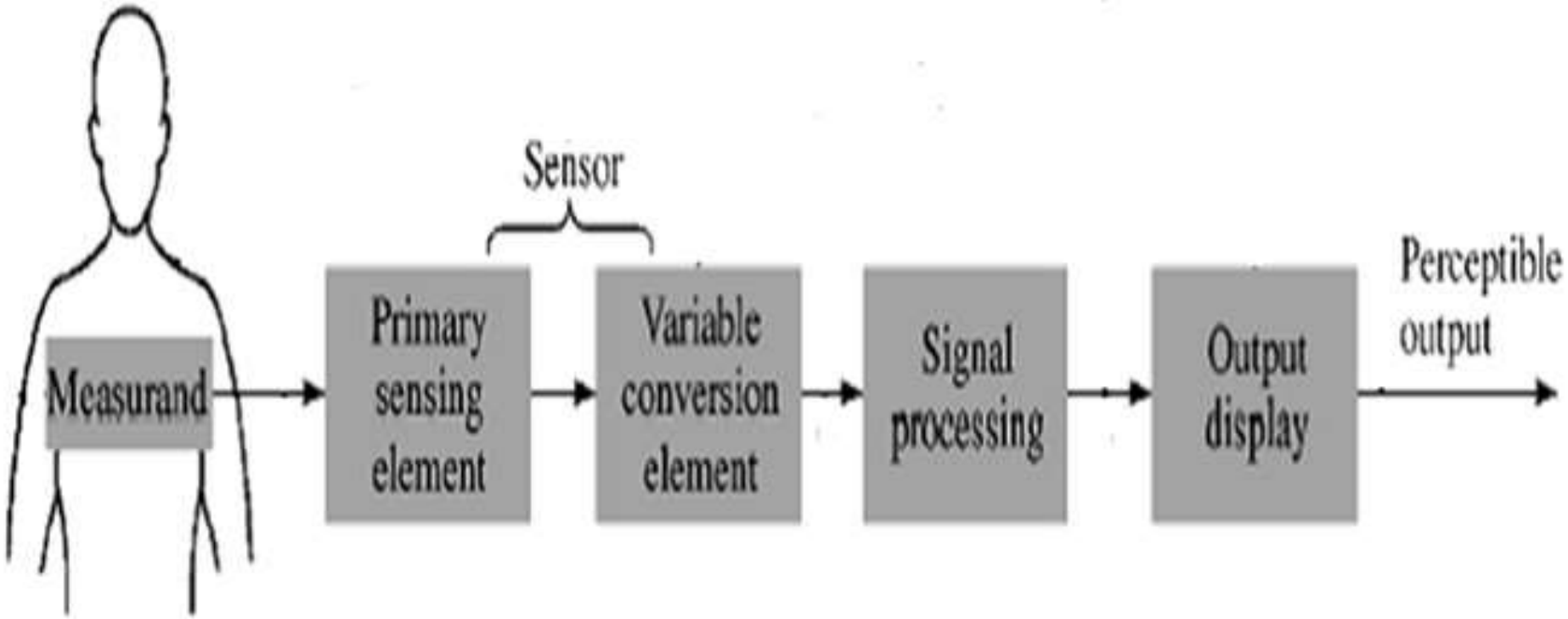
Bioelectric signals and their characteristics

Biolelectric signal	Frequency range (Hz)	Voltage range (µV)	Electrodes used	Origin
Electrocardiogram	0.05 to 100	10 to 5000 covers fetal range	Surface electrodes are used with jelly, paste or cream. Needle electrode are less noisy	Heart muscles
Electroencephalogram	0.1 to 100	2 to 200	Surface and needle electrode	Neuronal activity of the brain
Cerebral potentials (intracranially recorded)	Pulse duration 0.6ms to 0.1s	10 to 100000	Deep needle electrodes	Cerebrum of the brain
Electromyogram	5 to 2000	20 to 5000	Surface or needle electrodes	Skin muscles
Electrogastrogram	0.05 – 0.2	10 – 350	Surface electrodes	Peristaltic movements of the gastrointestinal tract
Electroretinogram	0.01 to 200	0.5 – 1000	Corneal electrodes	Retina of the eye
Electrooculogram	0.1 to 100	10 to 3500	Miniature surface electrodes	Corneal-retinal potential variations

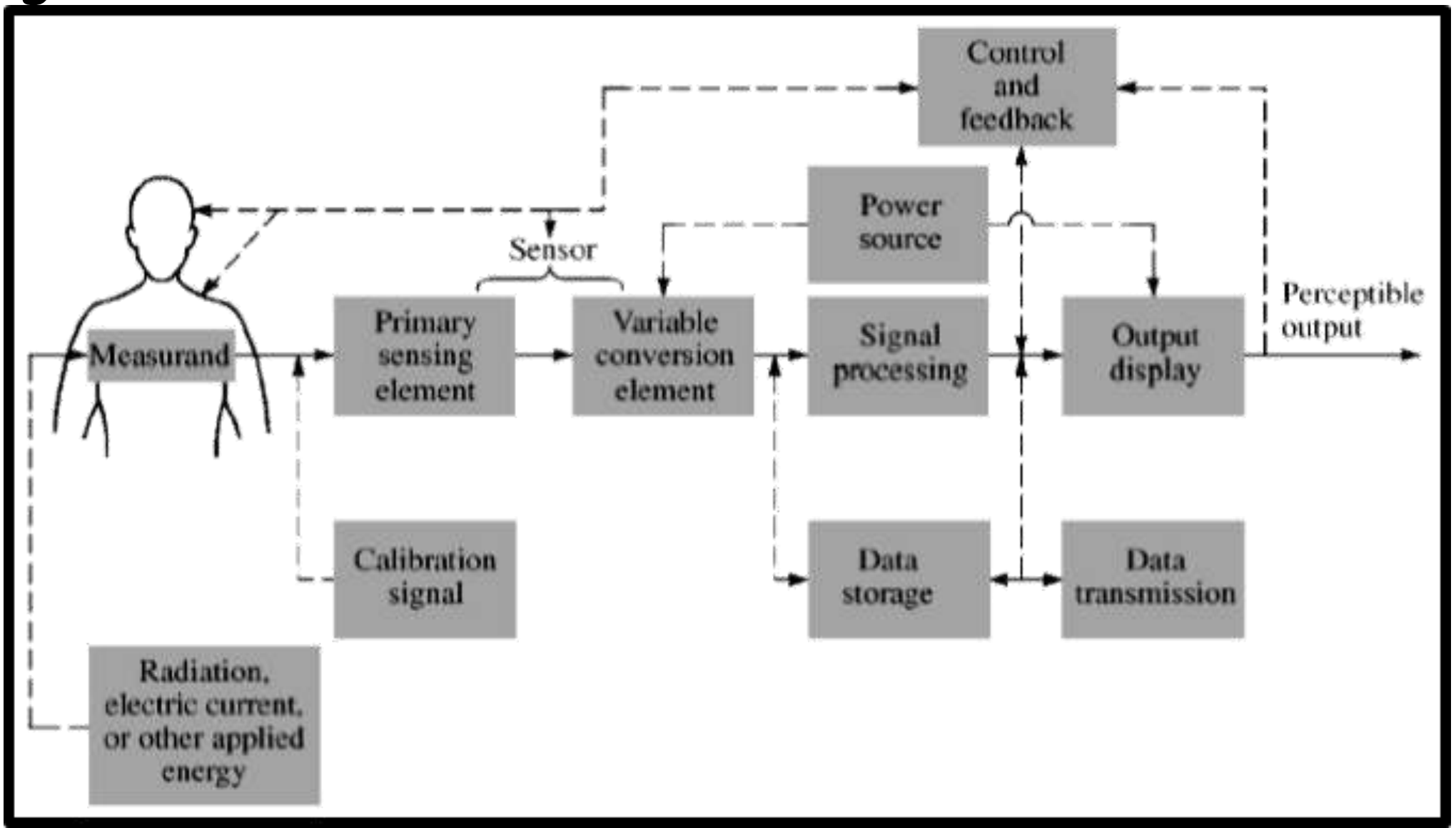
Uses of Computer in Hospitals

- Medical and Patient Data
- Monitor Patients
- Research and Studies
- Inventory
- Medical Imaging and Equipment
- Communication and Telemedicine
- Patients and Staff Scheduling
- Augmented Reality
- Asset Management

Basic Instrumentation System



Generalized Medical instrumentation System



Components of Medical Instrumentation System

- Measurand
- Sensor / Transducer
- Signal Conditioning
- Output Display
- Auxiliary Components

Measurand

- The physical quantity, property, or condition that the system measures is called measurand.
- The accessibility of the measurand is important because it may be:
  - Internal (Blood Pressure)
  - On the Body Surface (Electrocardiogram)
  - Emanate from the body (Infrared Radiation)
  - Derived from Tissue Sample (such as Blood or a Biopsy)

Cont…

- Most medically important measurands can be grouped in the following groups:
  - Biopotential,
  - Pressure,
  - Flow,
  - Dimensions (Imaging),
  - Displacement (Velocity, Acceleration, And Force),
  - Impedance,
  - Temperature, And
  - Chemical Concentrations
- The measurand may be localized to a specific organ or anatomical structure.

Sensor

- The **transducer** is defined as a device that converts one form of energy to another.
- A **sensor** converts a physical measurand to an electric output.
- The sensor should respond only to the form of energy present in the measurand, to the exclusion of all others.
- The sensor should non invasive and minimally invasive.

Signal Conditioning

- Simple signal conditioners may only amplify and filter the signal or merely match the impedance of the sensor to the display.
- Often sensor outputs are converted to digital form and then processed by specialized digital circuits or a microcomputer.
- For example, signal filtering may reduce undesirable sensor signals.
- It may also average repetitive signals to reduce noise, or it may convert information from the time domain to the frequency domain.

Output Display

- The results of the measurement process must be displayed in a form that the human operator can perceive.
- The best form for the display may be:
  - Numerical
  - Graphical,
  - Discrete or Continuous,
  - Permanent or Temporary
  - Visual / Hearing

Auxiliary Components

- A **calibration signal** with the properties of the measurand should be applied to the sensor input or as early in the signal-processing chain as possible.
- Many forms of **contro** l and **feedback** may be required to elicit the measurand, to adjust the sensor and signal conditioner, and to direct the flow of output for **display , storage** or **transmission.**
- The **control** and **feedback** may be **automatic** or **manual** .

Cont…

- Data may be **stored** briefly to meet requirements of signal conditioning or to enable operator to examine the data that precede alarm conditions. Or data may be **stored** before signal conditioning, so that different processing schemes can be utilized.
- Conventional **principles of communication** can often be used to **transmit data** to remote displays at nurses' stations, medical centers, or medical data-processing facilities.

Bio impedance

- Bio impedance refers to the electrical properties of a biological tissue, measured when current flows through it. The impedance varies with frequency and different tissue types and varies sensitively with the underlying histology.
- Bio impedance used for Bio impedance analysis, is a noninvasive, low cost and a commonly used approach for **body composition measurements and assessment of clinical condition**.

BIA - Bioelectrical impedance analysis

- Bioelectrical impedance analysis (BIA) is used to analyze human body composition by **applying a small alternating current through the body and measuring the impedance**. The smaller the electrode of a BIA device, the larger the impedance measurement error due to the contact resistance between the electrode and human skin.

Acoustic Impedance

- DEF: reflection or refraction of a sound wave when it encounters a boundary or an interface between 2 tissues.
- If the acoustic impedance is the same for both structures, all the the sound will be transmitted and none will be reflected.
- Standing waves or hot spots develop when the energy reflected at the tissue interfaces meets new energy being transmitted. This new energy can cause tissue damage.