1. (a) **Define Medical Imaging and why do use medical imaging techniques?**

**Answer:**

Medical imaging refers to a number of techniques that can be used as non-invasive methods of looking inside the body. This means the body does not have to be opened up surgically for medical practitioners to look at various organs and areas. It can be used to assist diagnosis or treatment of different medical conditions.

Imaging techniques use radiations that form part of the electromagnetic spectrum. It's easy to forget that visible light (that is the colors that we as humans can see) forms only a fraction of the electromagnetic spectrum.

In an ideal world we would be able to diagnose, treat and cure patients without causing any harmful side effects. The use of medical imaging has enabled doctors to see inside a patient without having to cut them open. Medical imaging also helps us learn more about neurobiology and human behaviours.

Medical imaging brings scientists from biology, chemistry and physics together and the technologies developed can often be used in many disciplines.

(b) **How do we describe attenuation of X-Rays by body? Explain with necessary mathematical equations and symbols if necessary and prove that, =**

**Answer:**

(c) **Determine and draw the medical diagnostic system.**

**Answer:**

1. (a) **Describe the underlying mechanism for creation of an ultrasound image.**

**Answer:**

* + 1. Ultrasound imaging, also called sonography, involves exposing part of the body to high- frequency sound waves to produce pictures of the inside of the body.
    2. Ultrasound examinations do not use ionizing radiation (as used in x-rays).
    3. Because ultrasound images are captured in real- time, they can show the structure and movement of the body's internal organs, as well as blood flowing through blood vessels.
    4. Sound waves above 20 KHz are usually called as ultrasound waves.
    5. Sound waves propagate mechanical energy causing periodic vibration of particles in a continuous, elastic medium.
    6. Sound waves cannot propagate in a vacuum since there are no particles of matter in the vacuum.
    7. Sound is propagated through a mechanical movement of a particle through compression and rarefaction that is propagated through the neighbor particles depending on the density and elasticity of the material in the medium.
    8. The velocity of the sound in
       - 1. Air: 331 m/sec; Water: 1430 m/sec
         2. Soft tissue: 1540 m/sec; Fat: 1450 m/sec
    9. Ultrasound medical imaging: 2MHz to 10 MHz
       - 1. 2 MHz to 5 MHz frequencies are more common.
         2. 5 MHz ultrasound beam has a wavelength of 0.308 mm in soft tissue with a velocity of 1540 m/sec.

(b) **What precautions we have to take for reducing X-ray radiation?**

**Answer:**

Reduction of radiation risks:

* Keeping a “medical x-ray history” with the names of your radiological exams or procedures, the dates and places where you had them, and the physicians who referred you for those exams
* Making your current healthcare providers aware of your medical x-ray history;
* Asking your healthcare provider about whether or not alternatives to x-ray exams would allow the provider to make a good assessment or provide appropriate treatment for your medical situation
* Providing interpreting physicians and referring physicians with recent x-ray images and radiology reports
* Informing radiologists or x-ray technologists in advance if you are pregnant or think you may be pregnant.

(c) **Compare the Doppler ultrasound and contrast ultrasound system with proper description.**

**Answer:**

| **Aspect** | **Doppler ultrasound** | **Contrast ultrasound** |
| --- | --- | --- |
| Principle | Uses the Doppler effect to measure the frequency shift of the sound waves reflected by moving blood cells1 | [Uses microbubbles as contrast agents that enhance the reflection of sound waves by blood](https://radiologykey.com/doppler-and-contrast-agents/)[2](https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01840-3) |
| Application | [Useful for evaluating blood flow in vessels and detecting abnormalities such as stenosis, occlusion, or turbulence](https://radiologykey.com/doppler-and-contrast-agents/)[1](https://radiologykey.com/doppler-and-contrast-agents/)[3](https://www.frontiersin.org/articles/10.3389/fonc.2022.872890/full) | Useful for evaluating blood perfusion in tissues and detecting abnormalities such as tumors, inflammation, or ischemia24 |
| Limitations | [Poor sensitivity and specificity for low-flow or complex vascular structures; limited by the angle and direction of the blood flow; does not require contrast agents](https://radiologykey.com/doppler-and-contrast-agents/)[1](https://radiologykey.com/doppler-and-contrast-agents/)[2](https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01840-3) | [Poor penetration through bone or air; requires contrast agents and specific equipment; may have potential risks or side effects2](https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01840-3)[5](https://theultrasoundjournal.springeropen.com/articles/10.1186/s13089-022-00274-6) |
| Advantages | Does not use radiation; easy to use and portable; inexpensive; can be performed in real-time12 | [Less direction dependence; higher sensitivity; better contrast of vasculature; not affected by the angle and direction of the blood flow; more comprehensive and dynamic assessment of blood flow2](https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01840-3)[4](https://bmjopen.bmj.com/content/11/12/e052830) |

1. (a) **Describe the mechanism of B-mode and D-mode operations of ultrasound imaging.**

**Answer:**

**B-Mode or 2-D Scan:**

* Provides two-dimensional images representing the changes in acoustic impedance of the tissue.
* The brightness of the B-Mode image shows the strength of the echo from the tissue structure.
* To obtain a 2-D image of the tissue structure, the transducer is pivoted at a point about an axis and is used to obtain a V-shape imaging region.
* Alternately, the transducer can be moved to scan the imaging region.
* Several images of the acquired data based on the processing kernel filters can be displayed to show the acoustic characteristics of the tissue structure and its medium.

**2-D or 2 dimensional mode:**

* Default mode that comes on when any ultrasound / echo machine is turned on.
* It is a 2 dimensional cross sectional view of the underlying structures and is made up of numerous B-mode (brightness mode) scan lines.
* The field of view is the portion of the organs or tissues that are intersected by the scanning plane.
* Depending on the probe used, the shape of this field could be a sector - commonly seen with Echo and abdominal ultrasound probes or rectangular or trapezoid - seen with superficial or vascular probes.
* Multiple images of the field or frames are generated every second on the screen, giving an illusion of movement.
* A frame rate of at least 20 frames per second is needed to give a realistic illusion of motion.
* On a grey scale, high reflectivity (bone) is white; low reflectivity (muscle) is grey and no reflection (water) is black.
* Deeper structures are displayed on the lower part of the screen and superficial structures on the upper part.

(b) **Explain the speckle noise in ultrasound. Describe a generalized noise model incorporating different kind of noises.**

**Answer:**

Speckle, a multiplicative random noise, is a common phenomenon in ultrasound images, which are produced by the superposition inferring echoes transmitted waveform coming with random phases and amplitudes.

Speckle noise is a type of noise that affects the quality and resolution of ultrasound images. It is caused by the interference of many waves of the same frequency that are reflected by small structures within the tissue.

Speckle noise makes the ultrasound images look grainy and textured, which can reduce the contrast and visibility of the features of interest. Speckle noise can also affect the accuracy of measurements and analysis based on ultrasound images.

A generalized noise model is a mathematical description of the random fluctuations or disturbances that affect a signal or a system. Different kinds of noises have different characteristics, such as distribution, power, frequency, and correlation. A generalized noise model can capture the diversity and complexity of real-world noise scenarios by using appropriate parameters or functions.

One example of a generalized noise model is the symmetric alpha-stable (SαS) model, which can describe noise that ranges from Gaussian to impulsive. The SαS model has two parameters: alpha and gamma. Alpha controls the shape of the noise distribution, and gamma controls the scale or variance of the noise. When alpha is2, the SαS model reduces to the Gaussian model. When alpha is less than 2, the SαS model becomes more impulsive and heavy-tailed.

1. (a) What is brain scanning technique? Illustrate the working principle of CT.

(b) **Compare the X-ray, CT and MRI system based on their advantages, disadvantages and applications.**

**Answer:**

| **Test** | **Technology** | **Advantages** | **Disadvantages** | **Applications** |
| --- | --- | --- | --- | --- |
| X-ray | Uses electromagnetic radiation to create 2D images of bones and some soft tissues. | Fast, easy, inexpensive, and widely available. | Low-quality images with less information and contrast. Exposes the patient to radiation. | Detecting fractures, dislocations, bone cancer, arthritis, osteoporosis, tooth decay, lung infection, enlarged heart, breast cancer, and blocked blood vessels. |
| CT | Uses a 360-degree beam of radiation and a computer to create detailed 3D images of internal structures. | High-quality images with more information and clarity. Provides 360-degree and cross-section views. | Expensive and exposes the patient to higher radiation levels than X-rays. | Seeing internal organs, soft tissues, blood vessels, tumors, complex injuries, and internal bleeding. |
| MRI | Uses a powerful magnet and radio waves to create detailed 3D images of internal structures without radiation exposure. | High-quality images with more information and clarity. Provides cross-section views. No radiation exposure. | Expensive and not widely available. Takes longer than X-rays or CT scans. Can be noisy and claustrophobic. Not suitable for patients with metal implants or devices. | Seeing internal body structures such as the brain, spinal cord, neck, breasts, abdomen, and muscles. |

(c) Explain the artifacts in CT.

Answer:

1. (a) Describe the working principle of MRI.

(b) Mention the advantages and disadvantages of MRI.

(c) Write down the difference between MRI and fMRI.

1. (a) What is nuclear medicine? Mention the uses of nuclear medicine.

(b) Write the advantages and disadvantages of DTI (Diffusion tensor imaging) and DOT (Diffuse optical tomography)

(c) Explain the iterative reconstructions methods.

1. (a) With appropriate figure describe the Otsu method of thresholding.

(b) Describe the watershed segmentation algorithm.

(c) Explain Homomorphic transform.

1. (a) Demonstrate the working principle of medical thermography with proper diagram

(b) What can a diagnostic mammography show? Explain with working principle this technique.

2018 Question

1. (a) **Write the importance and benefits of medical imaging.**

**Answer:**

In an ideal world we would be able to diagnose, treat and cure patients without causing any harmful side effects. The use of medical imaging has enabled doctors to see inside a patient without having to cut them open. Medical imaging also helps us learn more about neurobiology and human behaviours.

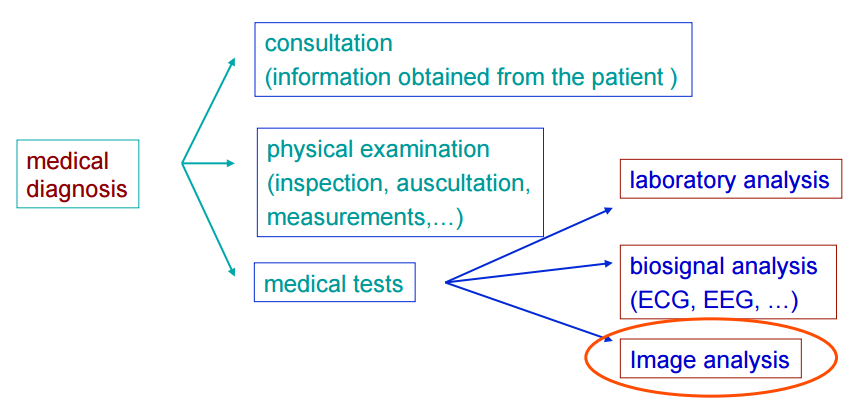
Medical imaging brings scientists from biology, chemistry and physics together and the technologies developed can often be used in many disciplines.

* **Health Benefit:** Medical imaging helps you detect and diagnose disease at its earliest, most treatable stages and guides physicians and patients in determining the most appropriate and effective care.
* **Health Care Costs & Quality:** By catching disease early, reducing the need for invasive, in-patient procedures and facilitating shorter recovery times, medical imaging saves money and improves efficiency in the health care system.
* **Technology & Innovation:** Radiation therapy and medical imaging technologies have revolutionized health care delivery in America and around the world. Extending human vision into the very nature of disease, medical imaging enables a new and more powerful generation of diagnosis and intervention. Radiation therapy offers highly personalized and targeted means of killing cancer cells while leaving healthy ones untouched.
* **Jobs & the Economy:** Medical imaging and radiation therapy is the source of hundreds of thousands of jobs all over the world.

(b) **How can you determine the identity of a possible disease or disorder.**

**Answer:**

Determination of the identity of a possible disease or disorder.



(c) **Differentiate between radiology and radiotherapy. Point out different modalities of medical imaging.**

**Answer:**

Radiology and radiotherapy are both related to the use of radiation in medicine, but they have different purposes and techniques. Here is a table that summarizes some of the main differences between them:

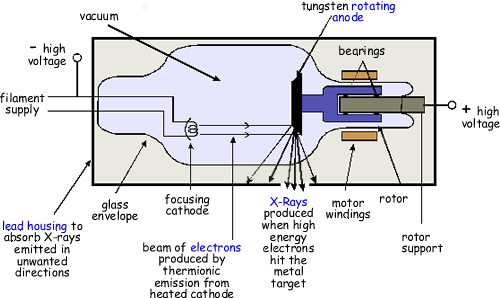
| **Radiology** | **Radiotherapy** |
| --- | --- |
| Uses radiation to produce images of the body, such as X-rays, CT scans, MRI, etc. | Uses radiation to treat cancer and other diseases by killing or shrinking tumors. |
| Has two main specializations: diagnostic radiology and interventional radiology. | Has two main types: external beam radiation therapy and internal radiation therapy. |
| Diagnostic radiologists interpret the images to diagnose illnesses and injuries. | Radiation oncologists prescribe and oversee the radiation treatments for patients. |
| Interventional radiologists perform minimally invasive procedures guided by imaging tools. | Radiation therapists operate the machines that deliver the radiation beams to the patients. |
| Radiology is essential for disease management and monitoring treatment outcomes. | Radiotherapy is one of the main modalities of cancer treatment, along with surgery and chemotherapy. |

Different modalities of medical imaging:

* Radiography
* Computed Tomography
* Magnetic Resonance Imaging
* Ultrasonography
* Nuclear Medicine
* Endoscopy
* Thermography

1. (a) **Illustrate the X-ray generation technique.**

**Answer:**



(b) **Mention the benefits and risks of X-rays**

**Answer:**

Some of the benefits of X-rays are:

* Medical x-rays have increased our ability to detect disease or injury early enough for a medical problem to be managed, treated, or cured.
* When performed appropriately and early enough, these procedures can improve health and may even save a person’s life.
* They are cheap and easy to use compared to other imaging techniques such as MRI or CT scans.
* They can provide clear and detailed images of bones, teeth, and some organs.
* They can help detect and monitor diseases such as fractures, infections, tumors, and lung problems.
* They can guide interventional procedures such as angiography, biopsy, or stent placement

Some of the risks of X-rays are:

* A small increase in the possibility that a person exposed to x-rays will develop cancer later in life
* The possibility of cataracts and skin burns, but only at extremely high levels of radiation exposure
* They expose you to ionizing radiation, which can damage your cells and DNA and increase your risk of cancer.
* The amount of radiation you receive depends on the type and duration of the X-ray procedure. Some procedures, such as CT scans, deliver higher doses than others.
* The effects of radiation are cumulative, meaning that repeated exposure can add up over time and cause more harm.
* Some people may have allergic reactions to the contrast agents used in some X-ray procedures

(c) **What precautions we have to take for reducing X-ray radiation.**

**Answer:**

Reduction of radiation risks:

* Keeping a “medical x-ray history” with the names of your radiological exams or procedures, the dates and places where you had them, and the physicians who referred you for those exams
* Making your current healthcare providers aware of your medical x-ray history;
* Asking your healthcare provider about whether or not alternatives to x-ray exams would allow the provider to make a good assessment or provide appropriate treatment for your medical situation
* Providing interpreting physicians and referring physicians with recent x-ray images and radiology reports
* Informing radiologists or x-ray technologists in advance if you are pregnant or think you may be pregnant.

1. (a) **What are the potential advantages of ultrasound imaging over other modalities of medical imaging**

**Answer:**

Some of the potential advantages of ultrasound imaging over other modalities of medical imaging are:

- Ultrasound uses non-ionizing sound waves and has not been associated with carcinogenesis - this is particularly important for the evaluation of the fetal and gonads.

- Ultrasound is useful to detect and measure the distance of objects, such as fluid levels, blood flow, and fetal growth.

- Ultrasound can provide clear images of soft tissues that do not show up well in X-ray images, such as muscles, tendons, ligaments, and organs.

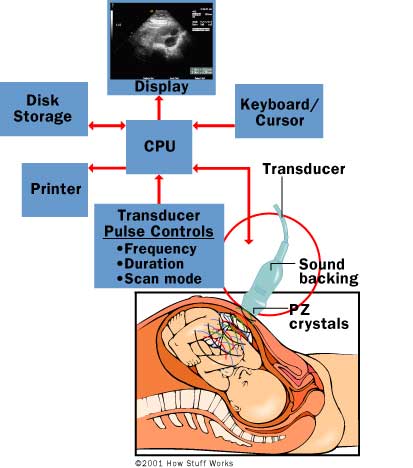
- Ultrasound is relatively inexpensive, portable, and easy to operate compared to other imaging modalities such as CT and MRI.

- Ultrasound can be performed in real-time, allowing dynamic assessment of moving structures and guidance for interventional procedures.

(b) **Describe the basic working mechanism of ultrasound.**

**Answer:**

* The ultrasound machine transmits high-frequency (1 to 18 megahertz) sound pulses into your body using a probe.
* The sound waves travel into your body and hit a boundary between tissues (e.g. between fluid and soft tissue, soft tissue and bone).
* Some of the sound waves get reflected back to the probe, while some travel on further until they reach another boundary and get reflected.
* The reflected waves are picked up by the probe and relayed to the machine.
* The machine calculates the distance from the probe to the tissue or organ (boundaries) using the speed of sound in tissue (5,005 ft/s or1,540 m/s) and the time of each echo's return (usually on the order of millionths of a second).
* The machine displays the distances and intensities of the echoes on the screen, forming a two dimensional image.



(c) **Differentiate among A-mode, B-mode and D-mode operations of ultrasound imaging.**

**Answer:**

| **Mode** | **Description** | **Display** | **Application** |
| --- | --- | --- | --- |
| A-mode | Uses a single transducer to scan the body and plots the echoes as a one-dimensional graph | X-axis: depth, Y-axis: amplitude of echoes | Measuring distances, detecting cysts or tumors |
| B-mode | Uses linear array transducers to scan a plane through the body and converts the echoes into a two-dimensional image | Brightness of pixels: amplitude of echoes | Visualizing anatomy and tissue texture, most common mode for ultrasound imaging |
| D-mode | Uses Doppler effect to measure the frequency shift of echoes due to the movement of blood or tissue and displays it as a color-coded image | Color of pixels: frequency shift of echoes | Measuring blood flow, detecting heart valve problems |

1. (a) What is brain scanning technique? Illustrate the working principle of CT.

(b) **Differentiate between CT and X-ray.**

**Answer:**

| **Parameter** | **CT** | **X-ray** |
| --- | --- | --- |
| Description | A type of advanced X-ray that uses a 360-degree beam and a computer to create detailed 3D images of internal structures. | A type of imaging that uses electromagnetic radiation to create 2D images of bones and some soft tissues. |
| Inventor | Allan Cormack and Godfrey Hounsfield in 1972. | Wilhelm Rontgen in 1895. |
| Use to diagnose | Internal organs, soft tissues, blood vessels, tumors, complex injuries, and internal bleeding. | Fractures, dislocations, bone cancer, arthritis, osteoporosis, tooth decay, lung infection, enlarged heart, breast cancer, and blocked blood vessels. |
| Advantages | High-quality images with more information and clarity. | Inexpensive and widely available. |
| Disadvantages | Expensive and exposes the patient to higher radiation levels. | Low-quality images with less information and contrast. |

(c) What are the artifacts in CT?

Answer:

1. (a) Describe the working principle of MRI.

(b) Mention the advantages and disadvantages of MRI

(c) Write down the difference between MRI and fMRI

1. (a) What is nuclear medicine? Write the uses of nuclear medicine.

(b) Write the advantages and disadvantages of DTI and DOT

(c) Explain the iterative reconstructions methods.

1. (a) Point out the advantages and disadvantages of region growing segmentation

(b) Describe the watershed segmentation algorithm

(c) Explain Homomorphic transform.

1. (a) Differentiate between ECG and EEG. How ECG and EEG signals are produced?

(b) Describe the feature extraction of EEG signal by Wiener filtering. Also explain the spectral error measure (SEM) for EEG signal

2020 Questions:

1. (a) **Write the importance and benefits of medical imaging.**

**Answer:**

In an ideal world we would be able to diagnose, treat and cure patients without causing any harmful side effects. The use of medical imaging has enabled doctors to see inside a patient without having to cut them open. Medical imaging also helps us learn more about neurobiology and human behaviours.

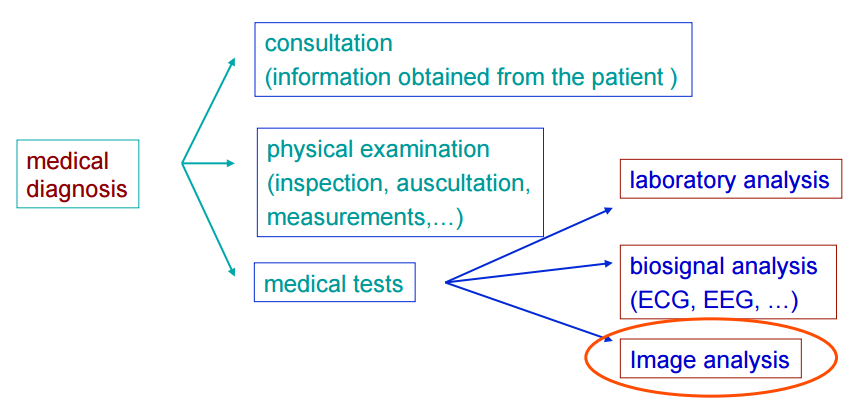
Medical imaging brings scientists from biology, chemistry and physics together and the technologies developed can often be used in many disciplines.

* **Health Benefit:** Medical imaging helps you detect and diagnose disease at its earliest, most treatable stages and guides physicians and patients in determining the most appropriate and effective care.
* **Health Care Costs & Quality:** By catching disease early, reducing the need for invasive, in-patient procedures and facilitating shorter recovery times, medical imaging saves money and improves efficiency in the health care system.
* **Technology & Innovation:** Radiation therapy and medical imaging technologies have revolutionized health care delivery in America and around the world. Extending human vision into the very nature of disease, medical imaging enables a new and more powerful generation of diagnosis and intervention. Radiation therapy offers highly personalized and targeted means of killing cancer cells while leaving healthy ones untouched.
* **Jobs & the Economy:** Medical imaging and radiation therapy is the source of hundreds of thousands of jobs all over the world.

(b) **How can you determine the identify of a possible disease or disorder?**

**Answer:**

Determination of the identity of a possible disease or disorder.



(c) **Differentiate between radiology and radiotherapy. Point out different modalities of medical imaging.**

**Answer:**

Radiology and radiotherapy are both related to the use of radiation in medicine, but they have different purposes and techniques. Here is a table that summarizes some of the main differences between them:

| **Radiology** | **Radiotherapy** |
| --- | --- |
| Uses radiation to produce images of the body, such as X-rays, CT scans, MRI, etc. | Uses radiation to treat cancer and other diseases by killing or shrinking tumors. |
| Has two main specializations: diagnostic radiology and interventional radiology. | Has two main types: external beam radiation therapy and internal radiation therapy. |
| Diagnostic radiologists interpret the images to diagnose illnesses and injuries. | Radiation oncologists prescribe and oversee the radiation treatments for patients. |
| Interventional radiologists perform minimally invasive procedures guided by imaging tools. | Radiation therapists operate the machines that deliver the radiation beams to the patients. |
| Radiology is essential for disease management and monitoring treatment outcomes. | Radiotherapy is one of the main modalities of cancer treatment, along with surgery and chemotherapy. |

Different modalities of medical imaging:

* Radiography
* Computed Tomography
* Magnetic Resonance Imaging
* Ultrasonography
* Nuclear Medicine
* Endoscopy
* Thermography

1. (a) **How ultrasound works? Write the major uses of ultrasound.**

**Answer:**

* The ultrasound machine transmits high-frequency (1 to 18 megahertz) sound pulses into your body using a probe.
* The sound waves travel into your body and hit a boundary between tissues (e.g. between fluid and soft tissue, soft tissue and bone).
* Some of the sound waves get reflected back to the probe, while some travel on further until they reach another boundary and get reflected.
* The reflected waves are picked up by the probe and relayed to the machine.
* The machine calculates the distance from the probe to the tissue or organ (boundaries) using the speed of sound in tissue (5,005 ft/s or1,540 m/s) and the time of each echo's return (usually on the order of millionths of a second).
* The machine displays the distances and intensities of the echoes on the screen, forming a two dimensional image.

**Major Uses of Ultrasound**

* + 1. Obstetrics and Gynecology
       - 1. Measuring the size of the fetus to determine the due date
         2. Checking the position, sex of the baby.
         3. Seeing the number of fetuses in the uterus
         4. Checking the fetus's growth rate by making many measurements over time
         5. Detecting ectopic pregnancy, the life-threatening situation in which the baby is implanted in the mother's Fallopian tubes instead of in the uterus
         6. Determining whether there is an appropriate amount of amniotic fluid cushioning the baby
    2. Cardiology
       - 1. Seeing the inside of the heart to identify abnormal structures or functions
         2. Measuring blood flow through the heart and major blood vessels
    3. Urology
       - 1. Measuring blood flow through the kidney
         2. Seeing kidney stones
         3. Detecting prostate cancer early

(b) **Describe the underlying mechanism for creation of an ultrasound image.**

**Answer:**

The creation of an image from sound is done in three steps – producing a sound wave, receiving echoes, and interpreting those echoes.

**Producing a sound wave**

* + 1. A sound wave is typically produced by a piezoelectric transducer encased in a plastic housing.
    2. Strong, short electrical pulses from the ultrasound machine drive the transducer at the desired frequency.
    3. The frequencies can be anywhere between 1 and 18 MHz. The sound is focused either by the shape of the transducer, a lens in front of the transducer, or a complex set of control pulses from the ultrasound scanner (Beamforming). This focusing produces an arc-shaped sound wave from the face of the transducer.
    4. The wave travels into the body and comes into focus at a desired depth. The sound wave is partially reflected from the layers between different tissues or scattered from smaller structures.

**Receiving the echoes**

* + 1. The return of the sound wave to the transducer results in the same process as sending the sound wave, except in reverse.
    2. The returned sound wave vibrates the transducer and the transducer turns the vibrations into electrical pulses that travel to the ultrasonic scanner where they are processed and transformed into a digital image.

**Forming the image**

To make an image, the ultrasound scanner must determine two things from each received echo:

* + 1. How long it took the echo to be received from when the sound was transmitted.
    2. How strong the echo was.
    3. Once the ultrasonic scanner determines these two things, it can locate which pixel in the image to light up and to what intensity.
    4. Transforming the received signal into a digital image may be explained by using a blank spreadsheet as an analogy. First picture a long, flat transducer at the top of the sheet. Send pulses down the 'columns' of the spreadsheet (A, B, C, etc.). Listen at each column for any return echoes. When an echo is heard, note how long it took for the echo to return. The longer the wait, the deeper the row (1,2,3, etc.). The strength of the echo determines the brightness setting for that cell (white for a strong echo, black for a weak echo, and varying shades of grey for everything in between.) When all the echoes are recorded on the sheet, we have a greyscale image.

**Displaying the image**

Images from the ultrasound scanner are transferred and displayed using the DICOM standard. Normally, very little post processing is applied to ultrasound images.

(c) **Write down the ultrasound advantages and disadvantages.**

**Answer:**

Ultrasound is a medical imaging technology that uses high-frequency sound waves to produce images of structures within the human body. Ultrasound has many advantages and disadvantages, depending on the application and the type of tissue being examined. Here are some of them:

**Advantages of ultrasound:**

- Ultrasound uses non-ionizing sound waves and has not been associated with carcinogenesis - this is particularly important for the evaluation of the fetal and gonads.

- Ultrasound is useful to detect and measure the distance of objects, such as fluid levels, blood flow, and fetal growth.

- Ultrasound can provide clear images of soft tissues that do not show up well in X-ray images, such as muscles, tendons, ligaments, and organs.

- Ultrasound is relatively inexpensive, portable, and easy to operate compared to other imaging modalities such as CT and MRI.

- Ultrasound can be performed in real-time, allowing dynamic assessment of moving structures and guidance for interventional procedures.

**Disadvantages of ultrasound:**

- Ultrasound has poor penetration through bone or air, which limits its use in some areas such as the brain, lungs, and spine.

- Ultrasound images can be difficult to interpret and require experienced operators or radiologists to avoid errors and artifacts.

- Ultrasound has lower resolution and image quality than CT and MRI, which may affect the detection of small or subtle abnormalities.

- Ultrasound is affected by external factors such as noise, temperature, humidity, and interference from other devices, which may degrade the performance of the equipment.

- Ultrasound may cause thermal or mechanical effects on the tissues due to the absorption or scattering of sound energy, which may have potential biological effects or risks.

1. (a) Explain the process of creation of X-ray image.

(b) Illustrate the X-ray generation technique.

(c) **How the radiation risks can be reduced?**

**Answer:**

Reduction of radiation risks:

* Keeping a “medical x-ray history” with the names of your radiological exams or procedures, the dates and places where you had them, and the physicians who referred you for those exams
* Making your current healthcare providers aware of your medical x-ray history;
* Asking your healthcare provider about whether or not alternatives to x-ray exams would allow the provider to make a good assessment or provide appropriate treatment for your medical situation
* Providing interpreting physicians and referring physicians with recent x-ray images and radiology reports
* Informing radiologists or x-ray technologists in advance if you are pregnant or think you may be pregnant.

1. (a) What is brain scanning technique? Illustrate the working principle of CT.

(b) Differentiate between CT and X-ray.

(c) What are the artifacts in CT?

1. (a) Describe the mechanism of producing an image in magnetic resonance imaging (MRI).

(b) Why MRI is commonly done? Discuss the merits and demerits of MRI.

1. (a) What is nuclear medicine? Write the uses of nuclear medicine.

(b) What are the differences of nuclear medicine with X-ray and CT imaging?

(c) Describe SPECT. Write the advantages and disadvantages of DTI and DOT.

1. (a) Point out the advantages and disadvantages of region growing segmentation

(b) Write the watershed segmentation algorithm.

(c) How tomography is performed? Describe the iterative reconstructions methods.

1. (a) Differentiate between ECG and EEG. How ECG and EEG signals are produced?

(b) Describe the feature extraction of EEG signal by Wiener filtering. Also explain the spectral error measure (SEM) for EEG signal

Medical Imaging topics  
  
Ultrasound  
X-ray  
CT-scan  
MRI  
FMRI  
ECG  
EEG  
Digital Image Processing  
Image Enhancement  
Histogram modeling, specification and equalization  
Reconstruction from projection  
Watershed Segmentation Algorithm  
Tomography  
PET  
SPECT  
DICOM  
Image Restoration  
Brain Scanning Technique  
Mammography  
Nuclear medicine  
Microscopy image  
DTI  
DOT