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INTRODUCTION

- Damaging (radiation) → safe (Ultrasound) (heating-*cavitation*)
- Analogous → digital
- 2 D → 3 D → 4D
- Image → object (volume) → funkcionality
- Post-processing → real-time processing
- Expensive → Cheaper

INTRODUCTION



- Ultrasound = sound $f > 20$ KHz
- Ultrasound in medicine represents a sound $f > 2-100$ MHz which converts into image.
- Ultrasound – the most commonly used imaging method
- Ultrasound generates a good resolution image – in real time

INTRODUCTION

Types of Ultrasound display:

- **A-mod**
amplitude modulation •Doppler
- **B-mod (2D)**
brightness modulation •Color doppler
- **M-mod**
motion modulation •Power doppler
- **3D**
Series of 2D images are used to reconstruct the 3D image
- **4D** •3D power doppler

PROBE (*transducer*):


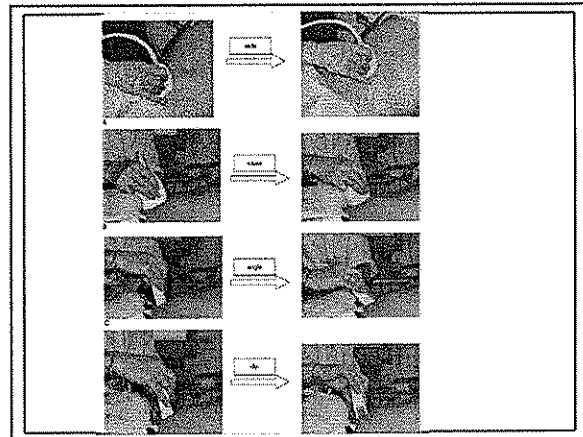
⇒ **emission 1/1000 sek**
⇒ **receives 999/1000 sek**

Acoustic properties of tissue

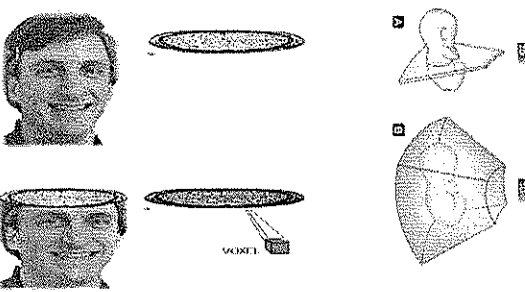
Speed of sound → soft tissues 1500 m/sek
Reflexion → ehogenicity
Atenuation → sonolucenost

Gel – ultrasound waves

don't travel well through air

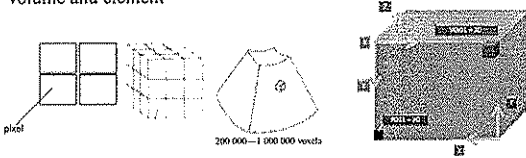
INTRODUCTION



INTRODUCTION

While at 2D ultrasound, the smallest information unit is Pixel (has 2 dimensions, i.e. x and y co-ordinate), in 3D ultrasound that is voxel (has 3 dimensions, i.e. x, y and z co-ordinate)

Pixel, the basic element of 2D image is a compound, created from words *picture and element*, and *voxel* is a compound from volume and element



Basic Terminology in Volume Sonography: Synonyms and Clinical Applicability

Key Word	Definition	Clinical applicability
2D image	2D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
3D image	3D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
4D image	4D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
5D image	5D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
6D image	6D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
7D image	7D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
8D image	8D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
9D image	9D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
10D image	10D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
11D image	11D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
12D image	12D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
13D image	13D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
14D image	14D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
15D image	15D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
16D image	16D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
17D image	17D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
18D image	18D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
19D image	19D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.
20D image	20D image is a picture in form of a picture and picture of the image.	For analyzing the surface in different section of volume.

1989. 3D

1989. Kretz technik the first 3D ultrasound device (motor operated probe) – 1. generation of 3D ultrasound

1993. COMBISON 530 – 2. generation

VOLUSON 530, completely digital, interactive 3D rendering in real time – 3. generation

1998. "LIVE 3D" (4D)

VOLUSON 730.

History

3D imaging of surface - end 80s

Translucent display – 1991

Superficial imaging -1994.

Live imaging was introduced, without the use of computer in 1996.

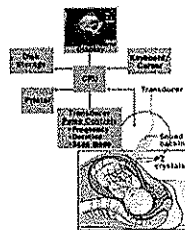
Ultrasound device with 3D imaging

The device for threedimensional imaging

Development phase

Components

- Transducer Probe
- Transducer Pulse Controls
- CPU
- Monitor
- Keyboard / mouse / trackball
- Hard disc / CD / DVD
- Printer ...



Technique

- Previous experience with conventional 2D ultrasound is necessary
- The ability to handle a certain 3D device
- To analyse the stored volume

Transparent mode – observation of structures within the filmed volume, - it is compared to X-ray image. promatranje struktura unutar snimljenog volumena

When calculating the volume, the wanted structure has to be marked in at three orthogonal planes and the noise must be removed by treshold regulator.

The process of calculating the volume lasts up to 20 seconds, depending on the volume, i.e. the amount of voxels and the speed of the computer (processor, memory)

The viewed structure may be rotated around the chosen axis and viewed from all angles.

Image Processing

- 3D Gaussian Smooth
- Eraser
- 3D CutUndo
- Active Contour
- Movie
- Rotation
- Lighting
- Brightness
- Contrast

Clinical implementation

Threedimensional ultrasound is nowadays used by physicians of various specialties, so the threedimensional imaging is used in all cases where 2D is used.

In gastroenterology, this method is useful in discovering tumors of liver, gall bladder, spleen, in cardiology in discovering and measuring aneurysms and arteriosclerosis, in diagnostics of hip luxation in children, in gynecology and obstetrics, in diagnosing breast cancer, in urology.

The use of 3D ultrasound is possibly of greatest use in perinatology. The reason for that lies in the fact that amniotic fluid is the ideal media that makes the ultrasound imaging of fetal surface possible.

The superiority of 3D ultrasound is especially accentuated in discovering the subtle morphological anomalies in fetus, especially superficial anomalies and defects, which makes it the diagnostic method of choice in screening superficial fetal anomalies, for its accuracy as well as un-invasiveness.

Threedimensional power-dopler

Vascular system in threedimensional perspective can nowadays be presented in couple of techniques:

- Rotational angiography
- Computerised tomographic angiography with blood vessel volumes
- Angiography by magnetic resonance
- Threedimensional ultrasound with Color Doppler
- Threedimensional ultrasound with Power Doppler

Advantage of 3D ultrasound

transversal sections

•The practitioner may study the saved data later in detail, while patient does not have to be present.

•The stored data may be sent to a re-evaluation (telemedicine)

The advantages of 3D ultrasound

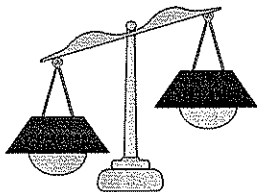
•The data is clear to the patient

•The multi-sectional technique enables the precise measurement of structural volumes

•The more precise spatial biopsy

•Improved recognising and detecting subtle fetal anomalies (often markers for chromosomopathias) of ear, feet, fingers, facial dysmorphys and similar, which makes this method superior in comparison to 2D ultrasound in detecting chromosomopathias.

•Examining function – behaviour – motion in 3D image (4D)



•Multiple times more expensive than conventional (2D) device,

•There are no damaging side effects

Conclusion

must be careful with it's critical use.

pregnant women no longer have to imagine how the baby will look like.

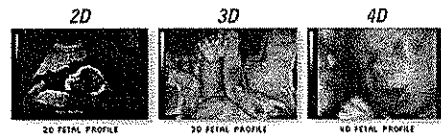
3D ultrasound disrupts the privacy of the fetus and therefore is dehumanizing.

It is a technique that hasn't yet reached its peak in quality and application

- Higher processing speed
- Higher resolution
- Easier use
- Lower price for the device

} Routine use

3D ultrasound will not replace 2D ultrasound, but will help an experienced practitioner in detecting minor anomalies



COMPLIMENTARY METHODS