Al-Mustaqbal University.

College of Engineering and Engineering Technologies.

Biomedical Engineering Department.

Subject: laboratory instrumentation

Class : 4th

Lecture: *8*

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Pulse oximeter (SpO2)

Introduction

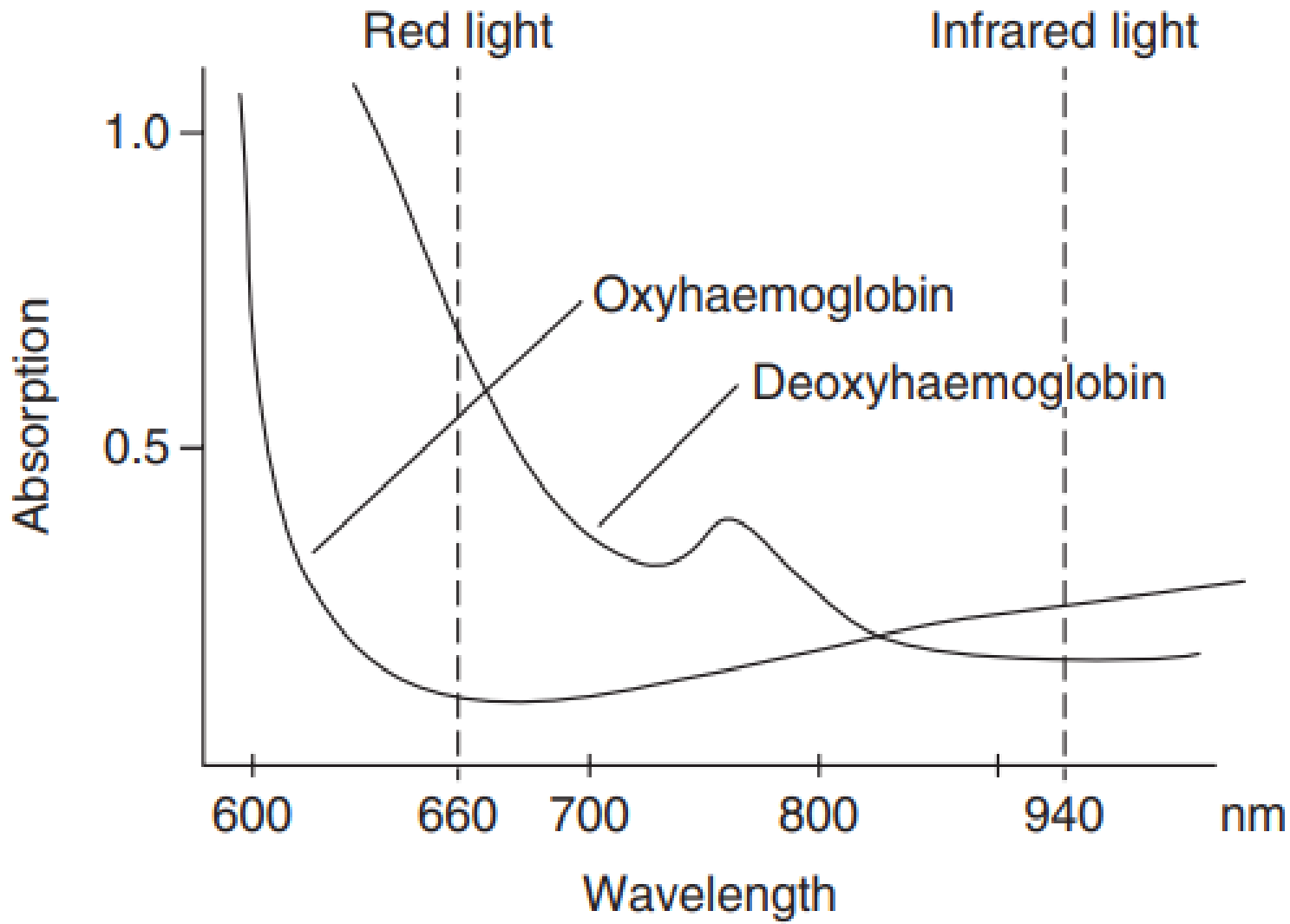
- Pulse oximetry (SPO2): saturation , peripheral, oxygen
- Pulse oximetry is an easy, painless method of measurement as to how well oxygen is being sent to parts of your body furthest from the heart, such as the arms and legs.
- Pulse oximetry is a simple, relatively cheap and noninvasive technique to monitor the percentage of haemoglobin that is oxygen saturated.

Purpose

- Pulse oximeter is a device used to measure the oxygen saturation level of the arterial blood.
- Oximeters are widely used in hospitals, medical clinics, operating rooms, and homes and can be used any time, at home, at work, or during exercise.
- Oximeters can give an accurate reading within seconds and therefore are especially useful in an emergency situation.
- Pulse oximeters also measure and display pulse rate as both oxygen saturation level and pulse rate are considered vital signs of a patient.

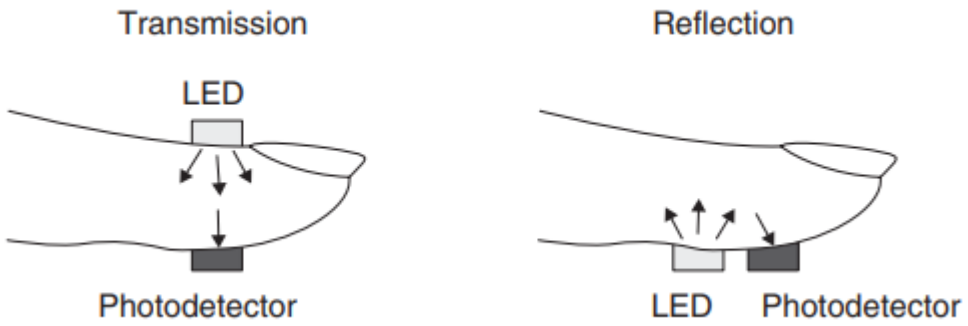
Principle

- The working of the pulse oximetry (SpO2) is based on a noninvasive spectrophotometric technique. The measurement for haemoglobin O2 saturation is based on the absorption of different wavelengths of light from oxygenated (HbO2) and deoxygenated (Hb) haemoglobin.
- Oxygenated haemoglobin absorbs more infrared light and allows more red light to pass through. Deoxygenated haemoglobin allows more infrared light (850–1000nm) to pass through and absorbs more red light (600–750nm). This difference in absorption by oxygenated and deoxygenated haemoglobin forms the basis of designing pulse oximeters.


Red light
Infrared light
1.0
0.5
Absorption
Oxyhaemoglobin
Deoxyhaemoglobin
600
660
700
800
940
nm
Wavelength

Techniques of pulse oximetry

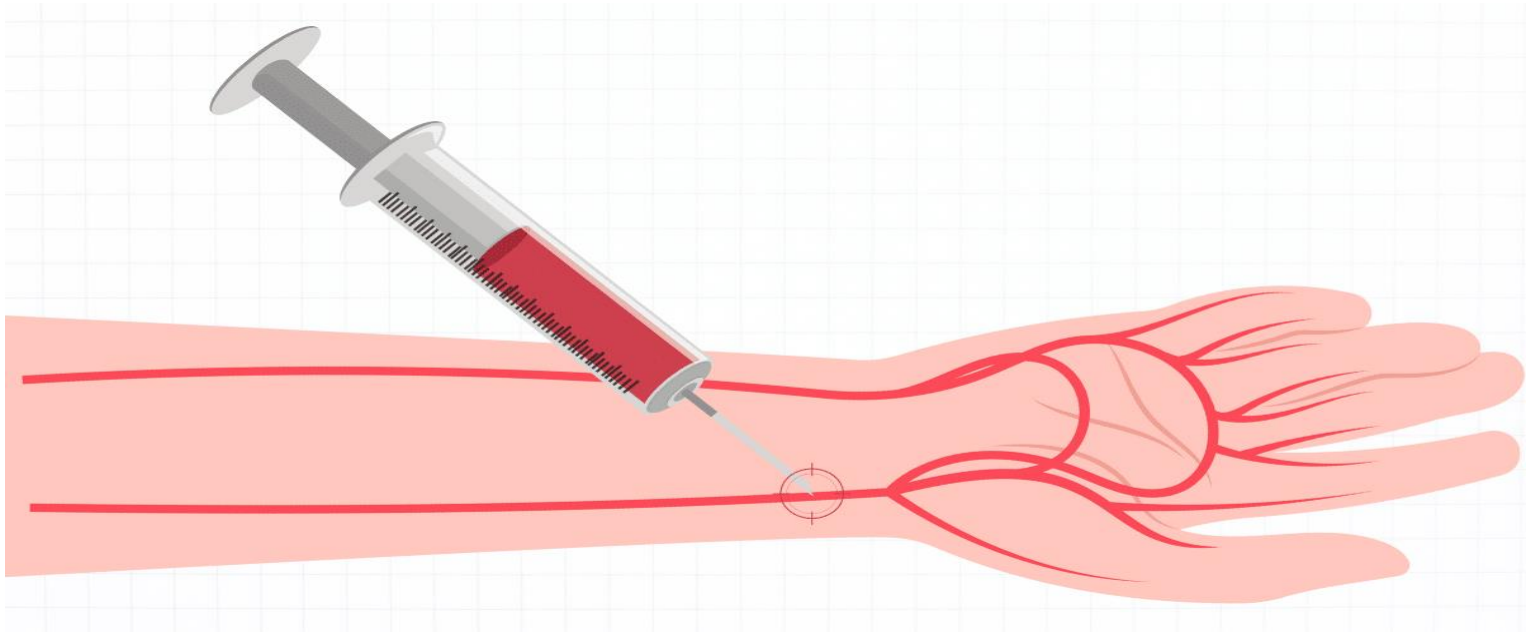
- There are two methods of sending light through the measuring site: transmission and reflectance.
- In the transmission method, the emitter and photodetector are opposite of each other with the measuring site in between. The light can then pass through the site.
- In the reflectance method, the emitter and photodetector are next to each other on top the measuring site. The light bounces from the emitter to the detector across the site.



How to measure the oxygen saturation

1. Invasive procedure (arterial blood gas analysis)

- Not real time measurement.
- Infection problem.
- Pain.



How to measure the oxygen saturation

2. Pulse oximeter is a noninvasive method for monitoring a person's oxygen saturation.

Consists of :

I. Peripheral probe.

A. Two light emitting diodes.

B. Light detector.

II. Microprocessor.

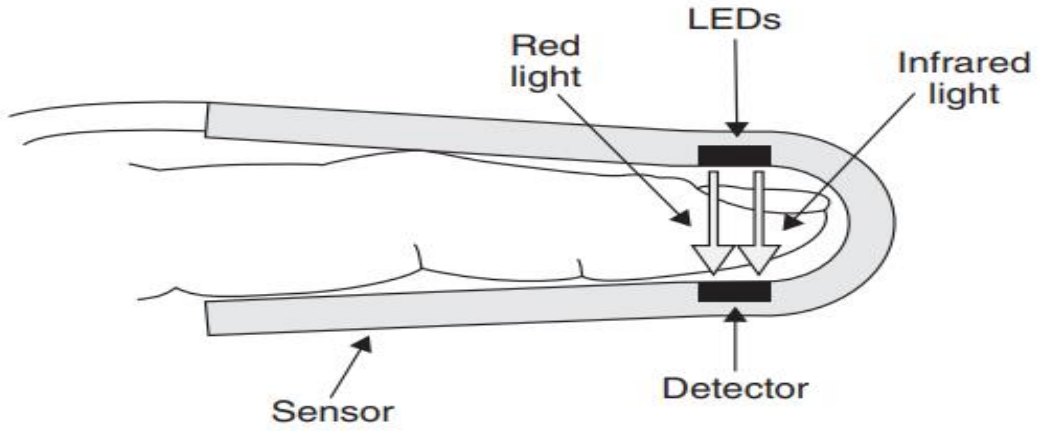
- The light emitted several hundreds times per second by diodes is absorbed by tissues.
- The amount of the absorption is measured by the detector.

Measuring site and light absorbance

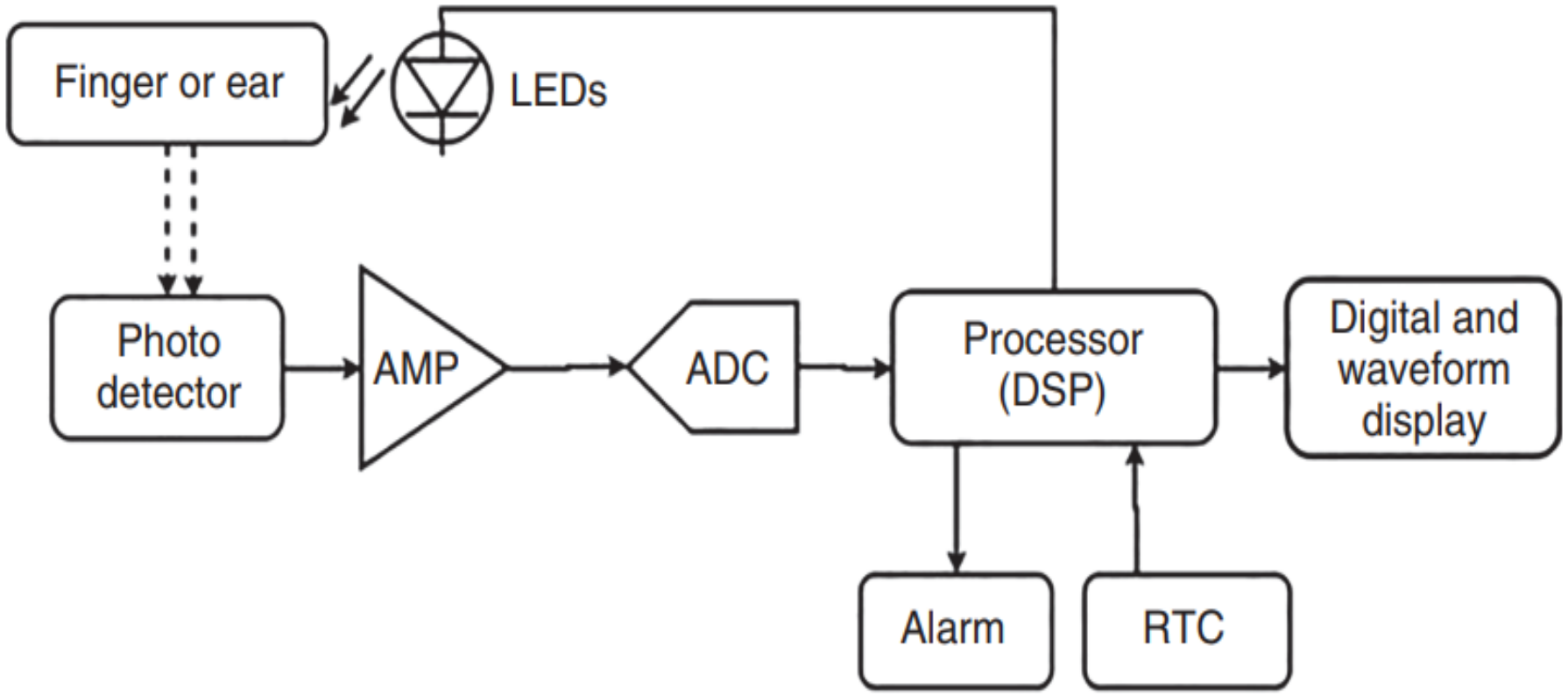
- At the measuring site, there are constant light absorbers that are always present: the skin, tissue, venous blood, and the arterial blood.
- However, with each heartbeat, the heart contracts and there is a surge of arterial blood, resulting in momentarily increasing the arterial blood volume across the measuring site.
- This results in more light absorption during the surge. The waveform detected at the photodetector, thus, will have peaks with each heartbeat and troughs between heartbeats. If the light absorption at the trough (which includes all the constant absorbers) is subtracted from the light absorption at the peak, then, in theory, the resultants are the absorption characteristics due to added volume of blood only, which is arterial.

Constructional details of pulse oximeter

- Pulse oximeters make use of two light-emitting diodes (LEDs), one in the red region (660nm) and the other in the infrared region (940nm).
- A light detector is also included in the probe. The difference in transmission of 660nm versus 940nm wavelength is used to calculate the amount of oxygenated haemoglobin by a digital signal processor with an inbuilt algorithm in which the ratio of absorption at red region to infrared region corresponds to an empirically found saturation value.



Block diagram of a pulse oximeter



The analog signal processing technique

- The signal from the sensor is a current.
- Amplifiers to further amplify the signal.
- Noise filters to remove different kinds of interference.
- Bandpass filters to separate the low frequency (dc) component from the pulsatile, higher frequency (ac) component.
- an analog – digital converter to convert the continuously varying signal to a digital representation.

Situation of measuring

- The SpO2 is usually obtained from the fingertip, earlobe or pinna (top of the ear). Pulse oximeters for general use are small, lightweight monitors that painlessly attach to a fingertip to monitor the amount of oxygen carried in the body.
- A typical fingertip probes are battery-powered devices and can be held on the finger by a clip.
- A waveform of pulsatile flow is also displayed along with the heart rate derived from the pulse waveform.
- The device contains adjustable alarms to alert when either saturation or heart rate is low.
- Reusable, sterilizable probes are robust and easily connected and disconnected

Tabletop oximeters

- Handheld or tabletop oximeters can work with ear clip sensors. Ear clip sensors are most commonly used when a patient has poor circulation in the fingers and/or toes.
- The ear clip sensor is placed on the ear lobe region of the ear. The blood flow at the ear is normally lower than other part of the body and is also subject to errors due to head movements.

Specifications of SPO2

- SpO2 measurement range: 70–99%
- Pulse rate range: At least 30–240bpm
- Display: Pulse waveform, oxygen saturation, and pulse
- Alarms: High and low audiovisual SpO2 and pulse rate alarms, sensor disconnected, sensor failure, and low battery

Applications of SPO2

- Pulse oximetry functions as a handy clinical tool and finds applications in intensive care units, inpatient/outpatient wards, operating rooms, and general clinics and even at home.
- Its particular applications are during or after surgery or procedures that use sedation, to study how well lung medicines are working, to check a person's ability to handle increased activity levels, to see if a ventilator is needed to help with breathing, or to see how well it is working and to check a person has moments when breathing stops during sleep (sleep apnoea).

Where pulse oximeter located is

- Intensive care units.
- Inpatient/outpatient wards.
- Operating rooms.
- General clinics.
- Even at home.

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Thank you