MEDICAL IMAGING AND PMS

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Introduction to Biometric systems

X-ray machine

(Cont…)

An **X-ray machine** is a device used by radiographers to acquire an x-ray image. They are used in various fields, notably medicine and security.

An X-ray imaging system consists of a X-ray source or generator (X-ray tube), and an image detection system which can either be comprised of film (analog technology) or a digital capture system (such as a picture archiving and communication system).

In the typical X-ray source of less than 450 kV, X-ray photons are produced by an electron beam striking a target. The electrons that make up the beam are emitted from a heated cathode filament. The electrons are then focused and accelerated towards an angled anode target. The point where the electron beam strikes the target is called the focal spot. Most of the kinetic energy contained in the electron beam is converted to heat, but around 1% of the energy is converted into X-ray photons, the excess heat is dissipated via a heat sink. At the focal spot, X-ray photons are emitted in all directions from the target surface, the highest intensity being around 60deg to 90deg from the beam due to the angle of the anode target to the approaching X-ray photons. There is a small round window in the X-ray tube directly above the angled target. This window allows the X-ray to exit the tube with little attenuation while maintaining a vacuum seal required for the X-ray tube operation.

(Cont…)

X-ray machines work by applying controlled voltage and current to the X-ray tube, which results in a beam of X-rays. The beam is projected on matter. Some of the X-ray beam will pass through the object, while some are absorbed. The resulting pattern of the radiation is then ultimately detected by a detection medium including rare earth screens (which surround photographic film), semiconductor detectors, or X-ray image intensifiers.

(Cont…)

X-ray machines are used in health care for visualising bone structures and other dense tissues such as tumours. Non-medicial applications include security and material analysis.

Radio graphic and fluoroscopic techniques

(Cont…)

In the typical radiographic examination the x-ray beam is projected through the patient's body

The point that receives maximum exposure is the entrance surface near the center of the beam. There are two reasons for this. The primary x-ray beam has not been attenuated by the tissue at this point, and the area is exposed by some of the scattered radiation from the body. The amount of surface exposure produced by the backscatter depends on the spectrum of the primary beam and the size of the exposed area. For typical radiographic situations, scattered radiation can add at least 20% to the surface exposure produced by the primary beam.

(Cont…)

As the x-ray beam progresses through the body, it undergoes attenuation. The rate of attenuation (or penetration) is determined by the photon-energy spectrum (KV and filtration) and the type of tissue (fat, muscle, bone) through which the beam passes. For the purpose of this discussion, we assume a body consisting of homogeneous muscle tissue. In the following figure, lines are drawn to divide the body into HVLs. The exposure is reduced by a factor of one half each time it passes through 1 HVL. The thickness of 1 HVL depends on the photon-energy spectrum. However, for the immediate discussion, we assume that 1 HVL is equivalent to 4 cm of tissue. A 20-cm thick body section consists of 5 HVLs. Therefore, the exposure decreases by one half as it passes through each 4 cm of tissue. At the exit surface, the exposure is a small fraction of the entrance surface exposure.

Fluoroscopic techniques

The fluoroscopic beam projected through the body will produce a pattern similar to a radiographic beam if the beam remains fixed in one position. If the beam is moved during the procedure, the radiation will be distributed over a large volume of tissue rather than being concentrated in one area. For a specific exposure time, tissue exposure values (roentgens) are reduced by moving the beam, but the total radiation (R - cm^2) into the body is not changed. This was illustrated in the figure titled, "Exposure" (in the section titled, "Radiation Quantities and Units").

Computer tomography

In computed tomography (CT) two factors are associated with exposure distribution and must be considered: (1) the distribution within an individual slice and (2) the effect of imaging multiple slices.

The rotation of the x-ray beam around the body produces a much more uniform distribution of radiation exposure than a stationary radiographic beam. A typical CT exposure pattern is shown in the figure below. A relatively uniform distribution throughout the slice is obtained if a 360° scan is performed. However, if other scan angles that are not multiples of 360° are used, the exposure distribution will become less uniform.

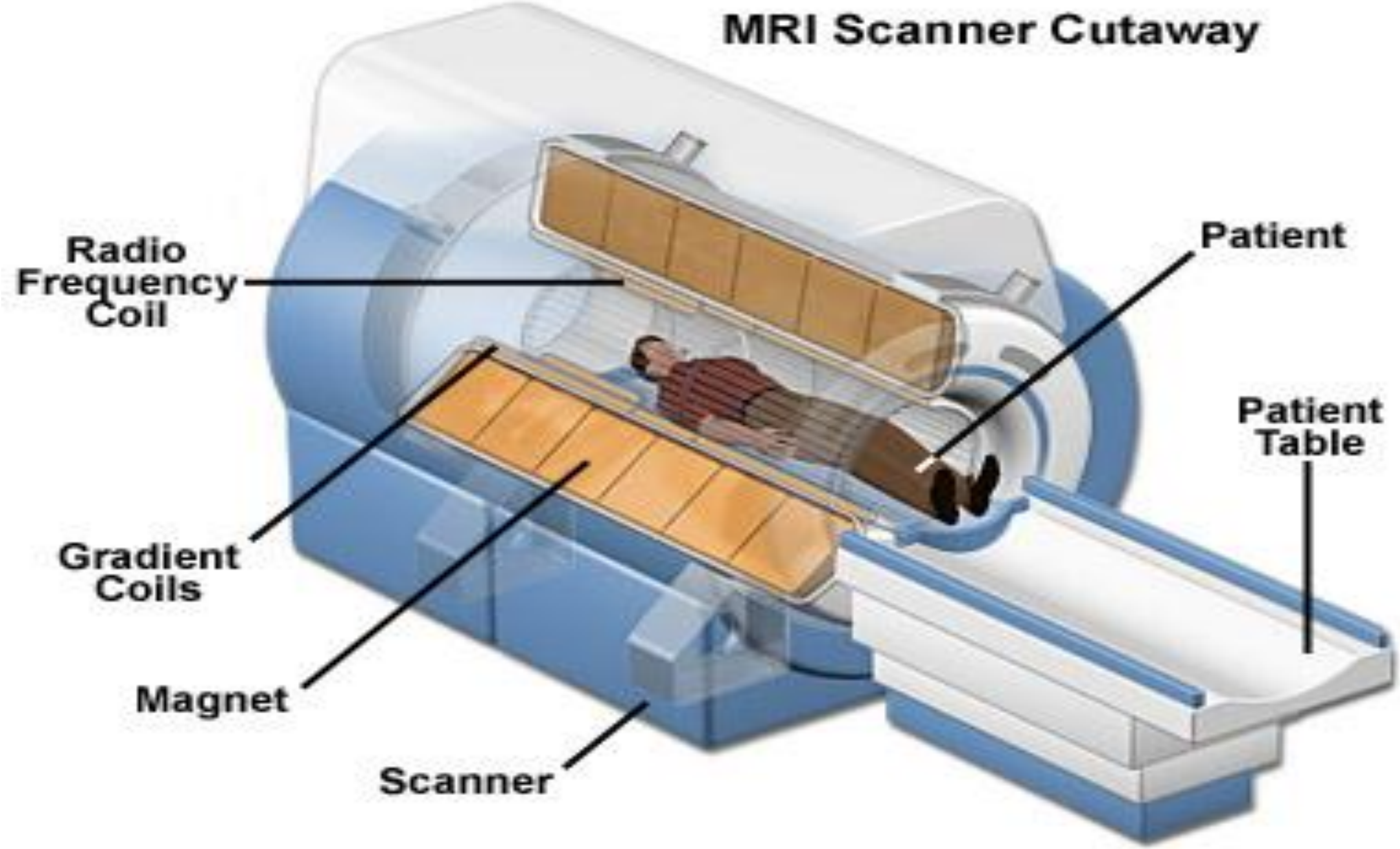
(Cont…)

When multiple slices are imaged, the dose (grays) does not increase in proportion to the number of slices because the radiation is distributed over a larger volume of tissue. However, when slices are located close together, radiation from one slice can produce additional exposure in adjacent slices because slice edges are not sharply defined and because of scattered radiation.

Magnetic Resonance Imaging (MRI)

MRI scanners, like **X-rays** and **CT scanners**, are basically machines doctors use to take pictures of your insides so that they can figure out what's ailing you. But MRI doesn't involve ionizing radiation, as do X-rays and CT scans. Rather, MRI takes advantage of something you have plenty of in your body: water. It is far more flexible than X-rays and CT scans, and can generate three dimensional images in any orientation and at any depth in the body.

MRI scanner


MRI Scanner Cutaway
Radio Frequency Coil
Patient
Patient Table
Gradient Coils
Magnet
Scanner

Magnetic Resonance Imaging (**MRI**), or **nuclear magnetic resonance imaging** (**NMRI**), is primarily a medical imaging technique most commonly used in radiology to visualize the internal structure and function of the body. MRI provides much greater contrast between the different soft tissues of the body than computed tomography (CT) does, making it especially useful in neurological (brain), musculoskeletal, cardiovascular, and oncological (cancer) imaging. Unlike CT, it uses no ionizing radiation, but uses a powerful magnetic field to align the nuclear magnetization of (usually) hydrogen atoms in water in the body. Radio frequency (RF) fields are used to systematically alter the alignment of this magnetization, causing the hydrogen nuclei to produce a rotating magnetic field detectable by the scanner. This signal can be manipulated by additional magnetic fields to build up enough information to construct an image of the body.[1]:36

The body is mainly composed of water molecules which each contain two hydrogen nuclei or protons. When a person goes inside the powerful magnetic field of the scanner, these protons align with the direction of the field.

A second radio frequency electromagnetic field is then briefly turned on causing the protons to absorb some of its energy. When this field is turned off the protons release this energy at a radio frequency which can be detected by the scanner. The position of protons in the body can be determined by applying additional magnetic fields during the scan which allows an image of the body to be built up. These are created by turning gradients coils on and off which creates the knocking sounds heard during an MR scan.

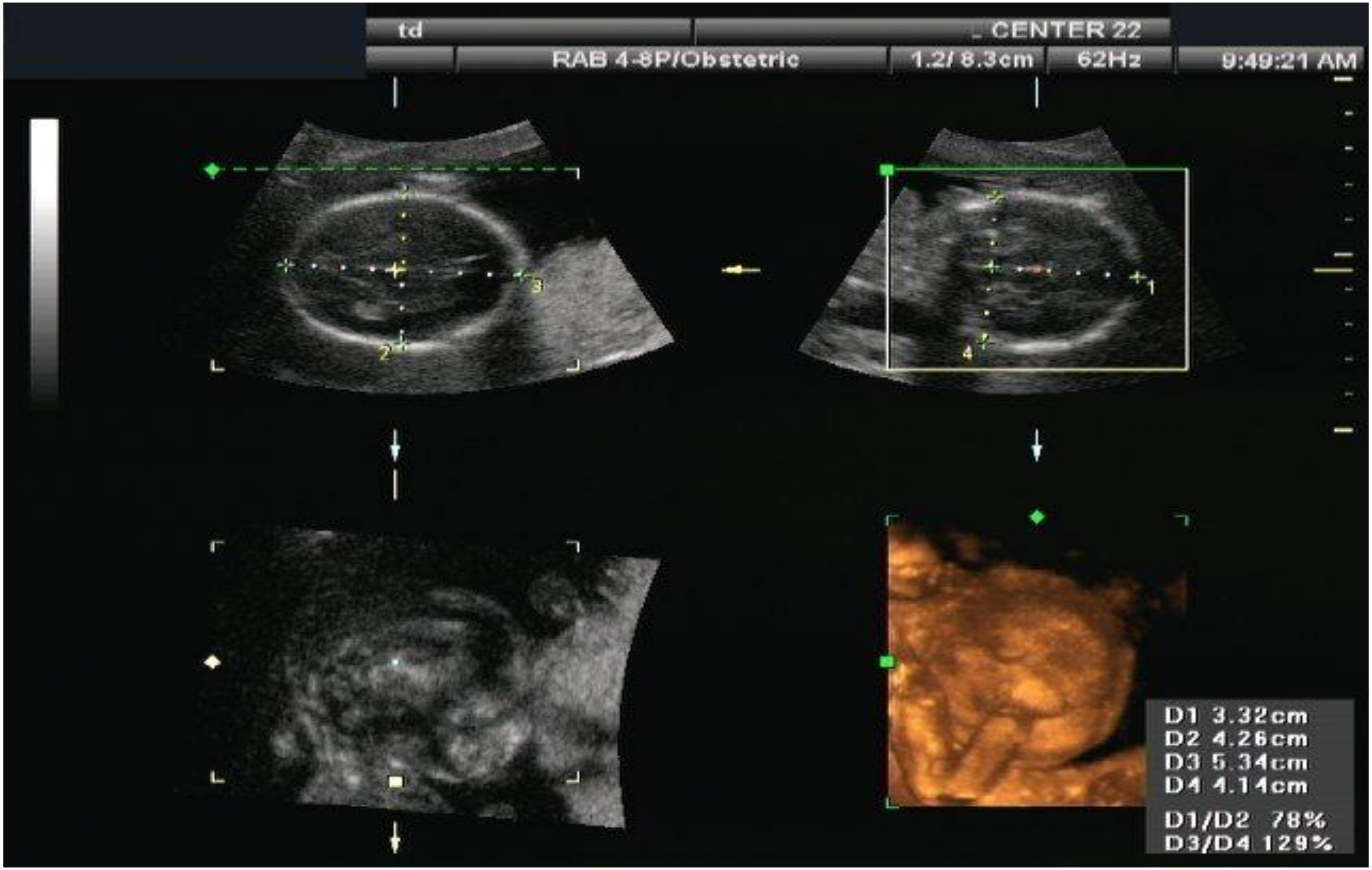
(Cont…)

Diseased tissue, such as tumors, can be detected because the protons in different tissues return to their equilibrium state at different rates. By changing the parameters on the scanner this effect is used to create contrast between different types of body tissue.

The upshot is that MRI, for most applications, is far superior to other imaging tools in providing non-invasive images (and even chemical information) at high resolution.

Ultrasonography instrument

Ultrasonography



Baby in ultrasound

(Cont…)

A general-purpose sonographic machine may be able to be used for most imaging purposes. Usually specialty applications may be served only by use of a specialty transducer. Most ultrasound procedures are done using a transducer on the surface of the body, but improved diagnostic confidence is often possible if a transducer can be placed inside the body. For this purpose, specialty transducers, including endovaginal, endorectal, and transesophageal transducers are commonly employed. At the extreme of this, very small transducers can be mounted on small diameter catheters and placed into blood vessels to image the walls and disease of those vessels.

(Cont…)

Once the ultrasonic scanner determines these three things, it can locate which pixel in the image to light up and to what intensity and at what hue if frequency is processed (see redshift for a natural mapping to hue).

(Cont…)

Transforming the received signal into a digital image may be explained by using a blank spreadsheet as an analogy. We imagine our transducer is a long, flat transducer at the top of the sheet. We will send pulses down the 'columns' of our spreadsheet (A, B, C, etc.). We listen at each column for any return echoes. When we hear an echo, we 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.

Linear Array Transducer

(Cont…)

Ultrasonography (sonography) uses a probe containing one or more acoustic transducers to send pulses of sound into a material. Whenever a sound wave encounters a material with a different density (acoustical impedance), part of the sound wave is reflected back to the probe and is detected as an echo. The time it takes for the echo to travel back to the probe is measured and used to calculate the depth of the tissue interface causing the echo. The greater the difference between acoustic impedances, the larger the echo is. If the pulse hits gases or solids, the density difference is so great that most of the acoustic energy is reflected and it becomes impossible to see deeper.

Modes of sonography

Four different modes of ultrasound are used in medical imaging.These are:

A-mode: A-mode is the simplest type of ultrasound. A single transducer scans a line through the body with the echoes plotted on screen as a function of depth. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.

B-mode: In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen.

(Cont…)

M-mode: M stands for motion. In m-mode a rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe.

Doppler mode: This mode makes use of the Doppler effect in measuring and visualizing blood flow

Endoscopy

(Cont…)

Endoscopy means *looking inside* and typically refers to looking inside the body for medical reasons using an instrument called an **endoscope**. Endoscopy can also refer to using a borescope in technical situations where direct line-of-sight observation is not feasible.

Endoscopy is a minimally invasive diagnostic medical procedure that is used to assess the interior surfaces of an organ by inserting a tube into the body. The instrument may have a rigid or flexible tube and not only provide an image for visual inspection and photography, but also enable taking biopsies and retrieval of foreign objects. Endoscopy is the vehicle for minimally invasive surgery, and patients may receive conscious sedation so they do not have to be consciously aware of the discomfort.

(Cont…)

Many endoscopic procedures are considered to be relatively painless and, at worst, associated with moderate discomfort; for example, in esophagogastroduodenoscopy, most patients tolerate the procedure with only topical anaesthesia of the oropharynx using lidocaine spray. Complications are rare but can include perforation of the organ under inspection with the endoscope or biopsy instrument. If that occurs open surgery may be required to repair the injury.

(Cont…)

An endoscope can consist of

a rigid or flexible tube

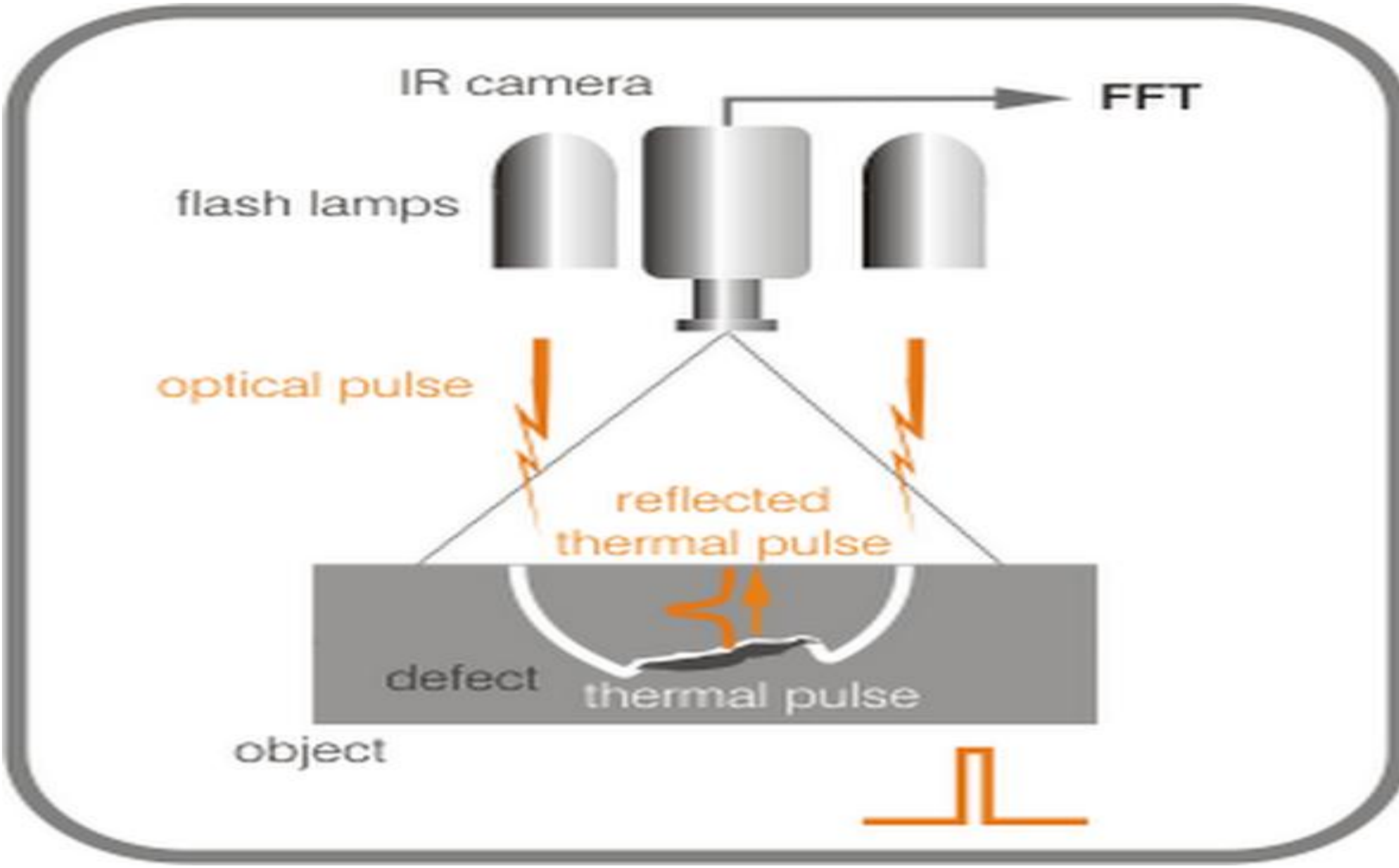
a light delivery system to illuminate the organ or object under inspection. The light source is normally outside the body and the light is typically directed via an optical fiber system

a lens system transmitting the image to the viewer from the fiberscope

an additional channel to allow entry of medical instruments or manipulators

Thermography

Thermography instrument



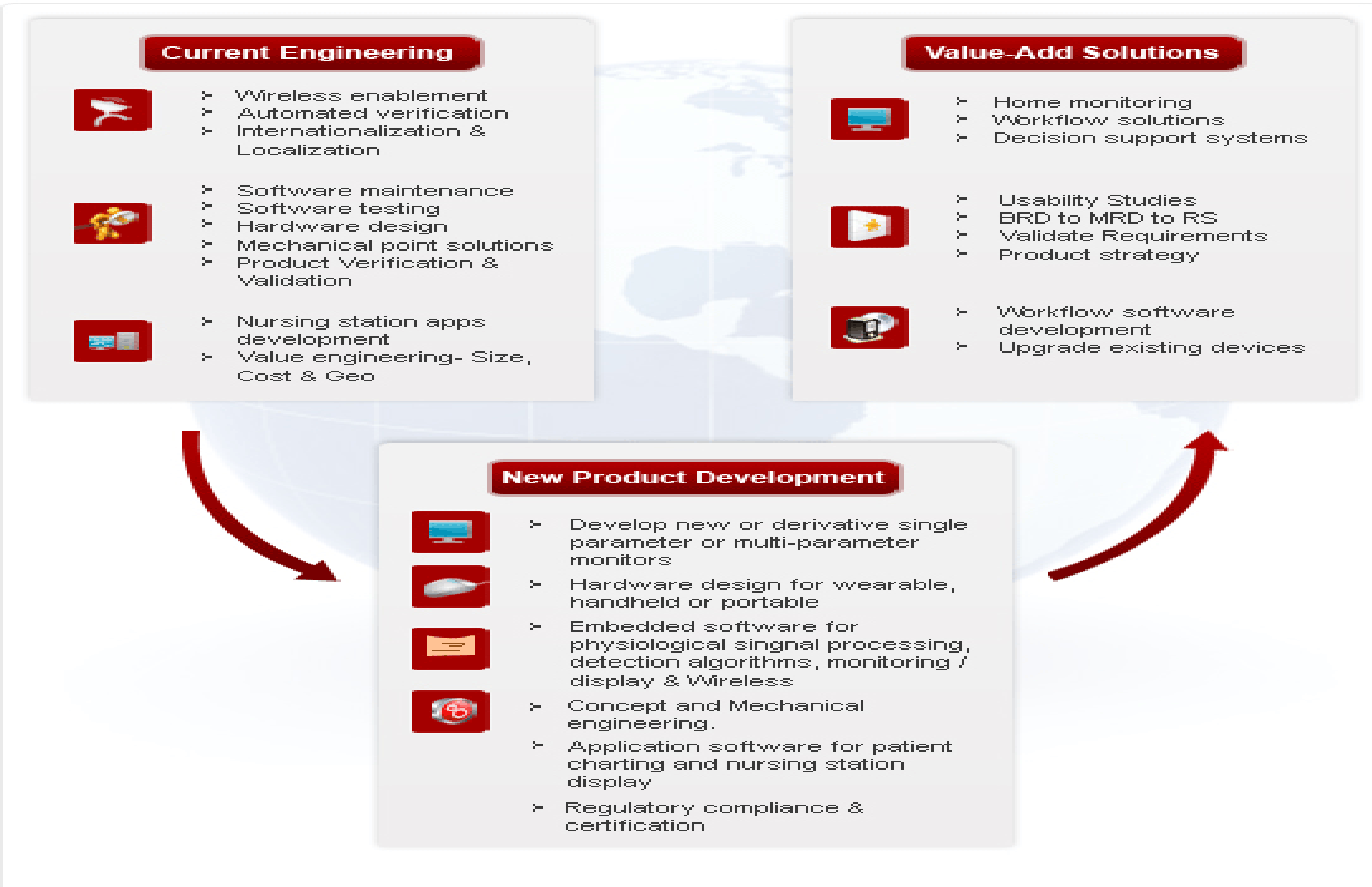
Infrared Thermography, **thermal imaging**, **thermographic imaging**, or **thermal video**, is a type of infrared imaging science. Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900–14,000 nanometers or 0.9–14 µm) and produce images of that radiation. Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermography makes it possible to "see" one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature, therefore thermography allows one to see variations in temperature (hence the name). When viewed by thermographic camera, warm objects stand out well against cooler backgrounds; humans and other warm-blooded animals become easily visible against the environment, day or night. As a result, thermography's extensive use can historically be ascribed to the military and security services.

Advantages of Thermography

It shows a visual picture so temperatures over a large area can be compared :

- It is capable of catching moving targets in real time
- It is able to find deteriorating (i.e. at higher temperature) components prior to their failure
- It can be used to measure or observe in areas inaccessible or hazardous for other methods
- It is a non-destructive test method
- It can be used to find defects in shafts and other metal parts
- Due to the low volume of thermal cameras, quality cameras often have a high price range (often $6,000 USD or above)
- Images can be hard to interpret accurately even with experience
- Accurate temperature measurements are hindered by differing emissivities and reflections from other surfaces

Different types of biotelemetry systems and patient monitoring



(Cont…)

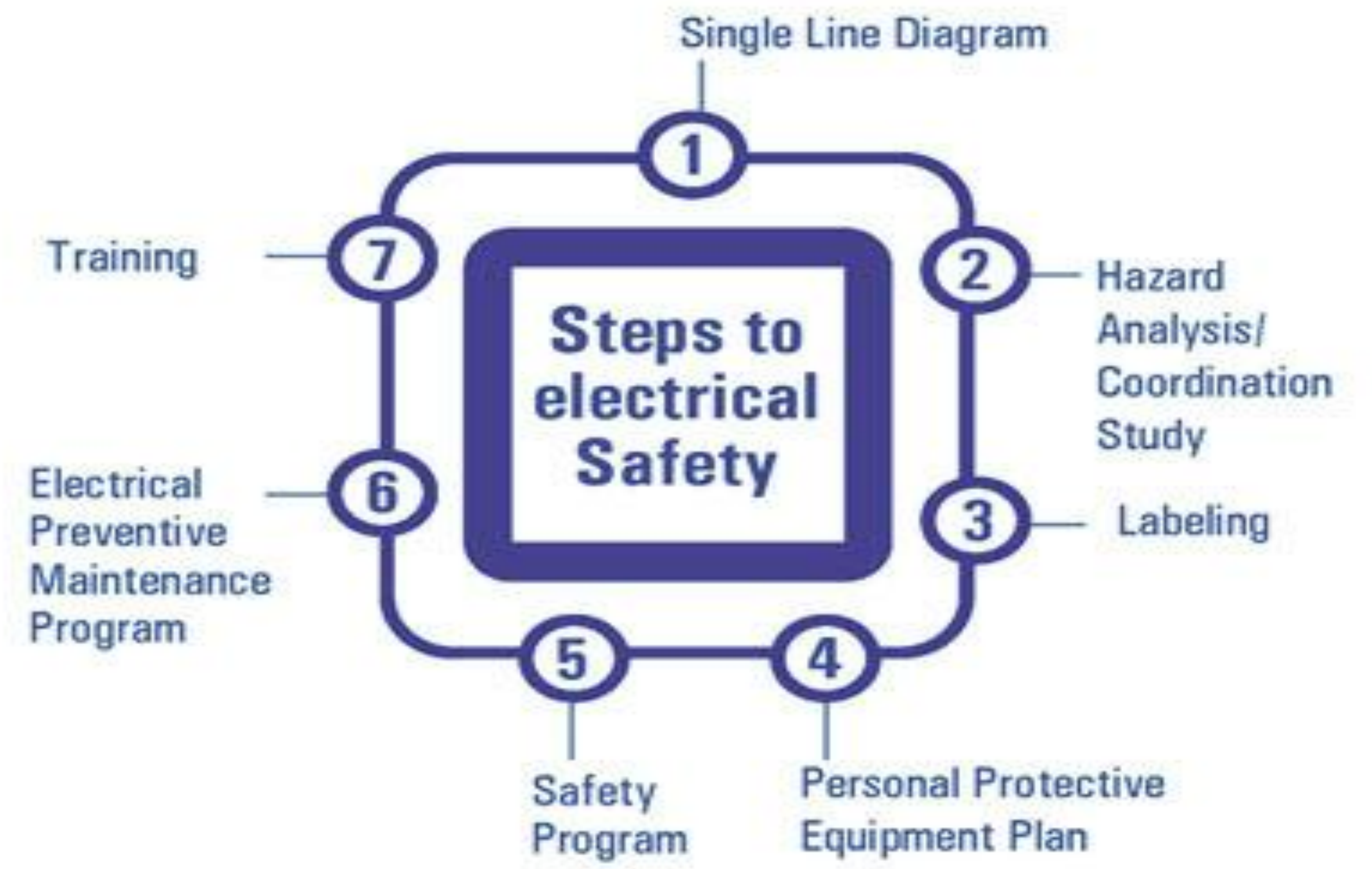
Monitoring many physiological signals from a large number of patients at the same time is one of the current needs in order to deploy a complete wireless sensor network system in medical centers. Such an application presents some challenges in both software and hardware designs. Some of them as follows: reliable communication by eliminating collisions of two patients' signals and interference from other external wireless devices, low-cost, low power consumption, and providing flexibility to the patients so that patients can be relocated anytime. We developed our own hardware and software designs to provide a multi-patient

Monitoring system with data transfer ability over a network or the internet to a remote computer. A media access layer (MAC) has been successfully implemented to support multi-patient monitoring facility

(Cont…)

A system and method for monitoring patient variables in a wireless mode via a patient worn monitoring devices. The patient worn monitoring device connects to a variety of bio-sensors with at least one microphone for voice communications. The pertinent worn device connects to a wireless network and thence to the internet for transmitting voice and data to a health care provider. The health care provider communicates with the patient worn device via the internet and the wireless network to send instructions to the patient worn monitoring unit and to communicate via voice with the patent. The health care provider can also flexibly reconfigure the patent worn monitoring device to change collection parameters for the bio-sensors worn by the patient. When an alarm limit is exceeded an detected by the bio-sensors, it is transmitted to the health care provider over the wireless network and thence over the internet thereby allowing full mobility to the patient wearing the device.

Electrical safety



Electrical Safety

Every year in India tens of thousands of people are killed or injured from contact with electricity.
Some of these people are young Children.
The more you know about how electricity works, the better you can keep yourself, your friends, and your family safe

Facts About Electric Shock

Electricity is always trying to get to the ground. Like all good travellers, electricity takes shortcuts whenever it can. If something that conducts electricity gives electricity an easy path to the ground, electricity will take it.

Electric shock can cause muscle spasms, weakness, shallow breathing, rapid pulse, severe burns, unconsciousness, or death.

(Cont…)

You can never tell when contact with electricity will be fatal, but you can be sure it will always hurt

In a shock incident, the path that electric current takes through the body gets very hot. Burns occur all along that path, including the places on the skin where the current enters and leaves the body.

It's not only giant power lines that can kill or injure you if you contact them. You can also be killed by a shock from an appliance or power cord in your home.

What to do on Electric Shock

•If someone has been shocked, there's a chance they may still be in contact with the source of the electricity. Do NOT touch the person or anything he or she is touching. You could become part of electricity's path and be shocked or even killed! Take these steps:

Tell an adult to turn off the main power to the house.

Call for a Doctor. Tell them it is an electrical accident.

When the victim is not in contact with the source of electricity and you're sure there is no danger, tell an adult to give first aid for electrical injury

Don't touch burns, break blisters, or remove burned clothing. Electrical shock may cause burns inside the body, so be sure the person is taken to a doctor.

THANK YOU