

Perinatal Fetal Weight Detection Using Image Processing

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Abstract: Image processing plays a very important role in medical imaging. As medical imaging is used most widely in areas such as Magnetic Resonance Imaging, Ultrasound Imaging, X-ray Scanning, etc. It is necessary to obtain the clear view of the images for proper diagnosis of the patient. Ultrasound Imaging is used to detect the status of the fetus in the womb. By measuring certain parameters such as Bi-parietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and Femur Length (FL) the weight of the fetus is being calculated using Hadlock IV formula. This detection would be helpful for the detection of the abnormalities of the fetus during the earlier stages of pregnancy automatically.

Index Terms: Fetal Analysis, Perinatal, Fetal Weight, Medical Imaging

1 INTRODUCTION

Fetal weight estimation is a very important feature in order to detect the abnormalities in the fetus in the initial stages of pregnancy. Many methods have been proposed to calculate the fetal weight using various criteria. Estimation of fetal weight was evaluated based on the measurement of head size, abdomen size and femur length using sonography models of the fetus [1]. A software program was developed to measure the weight of the fetus during the antenatal period with the help of pregnancy variables at first visit such as age, sex, size, weight and also depends on ethnic group and smoking effects [2]. Based on four parameters such as Bi-parietal Diameter (BPD), Head Circumference (HC) and Abdominal Circumference (AC) fetal weight is measured using ultrasound before planned delivery [3]. Detection of gender and fetal weight is done using ultrasound images by applying the method of thresholding and canny segmentation to the 2-D ultrasound image [4]. Models were developed to predict the Low Birth Weight babies based on few characteristics of mother and fetus like Gestation Age, fetal length, Haemoglobin level of mother ,BMI, Mother height and Chest circumference [5]. Fetal weight can be estimated using fuzzy logic in SVR (Support Vector Regression) for accuracy of the acquired weight of the fetus [6]. Fetal growth was evaluated by calculating the circumference of head and abdomen by using sonogram [7]. Hadlock and Johnsons formulae were used to determine the weight of the fetus by comparing the actual weight of the baby after delivery [8]. Fetal weight estimation was done using two formulae such as Dare and Johnsons formulae [9]. The proposed method was the estimation of the weight of the fetus using Randomized-Hough Transform for biometry measured and parameters such as BPD (Biparietal diameter) and FL (Femur Length) to predict the Gestational Age [10]. In this paper, the proposed idea is to measure the weight of the fetus using hadlock IV formula to the obtained ultrasound images automatically.

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2 BLOCK DIAGRAM

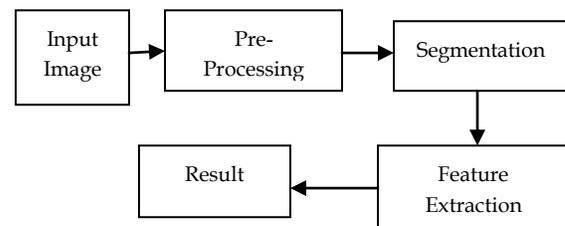


Fig. 1 General block diagram of proposed method

2.1 BLOCK DIAGRAM DESCRIPTION

i. Preprocessing

Preprocessing is technique which is applied for the enhancement of an image in processing the medical images. It is a technique used to remove the unwanted artifacts for improving the quality of the image in order to get a clear view of the internal organs. This can be achieved using various filters such as mean filter, median filter, lee filter, kuan filter, frost filter, etc.,

ii. Segmentation

Image segmentation is the process of partitioning the image obtained in the scanning process of medical images in order to simplify and analyze the image in an easier way which might also be used for the detection of boundaries or circumference of the certain parts of the body. Segmentation of an image can be obtained by canny edge detection, Sobel edge detector.

iii. Feature Extraction

Feature extraction is the process after preprocessing the image. Feature extraction is done to extract the relevant information from the original image and to represent the extracted image in a lower dimensionality space. Feature extraction is a very important process as it helps in recognizing the features accurately.

III. METHODOLOGY

i. Bi-Parietal Diameter:

Bi-parietal diameter is a measure of diameter between one parietal bone to other parietal bone. Bi-parietal Dimeter is accurate for 12-26 weeks. Each parietal bone is a curved

plate shaped bone and has two surfaces and four sides. In the process of Bi-parietal Diameter measurement there are four major steps. The first step is the process of anisotropic diffusion which is a technique to remove unwanted noise in the ultrasound images without altering the contents of the image, the second step is morphological operation where the shape or the features of the image are being detected. The third step is the application of canny edge detector where the edges or the circumference of the areas of interest are identified. The final step is the bounding box operation where the final segmented image is enclosed within a rectangular box along with the (x, y) coordinates.

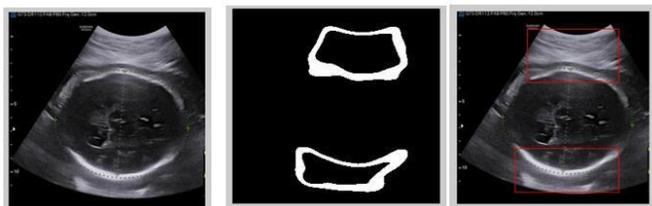


Fig.2. Results of Bi-parietal diameter

In the above fig.2 the first image is the input image, which is converted into gray image, and the final image is the processed image of the fetal head which gives the value of the bi-parietal diameter.

ii. Head Circumference

It is similar to Bi-parietal Diameter. Head circumference can be calculated accurately only after 13 weeks of gestation. The circumference of the fetal head can be done by three major steps. The first step is the preprocessing of the image obtained using filters, the second step is the process binary thresholding where the images are segmented based on their intensities of dark and gray shades and the final step is ellipse fitting where the segmented image is fit into the ellipse from which the value of head circumference can be obtained. By using Ellipse fitting and binary thresholding head circumference can be calculated.

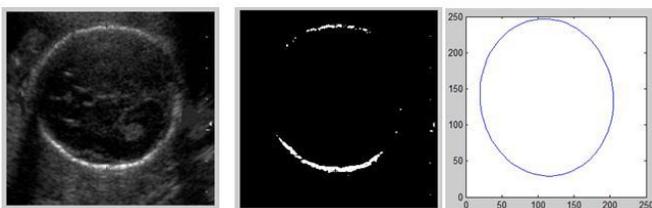


Fig.3 Results of Head Circumference

In the fig.3, the first image indicates the input image, the second image is the gray converted image of the input image and the final image is the value of the head circumference in the coordinated plot.

ii. Abdominal Circumference

It is the basic parameter to determine the fetal weight. AC can be measured during second half of pregnancy. AC doesn't depend on gender. It ranges from height of 31-33cm.

$$AC = 0.0053X + 14.83 \tag{1}$$

X-Body weight of the mother

0.0053-Regression co-efficient

14.83-Regression constant

In the process of measurement of abdominal circumference there are four main steps. The first step is the preprocessing of the medical image obtained by ultrasound scanning using filters, the second step is the morphological operation where the boundaries of circumference of the abdomen are being detected which finally undergoes the Circle-Hough Transform to determine the exact circumference of the abdomen.

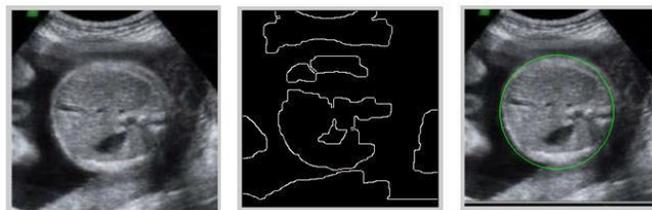


Fig.4. Results of Abdominal Circumference

In the fig.4, the first image is the ultrasound input image of the fetal abdomen, the second image is the gray image after conversion, and the final image is the processed image of the fetal abdomen along with the value of the abdominal circumference.

iv. Femur Length

Femur length indicates the longitudinal length of femur. In last three month of pregnancy, the length of the bone is the index of the length of baby at birth. In femur length calculation the techniques used are K Means clustering algorithm in which the images are clustered based on their pixel values of the neighbouring pixels, Bounding box and the final step is Blob analysis is a technique to detect the regions that differ in their brightness with the surroundings.



Fig.5. Results of Femur Length

IV.RESULTAND DISCUSSIONS

The following results of the weight of fetuses were obtained by using Hadlock IV formula from the values obtained from the above four parameters such Bi-Parietal diameter, Head Circumference, Abdominal Circumference and Femur Length.

Hadlock IV Formula= $\text{Log}_{10} BW = 0.3596 + (0.00061 \times \text{BPD} \times \text{AC}) + (0.0424 \times \text{AC}) + (0.174 \times \text{FL}) + (0.0064 \times \text{HC}) - (0.0386 \times \text{AC} \times \text{FL})$ (2)

ESTIMATED FETAL WEIGHT

| Gestational Age (in days) | Manual measurements (in grams) | Proposed method (in grams) |
|---------------------------|--------------------------------|----------------------------|
| 193 | 590.0 | 612.0 |
| 149 | 525.0 | 511.0 |
| 174 | 594.0 | 740.0 |
| 197 | 900.0 | 715.0 |
| 177 | 970.0 | 935.0 |
| 146 | 914.0 | 1074.0 |
| 178 | 670.0 | 989.1 |
| 232 | 1600.0 | 1561.0 |
| 161 | 501.0 | 520.0 |

V. CONCLUSION

Fetal weight estimation was done by applying the Hadlock IV formula accurately. This estimation would be beneficial for earlier detection of the abnormalities in the fetus during first and second trimester automatically. This idea results in the reduction of number of still birth of fetuses as the status of the fetus is being detected in the earlier stages of gestation.

VI. FUTURE WORKS

Apart from the current works, the idea could be further developed by applying more filters to the images and also to include computational techniques to avoid complexity and also to introduce these techniques into artificial intelligence

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