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Centralized System for Ultrasound Machines with Automatic Femur Length Measurement

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Abstract— **Determining gender of a fetus is illegal in India, the reason being an orthodox mindset of few people. They go for aborting a fetus only because it's a female. Still there are some hospitals which commit this crime. Female feticide is a curse for a developing India as it depicts an underdeveloped mentality of its citizens. The ultrasound sonography centers, which are responsible for gender detection and take a ransom amount of bribe for it, are equally at fault. Unlike humans, machines cannot be misleading unless programmed for that. Therefore, we can expect a computerized system to help keep track on these activities in a sonography centre. We thus realize a need of a machine system to control this activity. The ultrasound machine can itself be devised for this. We intend to create a server which will be accessible only by specific authorized government officials. This central server will store data from sonography centers of a province. Before getting saved on the server, data will be sorted based on certain attributes like gestational age and other details of patient including the number and gender of previous children. Records supporting the above conditions will be stored on central server. The calculation of fetal age majorly depends upon femur length of fetus. So we propose an image processing algorithm to automatically detect the femur from ultrasound image and calculate its length. Advanced techniques of segmentation, thresholding and support vector machines can be used.**

Index Terms— **Femur length, gestational age, segmentation, intensity threshold, shape threshold, data sorting.**

I. INTRODUCTION

We aim at developing a client-server based system, where the ultrasound machines are clients and a responsible and authorized organization/s is/are server. The ultrasound machines are authorized by their license and license no. lets us know the sonography center where the machine is installed. The system takes unique ID number of patients which helps keeping track on them. The length of femur (thigh bone) of fetus decides its age of the fetus. Currently, this femur is detected manually by the radiologist, by marking the ends of femur on the ultrasound image obtained. At back end of this, a simple distance formula calculates femur length (FL). Proposed system applies an image processing algorithm to automatically detect femur and calculate FL. Further, the sonography report is automatically generated as well as sent to the server. Storing details of all the patients will consume a huge memory on the server side. Also, it is unnecessary to keep track on all the patients, as abortion is medically possible and is safe, only during 11-19 weeks of pregnancy. Before 11weeks, the femur is not well developed and beyond the period of 19weeks, any kind of abortion is illegal. Thus, proposed system sorts out patients (women) whose pregnancy period lies between 11-19 weeks, and stores only their details. Now, how will these details help? The authorities, who are made responsible to keep a check on this activity, will have less no. of women to keep watch on. Taking regular follow-ups of these women will make sure that, unethical steps like female feticide is not being undertaken. We are aware of the "keep patients' data confidential" policy of our government. Hence, access to the server of the system should be given to specific few authorities, so that the patient data remains hidden from the rest of the world. This project is a step to correct a social menace and we expect cooperation from respective authorities for its implementation.

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II. LITERATURE SURVEY

Fig 1. Ultrasound Image showing manual femur detection

The femur length is a mandatory measurement. Apart from knowing about the longitudinal growth of the fetus, measuring the FL has a very important function of excluding dwarfism in the fetus. By convention, measurement of the FL is considered accurate only when the image shows two blunted ends. The extension to the greater trochanter and the head of femur should not be included. If the femur image is at an angle of over 30 degrees to the horizontal, then the measurement is considered inaccurate. There is no evidence to suggest that the length of the femur does not shrink as much as the diameter of the head in case of fetal growth retardation. We can always have a fetus with an average size head and a longer or shorter than average lower limb. The measurements should be reported as they are. Average is not taken. The FL of dwarfs is below the mean, amounting to 4-5 weeks behind the

actual dates. There is abnormality in the limb at times. Remember the lateral surface of the femur is always straight and the medial surface is always curved.

A. Literature Review

The main step in image processing is image segmentation. A digital image is divided into multiple regions for the sake of analyzing. In order to distinguish different objects in an image segmentation can be used. The segmentation strategies are application dependent. General methods for ultrasound image segmentation do not exist [1]. Famous techniques of image segmentation which are still being used by the researchers are Edge Detection, Threshold, Histogram, Region based methods, and Watershed Transformation [2]. Few basic image segmentation techniques currently being used by the researchers and industry will be discussed and evaluated in this section. F. C. Monteiro [3] proposed an image segmentation method comprises of edge and region based information with the help of spectral method and morphological algorithm of watershed. Firstly, they reduce the noise from image using bilateral filter as a pre-processing step, secondly, region merging is used to perform preliminary segmentation, region similarity is generated and then graph based region grouping is perform using Multi-class Normalized Cut method. Berkley segmentation dataset is use as a dataset. They compare the technique with mean shift, multi-scale graph based segmentation. Refik Samet [4] proposed a new Fuzzy Rule based image segmentation technique to segment the rock thin segment images. They take RGB image of rock thin segment as input and give segmented mineral image as output. Fuzzy C Means is also applied on rock thin images and results are compared of both techniques. Firstly, the user will take sample image from minerals; features are distinguished on the basis of red, green and blue components of image. Membership function is defined for each component using Fuzzy rules. Each membership function represents the color's distribution in the image. Strong and weak points are defined, whereas strong points are considered as seed points and weak points become their members. Jinsheng Xiao [5] proposed a new non-linear discontinue partial differential equation (PDE) that models the level set method of gray images. A discrete method is also proposed to find numerical solution and to implement the filter. Non-Linear discontinue PDE formula is applied on image of cameramen using MATLAB. Results have shown that image edges and boundaries are remained blurred and can be shifted by using Close operator. More information can be saved by using the proposed scheme. Fengchun Zhang [6] presents a variation model using 4^{th} order PDE with 2^{nd} order PDE for finger vein image de-noising. Wencang Zhao [7] proposed a new image segmentation algorithm based on textural features and Neural Network to separate the targeted images from background. Dataset of micro-CT images are used. De-noising filter is used to remove noise from image as a pre-processing step, Feature extraction is performed next, and then Back Propagation Neural Network is created, and lastly, it modifies the weight number of network, and save the output. D. Barbosa [8] proposed a new image segmentation technique which joins the edge and region based information with spectral method using Morphological Watershed algorithms. Firstly noise filter is used with Magnitude Gradient in a pre-processing stage, secondly, pre-segmentation is done using region merging, then region similarity graph is generated and finally segmentation is performed using Multi Class Normalized Cut. Method is compared with Mean Shift, MNCUT, and JSEG using natural images. Proposed technique overcomes Spectral Clustering method. Gang Chen found that fast extraction of object information from a given image is still a problem for real time image processing. They also found that region based methods are time consuming and do not give effective segmentation.

III. PROPOSED SYSTEM

The basic idea is developing a client-server based system which will keep track of Sonography Centers and the procedures taking place there. The system is to be designed exclusively for fetal sonography. The main feature of the system is "Automatic detection of the 'femur' (thigh bone)" of the fetus from the ultrasound image taken by the sonography machine. Also, the length of the fetus, which decides the fetal age, is to be calculated automatically. These details are reflected in the patient report. This is the duration during which, abortion is medically possible.

A. Novel features of proposed system

Unique Identity card authentication will be mandatory for registration. Access to Ultrasound scanner will be restricted if registration is pending. Fully-automatic femur length detection will minimize the doctor's intervention, thus minimizing chances of illegal procedures. A report containing vitals of patient and 'fetal age' will be automatically generated. Report along with the patient's details will be automatically saved on the central server. Data will be sorted and details of patients (lying between 11-19 weeks of fetal age), will be saved on the server, thus reducing memory requirement.

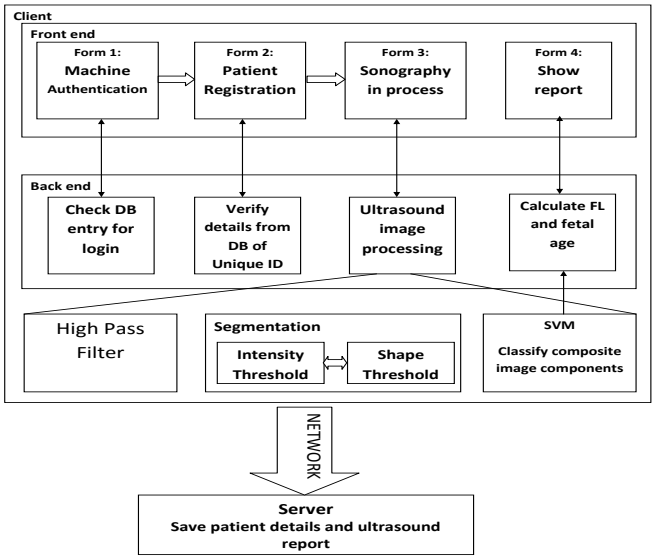

Fig. 2. System Architecture

B. Algorithm

1. Doctor will be granted access to ultrasound machine through password authentication.

2. Patient Aadhar number (ID number) to be entered to retrieve the patient's personal details from database. If patient details are not available to the database, further process is to be blocked.
3. Once, the second step is cleared, the doctor can perform sonography. Ultrasound images are captured through input probe.
4. Captured image to be subjected to segmentation.
5. Result of segmentation to be given to high pass filter (HPF) as input.
6. Output of HPF will undergo multilevel thresholding.
7. Objects extracted from all iterations of thresholding together form a composite image.
8. Composite image will be given as input to SVM.
9. Result of SVM is desired output.
10. Length of femur will be calculated and from FL, age of fetus will be obtained, by applying relevant formula.
11. If fetal age lies between 11 to 19 weeks, a report of the scan containing medical results, details of doctor, patient and hospital will be sent to the server which will keep track of this data.

C. Steps followed

Password authentication: Most of us are familiar with password authentication. To get access to a computer or a network, we require an authorized user account with a username and password. This combination is verified from a database that contains entries of authorized users and their passwords to confirm whether you are the one who you claim to be.

Image segmentation: As the definition goes, segmentation is the process of partitioning a digital image into multiple segments (sets of pixels). Segmentation has an important role of simplifying or converting the representation form of an image into such a form that is easier to analyze. Precisely, in image segmentation a label is assigned to every pixel in an image. Pixels that share certain characteristics have the similar label. It is helpful in locating required shapes or curves in an image.

High Pass filter: In order to increase the sharpness of an image, high pass filter is used. Here, fine details of the image are accentuated, as opposed to low-pass filter. Though, high-pass filtering works same as low-pass filtering; the convolution kernel used is different. If one pixel is brighter than its immediate neighbors, it gets highlighted. If difference in intensity is not noted, nothing happens. High-pass filtering causes minute, unnoticeable details to be greatly exaggerated. Over-processing makes the image to look unnatural (grainy). Point sources will have dark rings around them. So we can say that high-pass filtering improves an image by sharpening details, but it can actually degrade the image quality if overdone.

Thresholding: A process in which, by using an optimal threshold, a grayscale input image is converted into a binary image is called thresholding. When we want object or text to be extracted from an image, thresholding can be used. The pixels which represent the object or text are marked according to binary conventions and are extracted from that image. The pixels represent intensities in binary form. Thus pixels that belong to true foreground regions and background regions are marked with different intensities in binarization. Due to complex structure of ultrasound images, noisy background and application artifacts, application of conventional thresholding methods seem unfeasible [9].

Support Vector Machine: The basic idea of SVM is to find a hyper-plane which separates the d-dimensional data perfectly into its two classes [10]. Basically, only binary classification problems can be solved by SVM. That means, SVM can classify a dataset only into two classes. We can use it to classify the femur like objects extracted as a result of thresholding into two classes i.e. femur and no-femur. Certain attributes of femur need to be provided to the SVM so that it can classify given dataset. Some characteristics of femur are:

a. It is the longest bone in human body.
b. It is seen as one of the brightest objects in ultrasound image because it is whitish in color.
c. Medial surface of femur is curved.
d. Femur occupies the portion close to the center of image, normally.

These characteristics of femur can be passed as attributes for classification to the SVM.

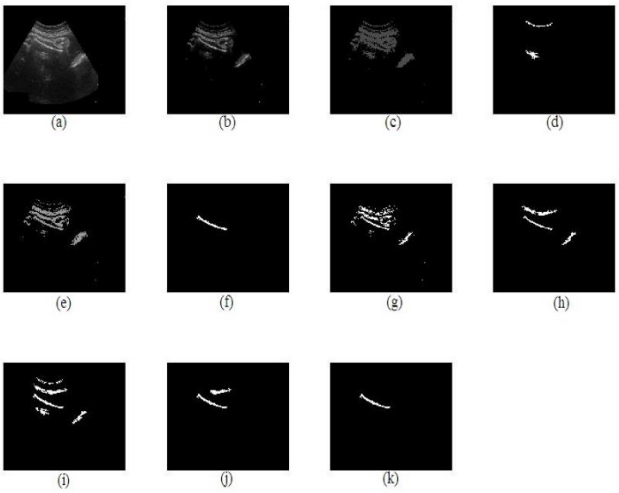

Fig. 3. Processing of image from segmentation to SVM

In the figure 3, the proposed system can be understood with the help of images (JPEG Image is considered here).
(a) Original Image.
(b) Filtered Image.
(c) After applying Intensity Threshold 1.
(d) After applying Shape Threshold 1.
(e) After applying Intensity Threshold 2.
(f) After applying Shape Threshold 2.
(g) After applying Intensity Threshold 3.
(h) After applying Shape Threshold 3.
(i) Composite Image.
(j) SVM based Classification.
(k) Segmented Femur.

Femur Length Measurement: Once the femur is detected, the next job is measuring its length. Fig. 3 shows a relation between the values of femur length and gestational age (fetal

age). In modern ultrasound scanners, fetal measurements are made by manually extracting diameters or contours from ultrasound images [11]. Observing the graph, a mathematical result can be formulated as follows:

GA (weeks) = 0.262 * 2FL (cm) + 2FL + 11.5 (1)

Now, for further processing, the GA obtained from (1) will be checked if it lies between 11 to 19 weeks. If yes, the details of that corresponding patient will be stored on central server. Otherwise, details will be saved to local memory.

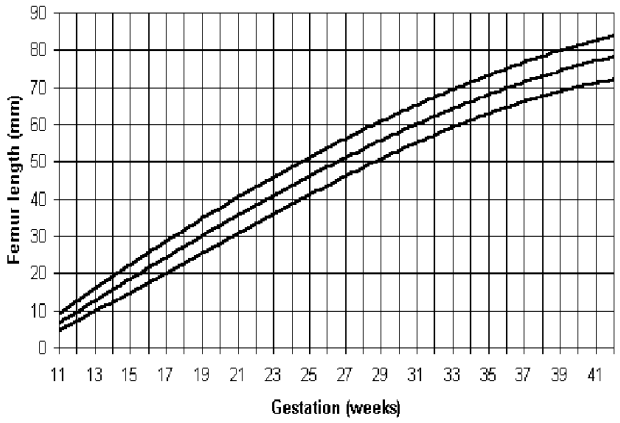

Fig. 4. Graph (FL versus GA)

D. Tools and Software used

1. The Graphical user interface will be created using ASP.net Visual Studio 15, with Java at the back end.
2. The central server will consist of MySql database for data storage as well as retrieval.
3. The proposed system shall use the HTTP protocol for communication over the internet and for the intranet communication will be through TCP/IP protocol suite.

IV. CONCLUSION AND FUTURE SCOPE

The proposed system has exclusive usage in the ultrasound imaging process. Image segmentation can be implemented with the help of Multicore Processing concepts to get faster results. The image is subjected to partitioning and these partitions can be assigned to different processing units. Higher processing speed can be attained this way. Preventive measures currently being taken for reducing the number of female feticides are not enough. New technology should contribute its part to this process. A machine based system is thus more efficient. Also, this project is an attempt to control the amount of corruption and illegal activities prevalent in this field. Current system is mainly based on human intervention, which cannot be 100% trustworthy. Police and respective authorities need to keep track on a large number of people. The proposed system is expected to reduce this number approximately by 70%. Machine intervention can bring reliability in the system, where corruption has deep roots. If approved by the government of India, the proposed system can be used nation-wide. This idea can be conceived as an important part of Digital India's E-hospital project. The aim of this project is to minimize the rate of female feticides in India to support PM Modi's “Beti Bachao, Beti Padhao” mission.

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REFERENCES

Journal References

[1] Sylvia Rueda, Sana Fathima, Caroline L. Knight, Mohammad Yaqub, Aris T. Papageorghiou, BahbibiRahmatullah, Alessandro Foi, MatteoMaggioni, AntoniettaPepe, JussiTohka, Richard V. Stebbing, John E. McManigle, AncaCiurte, Xavier Bresson, Meritxell Bach Cuadra, Changming Sun, Gennady V. Ponomarev, Mikhail S. Gelfand, Marat D. Kazanov, Ching-Wei Wang, Hsiang-Chou Chen, Chun-Wei Peng, Chu-Mei Hung, and J. Alison Noble, "Evaluation and Comparison of Current Fetal Ultrasound Image Segmentation Methods for Biometric Measurements: A Grand Challenge" *IEEE Transactions on Medical Imaging*, *vol*. 33, no. 4, April 2014.

[2] Muhammad Waseem Khan, “A Survey: Image Segmentation Techniques,” *International Journal of Future Computer and Communication*, Vol. 3, No. 2, April 2014

[3] F. C. Monteiro and A. Campilho, "Watershed framework to region-based image segmentation," *in Proc. International Conference on Pattern Recognition, ICPR 19th*, pp. 1-4, 2008.

[4] R. Samet, S. E. Amrahov, and A. H. Ziroglu, "Fuzzy rule-based image segmentation technique for rock thin section images," in *Proc. 3rd International Conference on Image Processing Theory, Tools and Applications (IPTA)*, pp. 402-406, 2012.

[5] J. Xiao, B. Yi, L. Xu, and H. Xie, "An image segmentation algorithm based on level set using discontinue PDE," *in Proc. First International Conference on Intelligent Networks and Intelligent Systems, ICINIS'08,* pp. 503-506, 2008.

[6] F. Zhang, S. Guo, and X. Qian, "Segmentation for finger vein image based on PDEs denoising," *in Proc. 3rd International Conference on Biomedical Engineering and Informatics (BMEI)*, pp. 531-535, 2010.

[7] W. Zhao, J. Zhang, P. Li, and Y. Li, "Study of image segmentation algorithm based on textural features and neural network," *in International Conference on Intelligent Computing and Cognitive Informatics (ICICCI)*, pp. 300-303, 2010.

[8] D. Barbosa, T. Dietenbeck, J. Schaerer, J. D'hooge, D. Friboulet, and O. Bernard, "B-spline explicit active surfaces: An efficient framework for real-time 3-D region-based segmentation," *IEEE Transactions on Image Processing*, vol. 21, pp. 241-251, 2012.

[9] G. V. Ponomarev, M. S. Gelfand, M. D. Kazanov, “A multilevel thresholding combined with edge detection and shape-based recognition for segmentation of fetal ultrasound images” in *Proceedings of Challenge US: Biometric Measurements from Fetal Ultrasound Images, ISBI 2012*, 2012, pp. 13–15.

[10] Mathews M, Deepa J, “Segmentation of Femur from Ultrasound Fetal Image using Shape based Approach,” *International Journal of Modern Communication Technologies & Research (IJMCTR) ISSN: 2321-0850*, Volume-2, Issue-6, June 2014

[11] C.-W. Wang, H.-C. Chen, C.-W.Peng, and C.-M. Hung, “Automatic femur segmentation and length measurement from fetal ultrasound images,” *Proceedings of Challenge US: Biometric Measurements from Fetal Ultrasound Images, ISBI 2012*, pp. 21–23, 2012.

Website References

[1] http://www.ncbi.nlm.nih.gov/pubmed
[2] http://www.baby2see.com