



Medical instrumentation System

1.1 Generalized Medical Instrumentation System:

Every instrumentation system has at least some of the functional components shown in Figure (1). The primary flow of information is from left to right. Elements and relationships depicted by dashed lines are not essential. The major difference between this system of medical instrumentation and conventional instrumentation systems is that the source of the signals in living tissue or energy applied to living tissue.

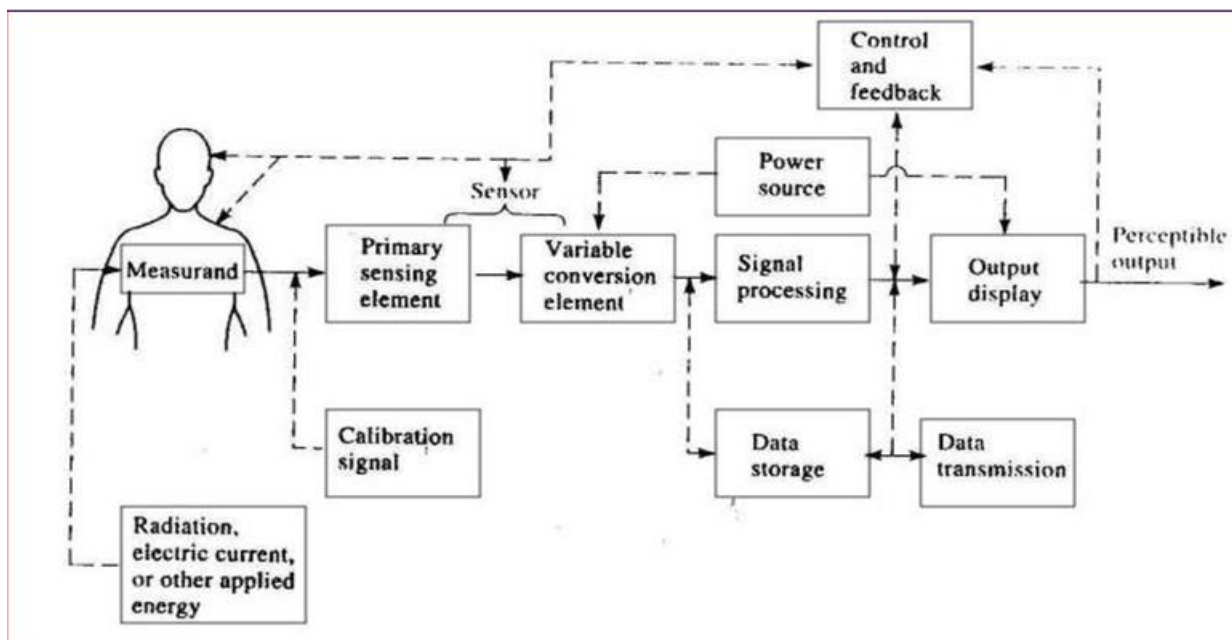


Fig. 1 generalized medical instrumentation system

The sensor converts energy or information from the measurand to another form (usually electric). This signal is processed and displayed so that humans can perceive the information. Elements and connections shown by dashed lines are optional for some applications.



Measurand

Any quantity subject to measurement in the human body

- ❖ It may be Physical quantity, property, or condition that the system measures
- ❖ Accessibility: it may be internal, body surface, emanation from the body, or tissue sample
- ❖ Category: biopotential, pressure, flow, dimensions, displacement, impedance, temperature, and chemical concentration
- ❖ Localization: organ or anatomical structure

Sensor

- ❖ Transducer (sensor) is a device that converts one form of energy to another (electric), the transducer should be
 - Specific
 - Minimization of the extracted energy
 - Minimally invasive
- ❖ It consists of two parts: Primary sensing element and variable conversion element

Signal Conditioning

Amplification, filtering, impedance matching, A/D conversion, DSP, etc.

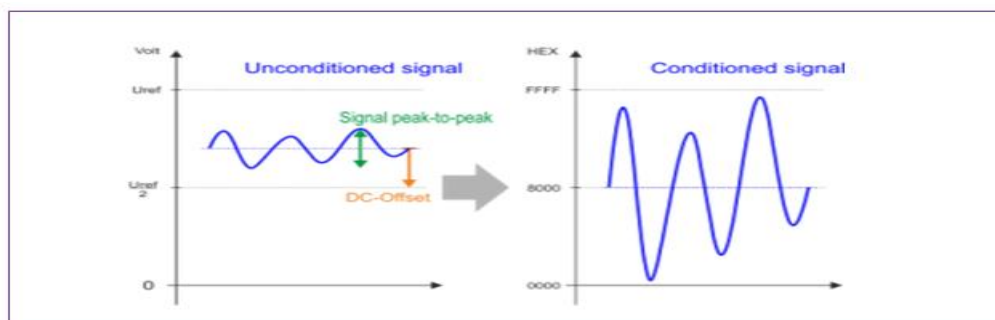


Fig. 2 Example for Signal Conditioning



Output Display

It has many types

- ❖ Visual sense
 - Numerical or graphical
 - Discrete or continuous
 - Permanent or temporary
- ❖ Auditory sense
- ❖ Tactile sense



Ultrasounds



Patient Monitor



Sphygmomanometer



Contactless tonometer



Oxygen Condensers

Fig. 3 Examples of Output Display



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Auxiliary Elements

- ❖ Calibration
- ❖ Control and feedback
- ❖ Storage + Transmission

1.2 SYSTEM ALTERNATIVE OPERATING MODES

Its system software that manages computer hardware and software resources and provides common services for computer programs in medical instrumentation devices. There are many modes that use in medical issue such as.



Fig. 3 Examples of system modes



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Direct-Indirect Modes

- ❖ Accessible (noninvasive or invasive) → direct mode
- ❖ Not accessible → indirect mode
 - Cardiac output (CO) by Fick method, dye dilution, or thermodilution
 - Morphology of internal organs by X-ray shadows
 - Pulmonary volumes by thoracic impedance plethysmography

Sampling and Continuous Modes

- ❖ Frequency content of the Measurand : temperature (sampling) or ECG(continuous)
- ❖ Objective of the measurement
- ❖ Condition of the patient
- ❖ Potential liability of the physician

Generating and Modulating Sensors

- ❖ Generating sensor: measurand produces output from the energy taken directly from itself, like photovoltaic cell.
- ❖ Modulating sensors: measurand alters the flow of energy from an external source, photoconductive cell

Analog and Digital Modes

- ❖ Analog: continuous in time and continuous in amplitude.
- ❖ Digital: discrete in time and take only a finite number of different values
 - Greater accuracy
 - Repeatability
 - Reliability
 - Noise immunity
 - No periodic calibration
 - Readability (in display)



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- ❖ Analog sensor, indirect digital sensor, and digital sensor
- ❖ Data conversions: ADC and DAC

Real-Time and Delayed-Time Modes

- ❖ Short processing time \Rightarrow real-time mode
- ❖ Long processing time \Rightarrow delayed-time mode