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Recent Developing Domain in Computer Science and Application of Digital Image Processing In Medical Field

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Abstract: *In the recent era medical image processing, for Ultrasound images, sonography machines are frequently used by healthcare professionals. The use of ultrasound imaging in medical diagnosis is well established because of its noninvasive nature, low cost, capability of forming real time image.The prenatal diagnoses of chromosomal disorders have been focused by researchers for detecting Down Syndrome (DS) in human fetuses. Trisomy 21 is recognized as severe chromosomal abnormality occurring approximately once in every 800 to1000 live births and the risk increase with the extra maternal age. In sonography test Nuchal translucency (NT) thickness is the most effective marker of trisomy 21. The main problem during diagnosis is the distortion of visual signals and continuing improvement in image quality is expected from computer professionals.*
Keywords: *prenatal, gastation week, ultrasound, sonography, speckle noise, Down Syndrome (DS),trisomy 21, Nuchal translucency (NT)*

I. Introduction

Digital Image Processing:- is Processing digital images by means of a digital computer. It encompasses a wide and various field of applications whose inputs and outputs both are images .It extract attributes from images including the recognition of the individual objects . Digital image processing is one of the fastest developing domain of computer science. Massive volume of digital images are produced every day by many sources and are beyond the limits of it manual assessment.Computer professionals accomplish this need..The Digital image processing algorithm has three levels ;techniques that handle the row ,noisy data and perform denoising,edge detection is the lowest level.Middle level does segementation and edge linking which make use of low level result for more enhancement.To drive semantic significance from the information provide by low level is the top most level.

Medical Image Processing:- Medical image processing[1] is fastest developing domain of computer science having powerful Digital Image Processing tools (like matlab) to carry out meaningful image processing tasks.
The noise can restrain information which is valuable for the doctors . . The main problem during diagnosis is the distortion of visual signals and continuing improvement in image quality is expected from computer professionals .These distortions are termed as 'Noise' which makes the image unclear. In the medical literature, speckle noise[2] is referred as "texture"which is prominantlly found in Ultrasound images. The success of ultrasonic examination depends on the image quality which is usually retarded due to speckle noise[3] .Therefore, noise reduction is very important. In medical image processing, image denoising [4]has become a very essential exercise all through the diagnose. In this paper several techniques for effective suppression of speckle noise present in ultrasound[5] [6]images has been studied Various modalities used in medical imaging are X-ray, CT, MRI and ultrasound **or** sonography. From 1970 sonography is used 1st time in medical field and digital image processing techniques began to use for human diagnostics.

Introduction to Medical Ultrasound
Father of Medical Ultrasound
Dr George Ludwig: Ultrasonic energy was first applied to the human body for medical purposes by Dr George Ludwig at the Naval Medical Research Institute, Bethesda, Maryland in the late 1940s


George D. Ludwig

John Julian Cuttance Wild: "Father of Medical Ultrasound **"** (August 11, 1914 – September 18, 2009) was an English-born American physician who was part of the first group to use ultrasound for body imaging, most notably for diagnosing cancer. Modern ultrasonic diagnostic medical scans are descendants of the equipment Wild and his colleagues developed in the 1950s. He has been described as the "Father of medical ultrasound

John J Wild c. 1953

Father of Medical Ultrasound in India

Dr. Mukund Joshi is, Consultant Radiologist, Jaslok Hospital, Mumbai, a name synonymous with ultrasound in India. His contributions to the field range from grey scale ultrasound to interventional procedures and 4D ultrasound imaging.Ultrasound department was established first by Jaslok Hospital in 1983.In order to spread awareness about the uses of ultrasound .Dr Joshi travel far and wide across the country and also bring the latest technology and applications to India. MediScan Systems was established on 15 August 1982 and registered under prenatal diagnostic techniques to provide varied services including diagnostic and interventional ultrasound and foetal medicine services and foetal therapy.

Dr Mukund Joshi

Ultrasound Image Processing:- Ultrasound has been used in a variety of clinical areas, including obstetrics and gynecology, cardiology and cancer detection. The main advantage of ultrasound is that certain structures can be observed without using radiation. Ultrasound can also be done much faster than X-rays or other radiographic techniques.The study deals with obstetric ultrasonography(The practice of examining pregnant women using ultrasound machine) is the major domain in medical field. Following are major causes for sonography test suggested to every patient by gynecologist.

- measuring the size of the fetus to determine the due date
- determining the position of the fetus to see if it is in the normal head down position or breech
- checking the position of the placenta to see if it is improperly developing over the opening to the uterus (cervix)
- seeing the number of fetuses in the uterus
- checking the fetus's growth rate by making many anatomic measurements[7] over time
- detecting ectopic pregnancy, the life-threatening situation in which the baby is implanted in the mother's Fallopian tubes instead of in the uterus
- determining whether there is an appropriate amount of amniotic fluid cushioning the baby
- monitoring the baby during specialized procedures - ultrasound has been helpful in seeing and avoiding the baby during amniocentesis (sampling of the amniotic fluid with a needle for genetic testing).
- seeing tumors of the ovary and breast
- checking anomalies by screening test/NT scan[8].

The images captured by sonography machine are of different modes. In this study we are using B-mode ultrasound images.

Nuchal Translucency Image Processing:- NT scan was introduced in 2006 for the first time in India **.NT** Is the accumulation of fluid in the nuchal region under the skin at the back of a baby's neck can be shown during the first trimester of pregnancy

Ultrasound Machine with Convex Probes

Following are the objectives of NT Image Processing system-

- Due to advanced marital age all pregnant women are suggested a nuchal translucency (NT) scan, to assess whether their babies are likely to have or not Down's syndrome.
- A nuchal translucency is detailed anomalies scan indicates level of risk of baby having Down's syndrome in late pregnancy.
- To detect nuchal translucency(NT) thickness accurately.
- To achieve uniformity in results among different doctors.
- To provide enhanced computer - aided NT measurement tool with low cost and low resources which will overcome the problems inherent in existing NT measurement system .

Introduction to NT Scan

- It is known as a Screening Test.
- It is abdominal scan done by convex probe .
- As the NT thickness is of few millimeters, a small variation in the measurement made by the doctor may lead to wrong diagnosis.
- Increased NT is associated with many fetal defects, abnormalities ,genetic syndromes and an adverse pregnancy outcome.
- So the computer aided evaluation is expected to enhance the NT measurement as nuchal translucency (NT) thickness is the most effective marker of trisomy 21 and all other major chromosomal disorders in human fetus.

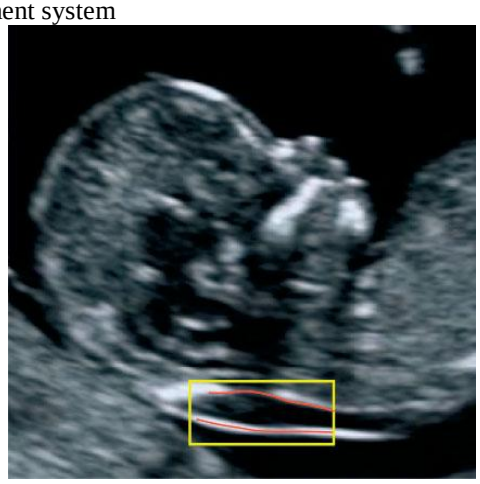
Advantages of NT Scans

- Non-invasive technique
- Harmless radiations
- Low cost and time,less hospital resources.
- Display real time images of body organs

Users of NT System

- Expert doctors specially trained in radiology; Radiologist
- Expert doctors technically trained in medical ultrasound ;Sonographer
- Specialist doctor particularly trained for special pregnancy scan; Fetal medicine specialist

NT measurement system



Mid-sagittal section of the fetal head and upper thorax

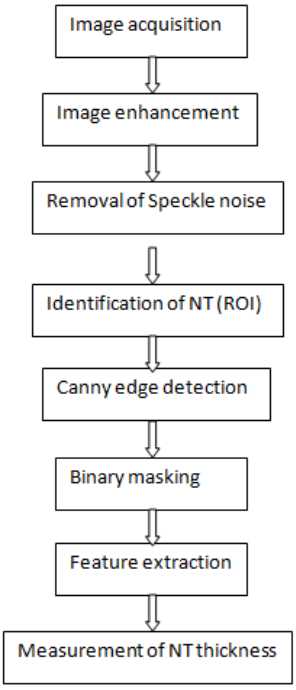
Thermal Printer

Clinical Aspect of NT Scans

- 11 to13 weeks abdominal scan with full water retentions
- Less repetition reduce suffering of patient and headache of doctors
- Selection of the exact place behind the fetal neck
- Selection of maximum vertical distance between the nuchal membrane and the edge[9] of the soft tissue overlying the cervical spine,
- Because the two lines[9] are not usually parallel;
- Selection of the exact position within the thickness[10] on the two linesfor accurate placement of the calipers.

Components of NT Measurement System:-
Transducer Probe:- Convex Probe that sends and receives the sound waves.
Central Processing Unit (CPU):- Computer that does all of the calculations
Display:-Monitor displays B-Mode image
Keyboard/mouse/Cursor:- Inputs data and takes measurements from the display.
Disk Storage Device(HD, CD) :- Stores the acquired images.
Thermal Printer:- Prints the sonography image.

Proposed Methodology:-



Database:- In this study we are using B-mode ultrasound images. (Brightness mode) – the basic two-dimensional intensity mode ,provides monochromic images
The database is collected form MINDRAY DP 6600 Black and White ultrasonic machine. This is the real time database .The database consist of total 40 fetus images grouped into 4 different categories. Each of these images are of 4-diffrent gastation week like 11,12,13,and 14 gastation week each group containing 10 fetus images for NT scanning .As screening test is done within first-trimester for the NT measurement[11] ,this gestation period is selected for database collection

Image Specification:- Dimensions:717x 550pixels
Horizontal &Vertical Resolution:150 dpi(dot per inches)
Bit depth:24
Size : varing (>100 KB)
Lence:35mm focal length

II. Experiment and Results

Case no in 11 GW	Length in Ed	Lenght in mm
1	26	6.93
2	12	3.20
3	13	3.47
4	17.5	4.67
5	10.5	2.80
6	7.25	1.93
7	8	2.13
8	7.75	2.07
9	9.5	2.53
10	7.75	2.07

NT measurement in 11 GW

Case no in 12 GW	Length in Ed	Lenght in mm
1	6	1.60
2	7	1.87
3	4.25	1.13
4	3.91	1.04
5	4	1.07
6	3	0.80
7	12	3.20
8	15	4.00
9	10	2.67
10	6.5	1.73

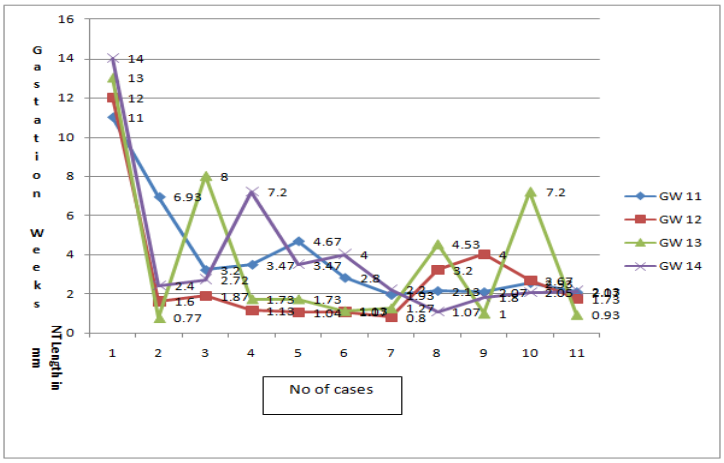
NT measurement in12 GW

Case no in 13 GW	Length in Ed	Length in mm
1	2.88	0.77
2	30	8.00
3	6.5	1.73
4	6.5	1.73
5	4.25	1.13
6	4.75	1.27
7	17	4.53
8	3.75	1.00
9	27	7.20
10	3.5	0.93

NT measurement in 13 GW

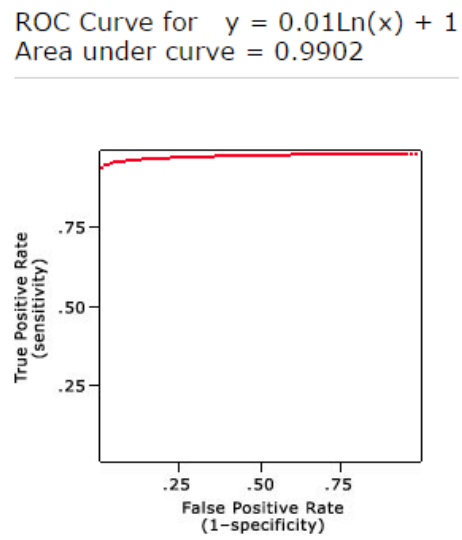
Case no in 14 GW	Length in Ed	Length in mm
1	9	2.40
2	10.2	2.72
3	27	7.20
4	13	3.47
5	15	4.00
6	8.25	2.20
7	4	1.07
8	6.75	1.80
9	7.7	2.05
10	8	2.13

NT measurement in 14 GW



Graph of all subjects(10 cases per GW)

Receiver Operating Characteristic



$$\text{Sensitivity} = \frac{\text{true positives}}{(\text{true positive} + \text{false negative})} \qquad \text{Specificity} = \frac{\text{true negatives}}{(\text{true negative} + \text{false positives})}$$

Receiver operating characteristic:- is a graphical plot which illustrate the performance of system
It is created by plotting the fraction of true positive values out of the total actual positive (TPR=True Positive Rate) vs fraction of true false positive out of the total actual negative (FPR=False Positive Rate)
TPR is known as sensitivity and specificity if (TNR=True Negative Rate) it is a probability that test result will be negative.
The accuracy of the semi automated system for measurement of NT thickness is 99 %.

III. Result Analysis

- In this study both the Subjective and Objective analysis is done on total 40 images .
- Subjective analysis is based on personal opinions, interpretations, points of view and judgment of expert doctors .
- Objective analysis is fact-based, measurable and observable. Using the fetal NT hickness cut-off point of 2.12 mm, the detection rate of chromosomal defect and trisomy 21 is highest

IV. Conclusion

- The Nuchal Translucency thickness measurement is made to identify the Down Syndrome in screening test of first trimester human fetus .
- The NT scan needs to carry out for all patients suggested by doctors
- However, the semi-automated system does not avoid the need of expert doctor
- In the 14th week of Gestation expected to have a nuchal translucency thickness of 1.87±0.25mm.
- The normal fetus with gestation week of 14 must not have NT thickness greater than 2.12 mm.
- It is concluded that the computer aided measurement tool is user friendly and provides valuable information to the doctors to take accurate decision.

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