**SECTION 1**

1. Building block of ultrasound imaging

Power control

USB/Wireless communication

User interface (display)

B-mode processor

RF demodulator

D-mode processor

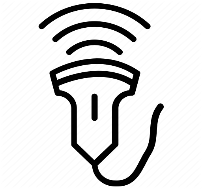
Beam former

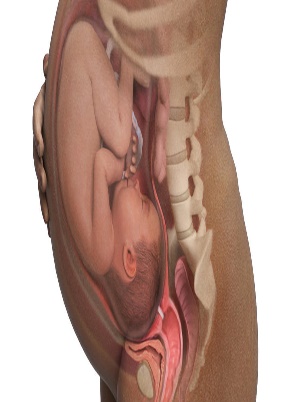
Signal conditioner

TX/RX control

ADC/DAC

Pulse generator

 TRANSDUCER



1. Markov Random fields, Fuzzy logic, spatial statistics, Image Segmentation were some of Image processing techniques for Optical camera images.
2. Stress is the force applied on the tissue whereas strain is the amount of change in dimensionality of tissue due to given stress, we already know stress=Force/Area and Strain=change in dimensional length/ Initial length, In F.pervin et al(2009), mechanical responses of bovine gray and white matter under compression was studied (By Split Hopkinson pressure bar method) where

Strain ε= -2 C0/Ls r (t) dt

Stress history t/As(E0εt(t),

Here Co speed of the elastic bar wave, Ls original length of specimen εr(t) is axial strain of the incident bar. We can clearly see here the ratio between the change in dimensionality and original length Ls, In stress As is initial cross sectional area of the specimen Eo is young’s modulus of specimen εt (t) is axial strain of transmission bar product of this will give the force, so we can find the ratio of force and area here, also they found gray matter attains higher strain rate with the minmum stress when compared to white matter which attains the strain at high stress.

1. The property of electromagnetism can be applied to inhomogeneous media like biological tissue, where we should consider electrical conductivity and permittivity of different regions of the tissue, electrical permittivity depends on frequency or susceptibility of the signal, this frequency sometimes may became arbitrary where relation between real and imaginary part of susceptibility was given by Kramers-kroenig relations. The odd part of response function is related to even part by

O(t)=sgn(t)E(t)

Where O(t) is odd part and E(t) is even part

And susceptibility relates to odd function and even function by

χ′′(ω)=−(t)sin(ωt)dt

*χ*′(*ω*)=(*t*)cos(ωt)dt

In frequency domain

χ′=−(1/π)P(ω′)ω′−ωdω′,

χ′′=(1/π)P(ω′)ω′−ωdω′.

1. Diffractive scattering can be defined as the process of scattering by the virtual photon or hadron which is produced due to the result of differential absorption of energy by the target. In lay man terms the energy was diffracted and absorbed by the target and it is scattered (scattered energies was again diffracted).

In jafari et al, he discussed about Vulvar cancer and radiation therapy, the patient was irradiated with the principle of Diffractive scattering.

1. Grade 1-5, 1(least) and 5(high)

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| --- | --- | --- | --- | --- |
| MODALITY | Ultra sound | X-ray | CT | MRI |
| What is imaged | Internal organs or foetus in real time | Planar internal imaging(hard bone tissue) | Tomographical images of internal cavities and organs | Tomographical images non-radiologically and functional images of brain |
| Access | 4 | 5 | 3 | 1 |
| Spatial resolution | 1 | 3 | 5 | 4 |
| Temporal resolution | 1 | 3 | 4 | 5 |
| Penetration depth | 2 | 5 | 4 | 4 |
| Safety | 5 | 1 | 3 | 4 |
| Cost | 4 | 5 | 2 | 1 |
| Speed | 5 | 4 | 3 | 1 |
| Portability | 5 | 4 | 2 | 1 |

1. In ultrasound scan transducers play a vital role as it transmits incident ultrasound waves and receives reflected, scattered, refracted US waves, transducers consist of a piezoelectric crystal which has a property to mechanical vibration for given electric signal and vice-versa, based on the application and area to be scanned different kind of transducers were used, Linear array transducer and phased array transducer were examples of it,
2. Linear array transducer

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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In linear array transducer array of single crystals are packed and each crystals are activated one after other and received signals after all crystals were integrated and images were produced. Frequency of ultrasound (7.5 MHz+) in linear array is higher than the phased array. Depth of waves is low.

1. Phased array transducer

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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In phased array transducer, it has similar arrangement of linear array transducer but all the crystals activated simultaneously and produce transmitted signal. The frequency of phased array is 1-5 MHz Depth of waves is higher.

For design a transducer probe, material for piezoelectric crystals, matching layer

Acoustic absorber, insulating cover, conversion efficiency PZT materials, Q-factor, number of crystals in array and type of array (Linear or Phased).

1. Artefacts in the given images

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | D |
| Acoustic shadowing | Present | Absent | Absent | Absent |
| Acoustic enhancement | Absent | Present | Absent | Absent |
| Ring down artefact | Present | Present | Present | Present |
| Dorsal acoustic window | Absent | Present | Present | Absent |
| Reverberation artefact | Absent | Absent | Absent | Absent |
| Mirror image artefact | Absent | Absent | Absent | Absent |

Acoustic shadowing - This artefact is produced by strongly absorbing tissue and hard structures like bones, where signal is void for reception.

Acoustic enhancement- It was produced by echoes produced by fluid filled structures like cyst and urinary bladder.

Reverberation artefact- This occurs when US waves face parallel reflectors, in which reflection from reflectors will reach first rather than deeper tissue.

Ring down effect - It is more like reverberation artefact, rather than single artefact ladder like structure will appear , this is mostly due to gas bubbles or cavities present within tissue.

Dorsal acoustic window- This mostly occurs at the area between soft tissues and bones, because of the sudden change in lower impedance to higher impedance region a bright echo will be produced.

Mirror image artefact - Sometimes duplication of structures will result in the image, it occurs when there is highly reflective surface in the path of the beam.