Feature Extraction from ECG

Feature extraction from ECG refers to the process of identifying and quantifying key characteristics or patterns in the raw ECG signal that are relevant for diagnosing heart conditions, analyzing rhythm, or feeding into machine learning models.

Why Feature Extraction?

Raw ECG signals are complex, noisy, and high-dimensional. Extracting specific features makes it easier to:

- Diagnose diseases like arrhythmias or myocardial infarction.

- Classify different heartbeats (normal vs. abnormal).

- Predict cardiac events.

- Reduce data complexity while preserving meaningful information.

What Features Are Extracted?

1. Time Domain Features

- Heart Rate (HR): beats per minute.

- RR Interval: time between two R-peaks (used to assess rhythm).

- PR Interval: onset of P wave to start of QRS.

- QRS Duration: width of QRS complex.

- QT Interval: start of Q to end of T wave.

- P wave, QRS, T wave amplitudes and durations.

2. Frequency Domain Features

- Uses Fourier Transform or Power Spectral Density (PSD).

- Measures energy in specific frequency bands (e.g., for HRV analysis).

3. Morphological Features

- Shape characteristics of P, QRS, and T waves.

- Slope, area under the curve, peak values, etc.

4. Statistical Features

- Mean, variance, skewness, kurtosis of signal segments.

Feature Extraction from ECG

5. Nonlinear Features

- Entropy, fractal dimension, Poincaré plot parameters.

Examples of Extracted Features:

- RR Interval: Detect arrhythmia, HRV

- QRS Duration: Bundle branch block

- QT Interval: Long QT syndrome

- P wave duration: Atrial enlargement

- T wave amplitude: Hyperkalemia, ischemia

Tools/Techniques Used for Feature Extraction:

- Pan-Tompkins Algorithm: R-peak detection

- Wavelet Transform: Time-frequency analysis

- PCA: Dimensionality reduction

- ML/DL models: Automatic feature extraction

Use in Machine Learning:

Extracted features are often used in models like SVM, Random Forest, CNN, RNN for classification and diagnosis.