTAL RESULTS

Here is an example for a ROI from the medical image given in the fig 11. The medical image should be saved at the location specified in the program so that program can access the image and allow for selecting the required area.

Fig. 11: *A sample medical image.*

The output of the image after processing is shown below in the sequence.

Fig.11*. Step-1*

In the first step, the region of interest is selected bas4ed on the requirement.

***Fig. 12**. Step-2*

In the second step, the heart image is selected for diagnosis of the health of the heart walls.

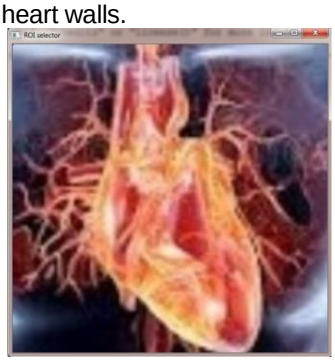

***Fig. 13**. Step-3*

In the third step, the heart image is more selected for checking the functioning of the arteries and veins.

***Fig. 14**. Step-4*

In the fourth step, the heart image is further selected for checking the functioning of the chambers of the heart.

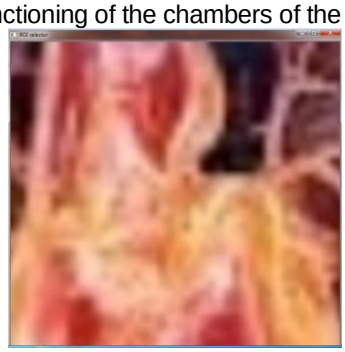

***Fig. 15**. Step-5*

In the fifth step, the image is further selected for diagnosis of the functioning of the heart.

***Fig. 16**. Step-6*

In the sixth step, the heart image is more selected to know the health of the tissues. Here in the figures 11, 12, 13, 14, 15, 16 are the experiment results after each and every iteration of the above experimental evaluation. Here a sample medical image of heart is shown. After selecting interested region for each and every iteration, the outputs are displayed. These outputs are diagnosed by a radiologist. Further doctors give effective treatment to the patient based on the report of the radiologist. By this way, we can use ROI in medical applications.

6. CONCLUSION

This paper discusses various aspects of ROI and the steps involved in ROI. It encourages one to prefer ROI in medical imaging over other methods because it gives more information. And this technique makes doctor easy to find the problem and they are able to give effective treatment to a patient. This method can overcome many real time problems and manual errors occurred in medical process. This method also saves image processing time, so that treatment can be provided in an earliest stages of underlying disease. In our experimental studies it is identify that ROI is best suitable method in selection of various regions in an image and it also gives accurate results when compared with some of the existing methods which are available in current literature.

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