Measuring Nuchal Translucency Thickness using Genetic Algorithm

Rajalakshmi O. V. K
Dept. of Biomedical Engineering
SRM University
Chennai, India

Rajalakshmi T
Dept. of Biomedical Engineering
SRM University
Chennai, India

***Abstract*- The Nuchal Translucency thickness measurement is made to identify the chromosomal anomalies in screening first trimester fetus and presented in this paper. Genetic algorithm is used to segment the image to recognize the nuchal translucency border and to measure the thickness**

Keywords-Nuchal Translucency, Segmentation, Genetic Algorithm, Chromosomal Abnormalities

I. INTRODUCTION

In the recent past, the non invasive prenatal diagnosis of chromosomal disorders has been focused by researchers for detecting Down's syndrome and other chromosomal anomalies. Fetal nuchal translucency thickness at the 11–13+6 weeks scan has been combined with maternal age to provide an effective method of screening for Trisomy 21 and other chromosomal anomalies [1].

Down syndrome or Trisomy 21 is recognized as severe and common chromosomal abnormality occurring approximately once in every 800 to1000 live births and the risk increase with the maternal age. In addition to its role in the assessment of risk for Trisomy 21, increased nuchal translucency thickness can also identify a high proportion of other chromosomal defects and is associated with major abnormalities of the heart and great arteries, and a wide range of genetic syndromes. [2]

It is found from the literature that the Down syndrome is a genetic condition most commonly caused by the extra number 21 chromosome. Affected babies are likely to suffer from severe mental disability and have a high chance of physical disabilities, affecting in particular the heart, gastrointestinal tract, eyes and ears. In trisomy 18, there is early onset intrauterine growth restriction (IUGR), relative bradycardia and, in about 30% of the cases, there is an associated exomphalos. Trisomy 13 is characterized by fetal tachycardia, observed in about two-thirds of the cases, early-onset IUGR, and holoprosencephaly or exomphalos in about 30% of the cases. Turner syndrome is characterized by fetal tachycardia, observed in about 50% of the cases, and early-onset IUGR. In triploidy, there is early onset asymmetrical IUGR, relative bradycardia, holoprosencephaly, exomphalos or posteriorfossa cyst in about 40% of cases, and molar changes in the placenta in about one-third of cases.

Nuchal translucency (NT) is the sonographic appearance of a subcutaneous collection of fluid behind the fetal neck. In the first trimester, the term translucency is used irrespective of whether the collection of fluid is septated, whether it is confined to the neck, or it envelopes the entire fetus.[3] There are several hypotheses regarding the pathophysiology of increased NT, and it is unlikely that a single common etiology for this sonographic sign underlies all associated abnormalities. Possible etiologies include cardiac failure secondary to structural malformation, abnormalities in the extracellular matrix, abnormal or delayed development of the lymphatic system, failure of lymphatic drainage because of impaired fetal movements in various neuromuscular disorders, fetal anemia or hypoproteinemia, and congenital infection that manifests as anemia or cardiac dysfunction

Recently, multiple studies have demonstrated that fetal NT has the potential of being a very powerful predictor of fetal aneuploidy.[4] Prospective studies in 200,000 pregnancies, including 900 fetuses with trisomy 21, have demonstrated that NT screening can identify 75% of fetuses with trisomy 21 and other major chromosomal abnormalities . With the association of some biochemical markers, like maternal serum free β-human chorionic gonadotrophin (β-hCG) and pregnancy-associated plasma protein-A (PAPP-A), with ultrasonography at gestational weeks 11–14, it is possible to identify 90% of chromosomal abnormalities.

Screening for chromosomal defects in the first trimester has the advantage of earlier prenatal diagnosis and consequently less traumatic termination of pregnancy for those couples who choose this option. A potential disadvantage is that earlier screening preferentially identifies those chromosomally abnormal pregnancies that are destined to miscarry. Approximately 30% of affected fetuses die between 12 weeks gestation and term. This issue of preferential intrauterine lethality of chromosomal defects is, of course, a potential criticism of all methods of prenatal screening, including second trimester maternal serum biochemistry; the estimated rate of intrauterine lethality between 16 weeks and term is about 20%

II. METHODS

The Block diagram of the proposed image processing system is shown in Figure1. The various process involved in NT segmentation is provided in this section. The fetus image is obtained from the ultrasound system and subjected to pre-processing for the segmentation using genetic algorithm.

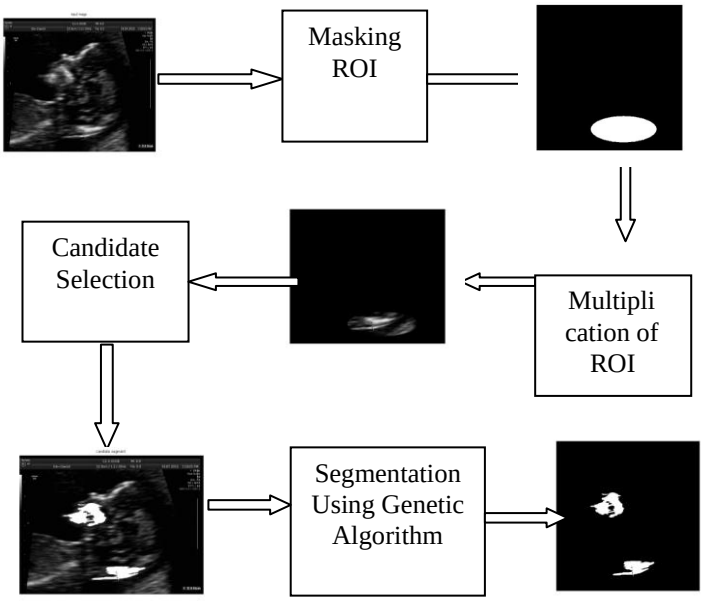


Fig. 1. Proposed Image Processing

A. Image Acquisition

The ultrasound fetus images are recorded by the ultrasound machine. The result is an exceptional precise beam providing enhancements in focus accuracy, spatial and contrast resolution the probe used is a multifrequency probe [7] of range 5-10 MHz. A perfect midsagittal view of the fetal profile is obtained [8]. The probe is moved from side to side so that the inner edges of the two thin echogenic lines that border the NT layer is obtained. The magnification of the image should be such that the head and thorax region occupy a major portion of the image in the neutral position. The ultrasound images are obtained as the sequence of moving pictures. Still frame which is suitable for the proposed work is chosen

B. Image Characteristics

Nuchal translucency refers to the normal subcutaneous fluid-filled space between the back of the neck [9] of a fetus and the overlying skin (see Figure 2.) The NT thickness is defined as the maximum thickness of the translucent space between the skin and the soft tissues overlying the cervical spine in the sagittal section of the fetus.

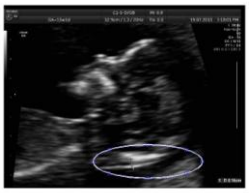


Fig. 2. Sample image

C. Region of Interest

Fetal ultrasound images are expected to have wide variation because of the fetal movement during the scanning process. Therefore it is necessary to define a ROI which can compensate for changes in the fetal head position and NT region. As the main objective is to segment NT, a suitable shape must be chosen for better diagnosis

D. Segmentation of NT Region

Segmentation is to subdivide an image into its component regions or objects. On 1 of 2 basis properties of intensity values

DiscontUnity: toartition an image based on sharp changes in intensity

Similarity: to partition an image into regions those are similar according to a set of predefined criteria

eg: Thresholding, region growing, region splitting and merging .

The segmentation of US images is an essential component of computer assisted diagnosis system. The purpose of such systems is always to detect the boundaries of different organs from the diagnostic US images. Many segmentation methods have been proposed for medical imaging. In this paper discontinuity based genetic algorithm has been used to segment the images.

E. Genetic Algorithm

Genetic Algorithm (GA) was proven to be the most powerful optimization technique in a large solution space. This explains the increasing popularity of GAs applications in image processing. They are used where an exhaustive search for solution is expensive in terms of computation time. Applications of GAs for image processing extend from evolving filters or detecting edges to making complex decisions

A simple GA consists of following steps:

1. Start with a randomly generated population of n bit Chromosomes (candidate solution to a problem).
2. Calculate the fitness f(x) of each chromosome x in the population which gives the desired ROI
3. Repeat the following steps until n offspring has been created.

(a) Select a pair of parental chromosomes from the current population, the probability of selection being an increasing function of fitness. Selection is done with replacement, meaning that the same chromosome can be selected more than once to become a parent.

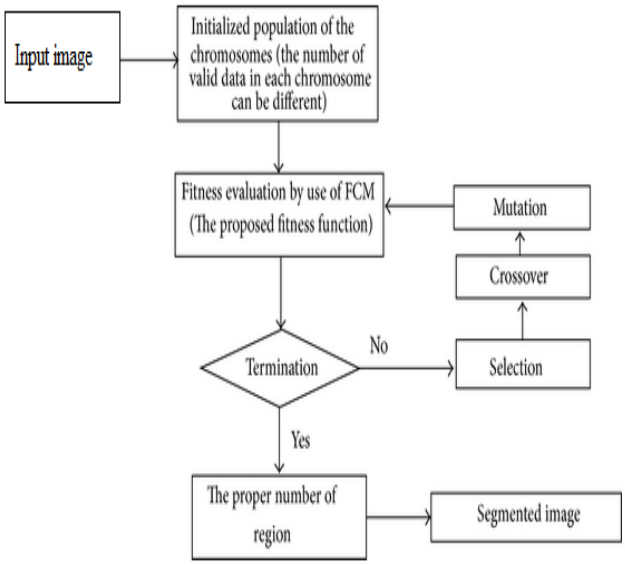
(b) With probability P_j, Crossover the pair at a randomly chosen point to form two offspring. If no crossover takes place, form two offspring that are exact copies of their respective parents.

(c) Mutate the two offspring at each locus with probability P_M and place the resulting chromosome in new population.

(d) Replace the current population with new population.

(e) Go to step 2.

The above steps are shown as flow chart in figure flow chart chart 1



Flow chart 1. A simple GA

III. RESULTS AND DISCUSSION

Experiments have been carried out on a set of sonographic images obtained from the Ultrasound machine. A total of 25 images under 11^{th} to 13^{th} weeks of gestation were considered for analysis. The images were processed and the region of interest has been masked for further analysis .NT region has been segmented from the masked image by choosing the candidate selection using genetic algorithm. The implementation steps were as follows.

Step1: Image acquisition using Ultrasound machine.

Step2: Identification of NT (ROI).

Step3: Binary masking of the ROI

Step4: Applying Genetic Algorithm

Step5: Chooing the candidate

Step6: Segmentation of the NT region

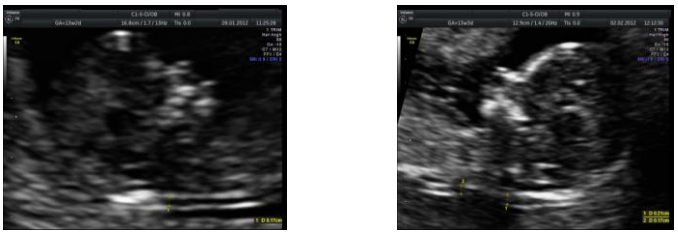


Fig. 3. Input Image

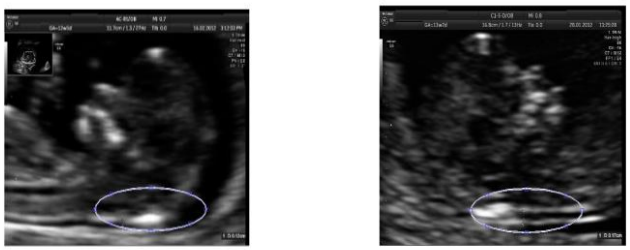


Fig. 4. ROI

Fig. 5. Binary Masking

Fig. 6. Multiplication

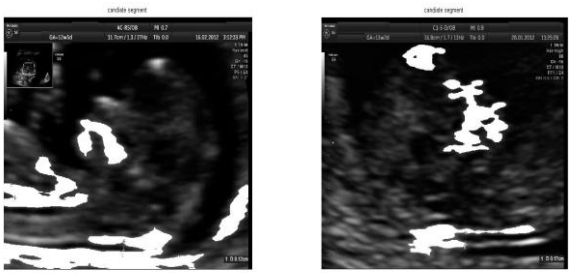


Fig. 7. Candidate Segment

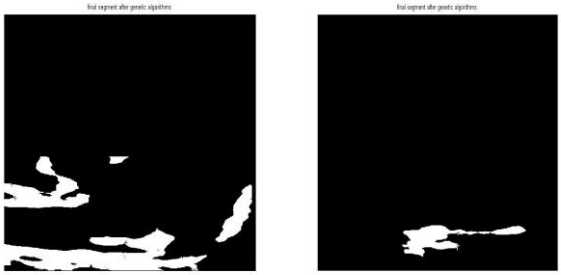


Fig. 8. Final Segmented Image

IV. CONCLUSION

The measurements of NT should be done as a next step to find out normal and abnormal NT. It is observed from this study that segmentation of NT by genetic algorithm helps in accurate measurement of it, which will provide valuable information to the physicians to take accurate decision. The results reveal that the normal fetus with gestation week of14 must not have greater than 2.12 mm of NT thickness

ACKNOWLEDGMENT

The authors would like to thank Dr.Anburajan, HOD, Department of Biomedical Engineering, SRM University for his valuable suggestions. They would like to express their gratitude to Dr. Usha Sahadevan, Lotus hospital, Erode for providing the necessary images for this study.

REFERENCES

[1] S.Nirmala, V.Palanisamy Measurement of Nuchal TranslucencyThickness for Detection of Chromosomal Abnormalities using First Trimester Ultrasound Fetal Images (IJCSIS) International Journal of Computer Science and Information Security, Vol. 6, No. 3, 2009

[2] Kypros H. Nicolaides, MD Nuchal translucency and other first trimester sonographic markers of chromosomal abnormalities

[3] Kypros H. Nicolaides*, Victoria Heath and Simona Cicero Increased fetal nuchal translucency at 11–14 weeks. PRENATALDIAGNOSIS Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/ pd.308

[4] Sadık Tamsel, Sureyya Ozbek, Gulgun Demirpolat Ultrasoundevaluation of fetal chromosome disorders. Turkish Society of Radiology 2007

[5] Mantas Paulinas, Andrius Ušinskas 2007 A survey of genetic algorithms applications for image enhancement and segmentation issn 1392 – 124x information technology and control Vol.36

[6] Poonam Panwar1, Neeru Gulati January 2013 Genetic algorithms for image segmentation using active contours Journal of Global Research in Computer Science

[7] Promoting excellence in ultrasound Guidelines for the Performance of First Trimester Ultrasound Australasian Socity for Ultrasound in Medicine Revised July 2005

[8] G. Rembouskos, S. Cicero, D. Longo, H. VandecruyS and K. H. Nicolaides 2 February 2004 Assessment of the fetal nasal bone at 11–14 weeks of gestation by three-dimensional ultrasound Ultrasound Obstet Gynecol

[9] Fetal Anomaly V Screening Programmes when a scan shows a nuchal translucency (NT) measurement of 3.5millimetres or more Information for parents

[10] Mohammad Talebi, Ahamd Ayatollahi, Ali Kermani February 2011 Medical ultrasound image segmentation using genetic active contour J. Biomedical Science and Engineering

[11] Shilpa Kamdi , R.K.Krishna Image Segmentation and Region Growing Algorithm Volume 2, Issue 1 International Journal of Computer Technology and Electronics Engineering (IJCTEE)

[12] Amiya Halder, Soumajit Pramanik Dynamic Image Segmentation using Fuzzy C-Means based Genetic Algorithm August 2011 International Journal of Computer Applications