1. (a) medical imaging?

Medical imaging refers to the use of various techniques to create images of the inside of the body for medical purposes. These images can be used to diagnose and treat a wide range of medical conditions. Some common types of medical imaging include: X-rays, CT scans, MRI, Ultrasound, PET.

(a) Modalities of medical imaging?

There are several different modalities used in medical imaging, which refer to the specific techniques or technologies that are used to create images of the inside of the body. Some common modalities include:

1. **X-ray:** X-ray is a type of medical imaging that uses ionizing radiation to create images of the inside of the body. It is often used to visualize bones, as well as to detect certain types of cancer and other abnormalities.
2. **Computed tomography (CT):** CT scans use x-rays to create detailed 3D images of the inside of the body. They are often used to diagnose cancer, injuries, and other conditions.
3. **Magnetic resonance imaging (MRI):** MRI uses a powerful magnet and radio waves to create detailed images of the inside of the body. It is often used to visualize soft tissue, such as organs and muscles, and is particularly useful for identifying brain abnormalities.
4. **Ultrasound:** Ultrasound uses high-frequency sound waves to create images of the inside of the body. It is often used to visualize organs and other structures in the abdomen and pelvis, as well as to monitor the development of a fetus during pregnancy.
5. **Positron emission tomography (PET):** PET uses a small amount of radioactive material to create images of the inside of the body. It is often used to diagnose cancer and other conditions.
6. **Fluoroscopy:** Fluoroscopy is a type of medical imaging that uses x-rays to create real-time images of the inside of the body. It is often used to visualize the movement of organs and other structures, such as the digestive system or heart.
7. **Mammography**: Mammography is a specialized type of x-ray imaging used to visualize the breasts. It is often used to detect breast cancer in its early stages.
8. **Angiography:** Angiography is a type of medical imaging that uses x-rays to visualize blood vessels in the body. It is often used to diagnose and treat conditions related to the blood vessels, such as blockages or aneurysms.

(b) Basic properties of image?

In medical imaging, the basic properties of an image refer to the characteristics that are used to describe and analyze the image. These properties include:

1. Resolution: Resolution refers to the detail or clarity of an image. Higher resolution images have more detail and are generally considered to be of better quality.
2. Contrast: Contrast refers to the range of light and dark tones in an image. Higher contrast images have a greater range of tones, while lower contrast images have a more limited range.
3. Brightness: Brightness refers to the overall lightness or darkness of an image.
4. Saturation: Saturation refers to the intensity or purity of the colors in an image. Higher saturation images have more intense colors, while lower saturation images have more muted or subdued colors.
5. Noise: Noise refers to unwanted variations or distortions in an image that can reduce its quality.

6. Artifacts: Artifacts are distortions or abnormalities in an image that are caused by the imaging process itself, rather than by the structure or tissue being imaged.

Understanding these basic properties of a medical image can help medical professionals accurately interpret the image and make a diagnosis.

(c) Define X-ray imaging

X-ray imaging is a medical imaging modality that uses ionizing radiation to create images of the inside of the body. X-rays are absorbed differently by different tissues, allowing bones and other structures to be visualized on an x-ray image. X-ray exams are noninvasive, quick, and widely available, and are commonly used to visualize bones and joints, as well as to detect certain types of cancer and other abnormalities.

(c) Briefly describe roentgen x-ray setup and his detection and conclusion about the ray

Roentgen was conducting **experiments with cathode ray tubes**, which are devices that **produce a beam** of **electrons** when subjected to **a high voltage**.

During one of his experiments, **Roentgen noticed that a fluorescent screen**, which was **located a few feet away from the cathode ray tube, was glowing even when the tube was covered with a thick layer of black cardboard**. He realized that this was **due to a type of radiation that was passing through the cardboard and causing the screen to fluoresce.**

Roentgen called this new type of radiation "x-rays," because they were unknown at the time and he didn't know what to call them.

He found that the new ray could pass through most substances casting shadows of solid objects. Roentgen also discovered that the ray could pass through the tissue of humans, but not bones and metal objects.

Roentgen's discovery of x-rays had a significant impact on the field of medical imaging and revolutionized the way that doctors were able to diagnose and treat medical conditions. X-rays are still widely used today as a noninvasive way to obtain images of the inside of the body. Roentgen received the Nobel Prize in Physics in 1901 for his discovery of x-rays.

(d) Mention the advantages and disadvantages

X-ray imaging is a non-invasive medical technique that uses ionizing radiation to produce images of the inside of the body. It is quick, convenient, relatively inexpensive, and does not require the use of contrast agents. X-rays provide good contrast between different types of tissue and can be taken from various angles, making them a useful tool for the diagnosis and treatment of a wide range of medical conditions.

There are several disadvantages to using x-ray as a medical imaging modality, including the use **of ionizing radiation, limited tissue contrast**, **inability to visualize certain structures**, and **limited use in certain situations**.

There are several advantages to using x-ray imaging:

1. X-rays are quick and easy to produce, making them a convenient and widely available imaging modality.
2. X-rays are relatively inexpensive compared to other imaging techniques, such as CT or MRI.
3. X-rays do not require the use of contrast agents, which can be harmful for some patients.
4. X-ray images provide good contrast between different types of tissue, making it easier to identify abnormalities or problems.
5. X-ray images can be taken from various angles, allowing for detailed views of the body from different perspectives.
6. X-rays are widely available and can be performed at most hospitals and medical centers.

Overall, x-ray imaging is a useful tool for quickly and easily obtaining detailed images of the inside of the body, and it can be an important tool in the diagnosis and treatment of a wide variety of medical conditions.

There are a few potential disadvantages to using x-ray as a medical imaging modality:

1. Ionizing radiation: X-rays use ionizing radiation, which has the potential to damage cells and tissues in the body. While the amount of radiation used in x-ray exams is generally considered to be safe, repeated or prolonged exposure to ionizing radiation can increase the risk of cancer and other negative health effects.
2. Limited tissue contrast: X-rays do not provide as much contrast between different tissues as other imaging modalities, such as MRI or CT. This can make it more difficult to distinguish between certain tissues or abnormalities on an x-ray image.
3. Inability to visualize certain structures: X-rays do not pass through certain materials, such as air-filled organs or tissues with low density, very well. As a result, they are not always able to visualize these structures accurately.
4. Limited use in certain situations: X-rays may not be the best imaging modality for certain conditions or situations. For example, they may not be as effective at visualizing soft tissues or structures in the abdomen or pelvis as other modalities, such as ultrasound or CT.

2 (a)Define image quality

Image quality refers to the clarity and detail of an image, and is an important factor in determining the diagnostic value of a medical image. It is affected by factors such as image resolution, contrast, noise, and artifacts. Good image quality is essential for accurate diagnosis and effective treatment of medical conditions.

(a) mention principal component of image quality

The principal components of image quality are resolution, contrast, noise, artifacts, and SNR, and they all contribute to the clarity and diagnostic value of an image.

There are several principal components that contribute to the overall quality of an image:

Image resolution: This refers to the number of pixels in an image and determines how much detail can be seen. A higher resolution image will have more pixels and therefore more detail.

Image contrast: This refers to the difference in brightness between different structures or tissues in an image. Good contrast makes it easier to distinguish between different structures and identify abnormalities.

Noise: Noise is random variations in the intensity of pixels in an image and can reduce image quality.

Artifacts: Artifacts are **distortions or abnormalities** in an image that are not caused by the structures being imaged. They **can be caused by technical issues or errors in the imaging process** and can reduce image quality.

Signal-to-noise ratio (SNR): This refers to the ratio of the strength of the signal being imaged to the strength of the noise in the image. **A higher SNR means a clearer, more detailed image**.

(b) prove "if the difference in thickness increases, the subject contrast increases"

The contrast of an image is determined by the difference in brightness between different structures or tissues in an image. When the difference in thickness between two structures increases, the difference in the amount of x-rays absorbed by the two structures also increases. This leads to a greater difference in brightness between the two structures, resulting in an increase in subject contrast in the image.

For example, consider an x-ray image of a chest that shows the ribs and the surrounding soft tissue. If the thickness of the ribs increases, the amount of x-rays absorbed by the ribs will also increase, resulting in a darker appearance of the ribs in the image. On the other hand, the surrounding soft tissue will appear lighter in the image because it absorbs fewer x-rays. This difference in brightness between the ribs and the surrounding soft tissue is what contributes to the subject contrast in the image.

Overall, the greater the difference in thickness between two structures, the greater the difference in the amount of x-rays absorbed, leading to an increase in subject contrast in the image.

(c) define "contrast to noise ration (CNR)"

Contrast-to-noise ratio (CNR) is a measure of the quality of an image, specifically the ratio of the contrast between two structures or tissues in an image to the noise present in the image. CNR is an important factor in determining the diagnostic value of an image, as it reflects the ability of the image to distinguish between different structures and tissues and to accurately represent their relative brightness.

CNR is calculated by dividing the difference in intensity between two structures or tissues in an image by the standard deviation of the noise in the image. A higher CNR indicates a greater contrast between the two structures and a lower level of noise, resulting in a clearer, more detailed image.

(c) Illustrate the concept of noise with isometric display

Noise in an image is random variations in the intensity of pixels that can reduce image quality and make it harder to accurately interpret the image. Noise can be caused by various factors, such as electronic interference or patient movement during the imaging process.

Here is an example of how noise can affect an image using an isometric display:

Imagine that we have a 3D object represented by a grid of pixels, where the intensity of each pixel represents the height of the object at that point. If the object is a smooth, uniform shape, the pixels will have a consistent intensity across the grid. This would be a high-quality image with low noise.

(d) define

Quantum noise:

Quantum noise, also called quantum mottle, is the main and the most significant source of noise in plain radiography. It is a random process due to fluctuations in the number of photons reaching the detector from point to point

Relative noise:

Relative noise refers to the amount of noise or variability present in a measurement or system relative to some reference or baseline. It can be expressed as a percentage or ratio, and it is often used to compare the noise level in different measurements or systems.

SNR:

The signal-to-noise ratio (SNR) is a measure of the strength of a signal relative to the background noise. It is defined as the ratio of the power of the signal to the power of the noise.

Relationship:

3 (a) CT imaging with basic history

Computed tomography (CT) is a medical imaging technique that uses X-rays to produce detailed images of the body. It is commonly used to diagnose a wide range of conditions, including cancer, heart disease, and internal injuries.

CT scans work by using a series of X-ray beams to produce detailed images of the body from different angles. These images are then combined using a computer to create a detailed, cross-sectional view of the body.

CT scans are non-invasive and painless, and they can be performed quickly and easily. They are also more accurate than traditional X-ray images, as they provide more detailed views of the body's internal structures.

(b) Explain CT image acquisition process

The CT image acquisition process involves the following steps:

Patient preparation, Positioning, Scanning, Image reconstruction, Image interpretation.

(c) principles of back projection techniques

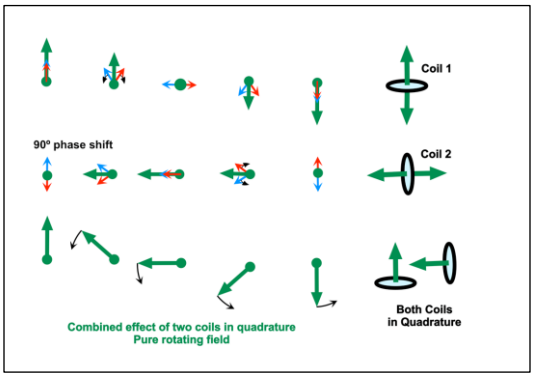
Back projection is a mathematical technique used in computed tomography (CT) to reconstruct images of the internal structures of an object from a series of projections. It is based on the principles of radon transform, which is a mathematical tool used to reconstruct images from projections.

In CT, back projection is used to reconstruct images from a series of X-ray projections taken from different angles around the object. The projections are first converted into a set of linear equations, which are then solved using an iterative algorithm. The resulting image is a detailed, cross-sectional view of the object.

The main advantage of back projection is that it allows for the reconstruction of images from a relatively small number of projections, making it faster and more efficient than other image reconstruction techniques. However, it is sensitive to noise and can produce images with low contrast and poor resolution.

(d) FBP vs ABP

4.(a) Short notes on polarized MRI



(b) Evolution of MRI

Magnetic resonance imaging (MRI) is a medical imaging technique that uses a strong magnetic field and radiofrequency (RF) pulses to produce detailed images of the body's internal structures. It is a non-invasive and painless way to diagnose a wide range of medical conditions, including cancer, heart disease, and neurological disorders.

The concept of MRI was first proposed in the early 1950s. However, it was not until the 1970s that MRI technology was developed to the point where it could be used for medical imaging.

In the early 1980s, the first commercial MRI scanners became available, and MRI began to be used increasingly in hospitals and clinics around the world. Since then, MRI technology has continued to evolve, with improvements in image quality, scan speed, and patient comfort.

Today, MRI is one of the most widely used medical imaging techniques, and it is an essential tool in the diagnosis and treatment of many different medical conditions. It is also used in research settings to study the structure and function of the human body.

5.(d) What problems will occur when partial k-space data is taken for reconstruction?

Partial k-space data refers to incomplete data from the k-space, which is a mathematical representation of an MRI image. In MRI, the k-space data is collected using a series of radiofrequency (RF) pulses that excite the protons in the body. The resulting signal is then used to reconstruct an image of the body's internal structures.

If partial k-space data is used for reconstruction, it can result in a number of problems, including:

1. Incomplete images: If not all of the k-space data is collected, the resulting image will be incomplete, with missing or distorted areas.
2. Reduced image quality: Partial k-space data can result in lower image quality, with reduced contrast and resolution.
3. Increased scan time: Collecting partial k-space data may require additional scans to fill in the missing data, resulting in a longer overall scan time.
4. Increased risk of motion artifacts: If the patient moves during the scan, partial k-space data can result in motion artifacts, which are distortions in the image caused by movement.

Overall, using partial k-space data for reconstruction can result in lower quality images and increased scan time, which can impact the accuracy of the diagnosis and the effectiveness of the treatment.