Physiological signals

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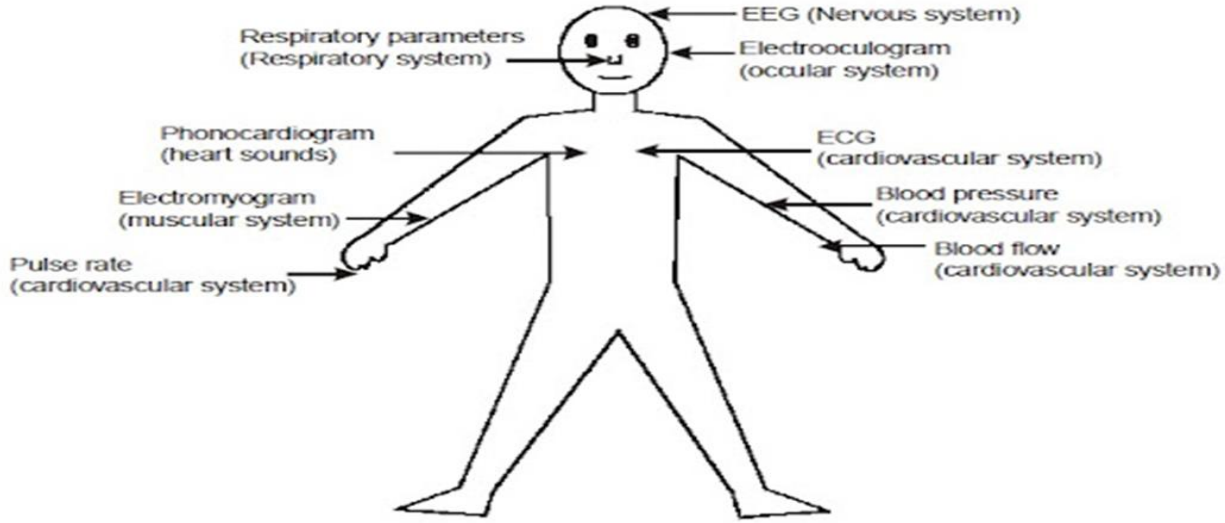
Introduction

Physiological signals are measurable quantities that reflect the state and functioning of the human body. These signals are essential in medical diagnosis, monitoring, and research.

Signal Acquisition Systems:

- Sensors and Transducers: Devices that convert biological signals into electrical signals. Examples include electrodes, pressure sensors, and photodetectors.
- Signal Conditioning: Amplification, filtering, and conversion of the raw signal into a format suitable for analysis.



Sources of Physiological Signals

Signal Acquisition Process

1. Transduction:

- Conversion of physiological parameters into electrical signals.
- Examples: ECG electrodes convert ionic currents from the heart into electrical voltages.

2. Amplification:

- Increases the magnitude of the signal to make it detectable and usable.
- Ensures the signal is strong enough to be processed by subsequent stages without significant noise interference.

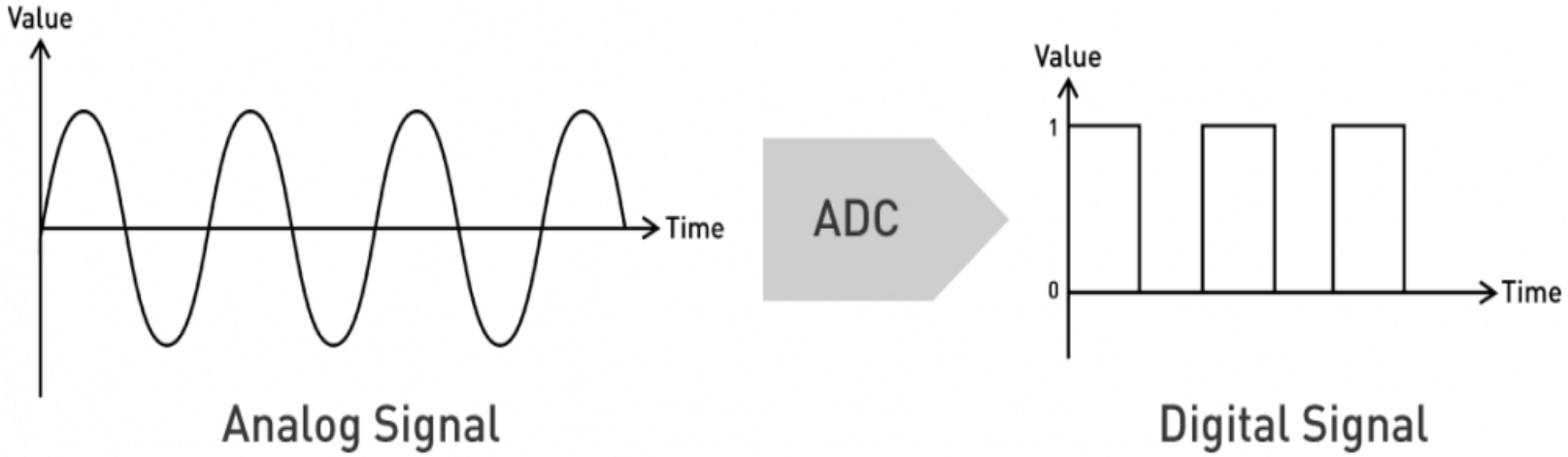
3. Filtering:

- Removes unwanted noise and artifacts.
- Types: Low-pass, high-pass, band-pass, and notch filters.
- Importance: Enhances the quality of the signal for accurate analysis.

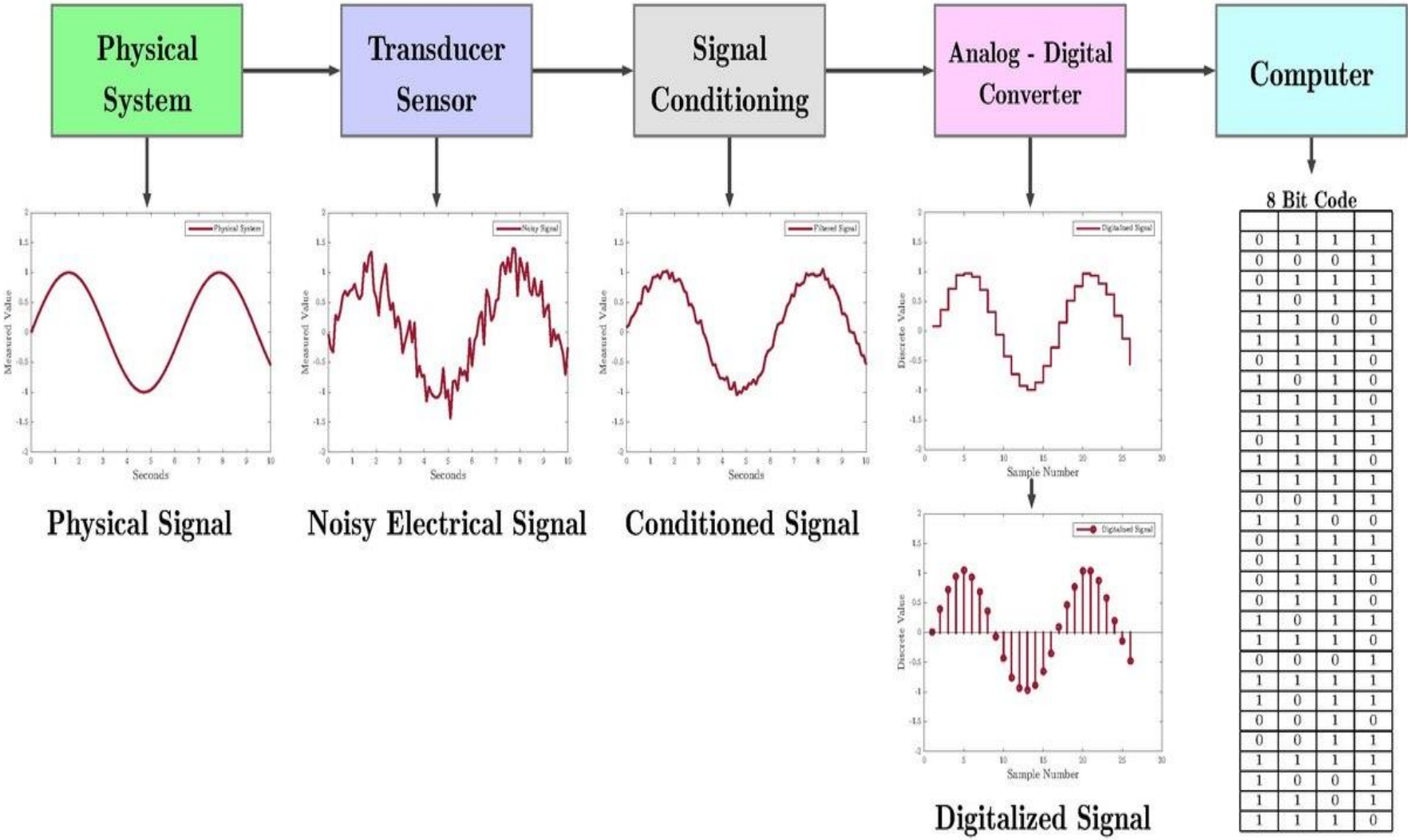
- Low-pass filter: To remove high-frequency noise like EMG.
- High-pass filter: To eliminate low-frequency noise like baseline wander.
- Notch filter: To specifically target power line interference.

4. Analog-to-Digital Conversion (ADC):

- Converts continuous analog signals into discrete digital signals.
- Parameters: Sampling rate (must be sufficiently high to capture signal details, per Nyquist theorem) and resolution (number of bits used in conversion).



Digital Data Acquisition System



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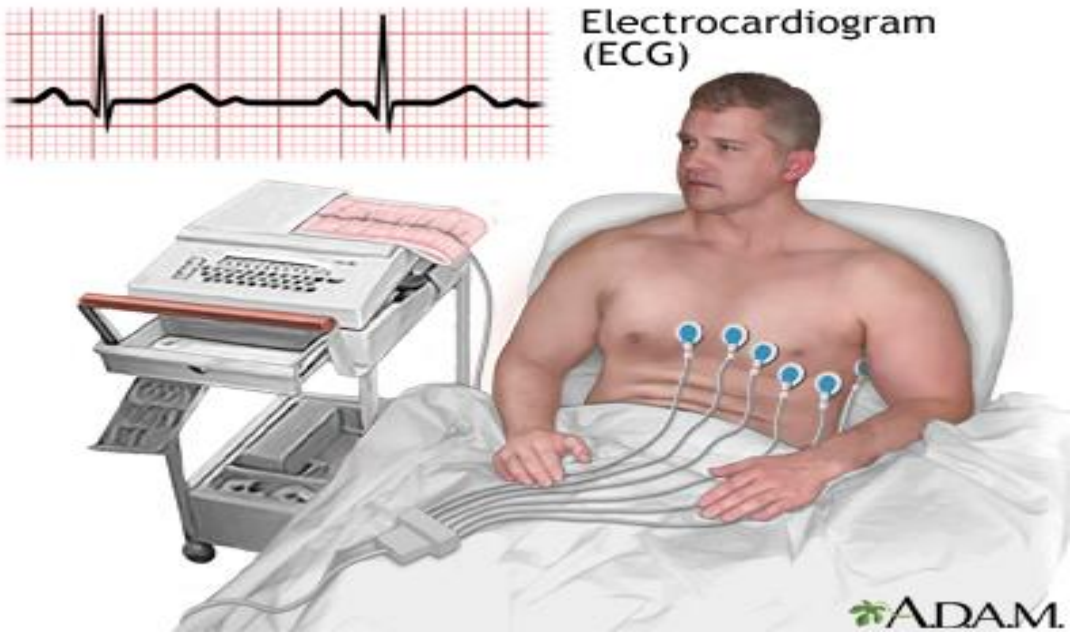
Types of Biomedical Signals and Acquisition Techniques

1.Electrocardiography (ECG):

- Measures electrical activity of the heart.
- Electrodes placed on the skin detect the voltage differences caused by cardiac muscle depolarization and repolarization.
- Common configurations: 3-lead, 5-lead, and 12-lead systems.

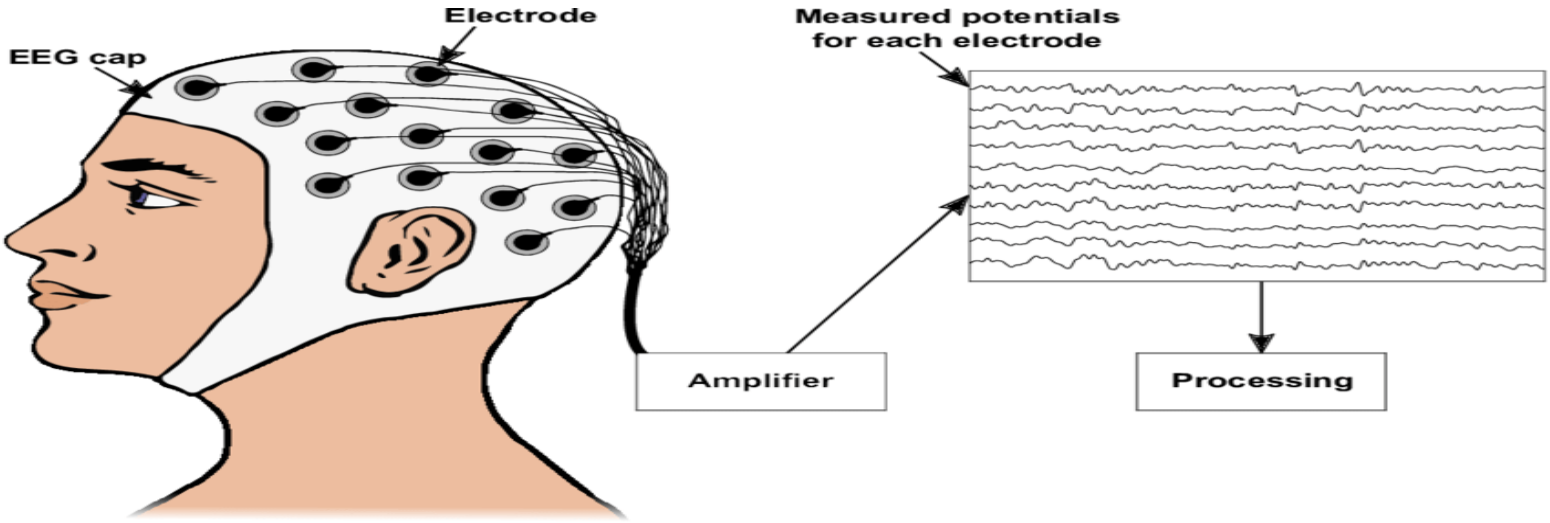


2. Electroencephalography (EEG):

- Records electrical activity of the brain.
- Electrodes placed on the scalp capture voltage fluctuations resulting from neuronal activity.
- Used in diagnosing epilepsy, sleep disorders, and brain death.

3.Blood Pressure Monitoring:

- Non-invasive: Uses a cuff and oscillometric or auscultatory methods.
- Invasive: Direct measurement via a catheter inserted into an artery.



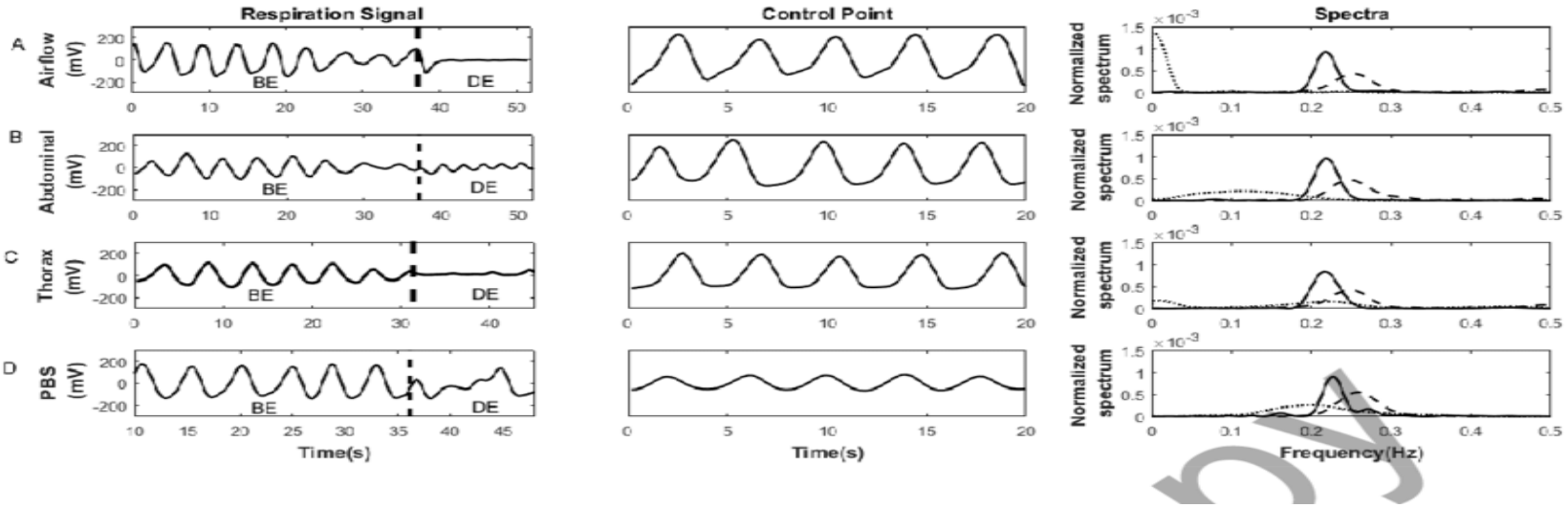
4. Electrooculography (EOG)

- Signal: Electrical potential generated by eye movements.
- Measurement: Electrodes placed around the eyes.
- Uses: Tracking eye movements, diagnosing oculomotor disorders, and in human-computer interface systems.

Components: Horizontal and vertical eye movements.

5. Respiratory Signals

- Signal: Airflow and lung volumes during breathing.
- Measurement: Spirometry, respiratory inductive plethysmography, and capnography.
- Uses: Diagnosing and monitoring respiratory conditions like asthma, COPD, and sleep apnea.
- Components: Tidal volume, respiratory rate, and end-tidal CO2 levels.

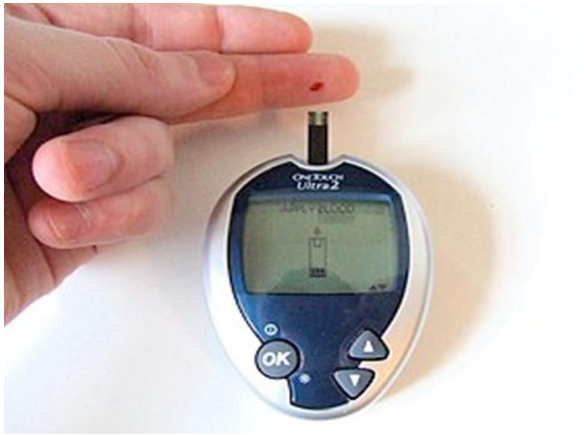


6. Temperature

- Signal: Body temperature.
- Measurement: Thermometers, thermocouples, and infrared sensors.
- Uses: Detecting fever, hypothermia, and monitoring during surgery or critical care.
- Components: Core and peripheral temperature measurements.

7. Blood Glucose

- Signal: Concentration of glucose in the blood.
- Measurement: Blood samples using glucometers or continuous glucose monitors (CGMs).
- Uses: Managing diabetes, monitoring metabolic health.
- Components: Blood glucose levels at different times, trends over time.



8. Pulse Oximetry

- Signal: Oxygen saturation of hemoglobin in the blood.
- Measurement: Optical sensors (typically finger clip).
- Uses: Monitoring oxygen levels in various clinical settings, especially during anesthesia and intensive care.
- Components: SpO2 percentage.