3D Obstetric Ultrasound Imaging

Ultrasound imaging was first introduced in the 1950s and has since become the primary method of monitoring fetal development during pregnancy. 3D ultrasound images of fetuses were first constructed in 1986 by Kazunori Baba at the University of Tokyo. However, it wasn't until 1996 that new techniques and more powerful computers allowed real-time viewing of 3d ultrasound images.

Ultrasound works by the emission of very high frequency (3.5-7 MHz) sound waves from a transducer placed on the mother's stomach. At such high frequency, sound waves follow the same laws of reflection and distortion as light, changing wavelength as direction as it crosses the border between mediums. The transducer emits a single 'beam' of sound into the target area and then records the sound that is reflected off of internal boundaries in the body. The result is a detailed scan of the densities and materials the beam passed through.

Conventional ultrasound imaging provides a great deal of information about the internal state of the fetus and mother. An ultrasound scan can identify a developing gestational sac within 5 weeks of impregnation. It can also identify vaginal bleeding, age/size of the fetus and it's body parts, abnormality of the placental development, multiple pregnancies, excessive or insufficient amniotic fluid, and gross fetal deformations.

However, 2D ultrasound images, while detailed, do not provide a clear view of the 3 dimensional structure of the fetus. It is difficult, for instance, to count the digits of a fetus's hands and feet from a 2D ultrasound. Partly this is due to the relatively small difference in sonic properties of the amniotic fluid and the skin and muscles of a young fetus. It is also difficult for a doctor to visualize a fetus in 3d from only 2d scans.

Layering many ultrasound images into a composite 3D image greatly improves the ability of the doctor to identify less obvious deformities such as cleft palate, congenital heart abnormalities, and Down Syndrome. It also increases the clarity of the internal organs of the fetus and makes it easier to notice abnormalities in their locations relative to each other and the mother.

The most popular method of producing a 3d ultrasound image is the mechanical driven arrays developed in the mid 1990s. These transducers take several hundreds or thousands of 2d ultrasound images over a short (30-40 degree) arc. These images are then transferred to a computer which composites them into a single image.

The time and expensive required for a computer to render the 3d image decreased greatly throughout the 1990s. In 1999 a new algorithm and the increased computing power available made real-time rendering of detailed images possible in the hospital. This allows obstetricians to monitor the movements of the fetus's heart, blood flow, and limbs for signs of abnormalities.

Another application that is extremely popular is using 3D, real-time ultrasound to give expectant mothers a look at their unborn child. This is said by some medical psychologists to increase the intensity of the mother/child bond. It is documented that mothers who have seen their unborn child tend to remain calmer and healthier over the course of a pregnancy.

References:

http://www.ob-ultrasound.net/
http://www.fetus.com/