SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF BIOMEDICAL ENGINEERING

19BMB302 - BIOMEDICAL SIGNAL PROCESSING

III YEAR/ V SEMESTER

Unit IV : BIOSIGNALS AND THEIR CHARACTERISTICS

- Source of Bioelectric potential
- Resting and action potential
- Propagation of action potentials nerves
- Characteristics of biomedical signals
- The ECG-Cardiac electrophysiology
- Relation of ECG components to cardiac events
- Clinical applications

Clinical Applications of Biosignals

Introduction

- **Biosignals** are recordings of physiological activities in the body, reflecting various biological processes. Common biosignals include ECG (heart), EEG (brain), EMG (muscle), and blood pressure signals.
- These signals are crucial in clinical diagnostics, monitoring, and therapeutic applications, aiding healthcare providers in making informed decisions and tailoring treatments.

Electrocardiogram (ECG) – Cardiac Health

Description: ECG records the electrical activity of the heart, providing information on heart rate, rhythm, and conduction.

Applications:

- **Diagnosis of Arrhythmias**: Identifies abnormal heart rhythms, such as atrial fibrillation, which can lead to stroke if left untreated.
- **Detection of Myocardial Ischemia and Infarction**: ST-segment changes on ECG indicate ischemia (lack of blood flow) or infarction (heart attack), enabling rapid treatment.
- **Monitoring Cardiac Health**: Used in stress testing and continuous cardiac monitoring, especially in ICU settings.
- **Guidance for Pacemaker and Defibrillator Placement**: Helps determine placement and functioning of cardiac devices in patients with conduction disorders.

Electroencephalogram (EEG) – Neurological Function

Description: EEG records the brain's electrical activity, providing insights into brain function and neurological health.

Applications:

- **Diagnosis of Epilepsy and Seizures**: EEG helps identify epileptic discharges and pinpoint seizure locations, essential for epilepsy management.
- **Sleep Disorders**: Used in sleep studies (polysomnography) to analyze sleep stages and diagnose conditions like sleep apnea, insomnia, and narcolepsy.
- **Brain Injury and Coma Monitoring**: Assesses brain activity in coma patients, helping gauge the extent of brain damage.
- **Cognitive and Mental Health Disorders**: Abnormal EEG patterns can indicate disorders like schizophrenia, ADHD, and dementia, aiding in diagnosis and treatment.

Electromyogram (EMG) – Muscle Function

Description: EMG measures electrical activity in muscles, reflecting muscle function and nervous system health.

Applications:

- **Diagnosis of Neuromuscular Disorders**: Helps identify conditions like muscular dystrophy, myasthenia gravis, and motor neuron diseases by analyzing muscle response and strength.
- **Assessing Nerve Function and Injury**: EMG can detect nerve compression or injuries, such as carpal tunnel syndrome, by measuring the latency and strength of muscle response.
- **Rehabilitation Monitoring**: Used in physical therapy to track recovery progress, particularly in patients who have had strokes, spinal cord injuries, or other motor impairments.
- **Biofeedback Therapy**: EMG is used in biofeedback for patients with muscle control issues, helping them gain voluntary control over certain muscles.

Blood Pressure and Cardiovascular Signals

Description: Blood pressure monitoring provides insights into the cardiovascular system's status, including blood pressure (BP), heart rate (HR), and blood flow.

Applications:

- **Hypertension Diagnosis and Management**: Continuous BP monitoring helps diagnose and manage hypertension, reducing the risk of cardiovascular diseases like heart attacks and strokes.
- **Assessment of Cardiac Output and Vascular Health**: Helps detect conditions like heart failure by providing data on cardiac output and vascular resistance.
- **Hemodynamic Monitoring in ICU**: Blood pressure and other cardiovascular signals are continuously monitored in critical care, especially in patients with unstable blood pressure, shock, or sepsis.
- **Anesthesia Monitoring**: During surgery, blood pressure and other vital signs are monitored to ensure the patient's stability and adjust anesthesia levels.

Blood Glucose Monitoring – Metabolic Health

Description: Continuous glucose monitors (CGM) or traditional blood glucose meters measure blood sugar levels.

Applications:

- **Diabetes Management**: Regular monitoring helps individuals with diabetes maintain glucose levels within the target range, preventing complications like ketoacidosis and hypoglycemia.
- **Detection of Hyperglycemia and Hypoglycemia**: Continuous monitoring provides alerts for dangerously high or low glucose levels, especially beneficial for insulin-dependent patients.
- **Post-Surgical and ICU Monitoring**: Blood glucose monitoring is crucial in critically ill patients, as stress and medications can impact glucose levels.
- **Research in Metabolic Disorders**: CGMs aid in studying metabolic conditions, such as obesity and insulin resistance, by providing real-time data on glucose fluctuations.

Pulse Oximetry and Blood Oxygen Levels

Description: Pulse oximetry measures blood oxygen saturation (SpO_2) and heart rate.

Applications:

- **Respiratory Disorders**: Essential for monitoring patients with conditions like chronic obstructive pulmonary disease (COPD), asthma, and sleep apnea to prevent hypoxemia.
- **Anesthesia and Surgery**: Continuously monitored during surgery to ensure adequate oxygenation while under anesthesia.
- **COVID-19 and Other Infectious Diseases**: Vital in detecting silent hypoxia in COVID-19 patients, where oxygen levels drop without noticeable symptoms.
- **Pediatric and Neonatal Care**: Used to monitor oxygen levels in newborns, especially premature infants, to prevent complications from hypoxia.

Electrooculogram (EOG) – Eye Movement and Vision

Description: EOG records eye movements and helps understand visual and neurological responses.

Applications:

- **Sleep Studies and REM Monitoring**: EOG detects rapid eye movement (REM) sleep, crucial for analyzing sleep architecture.
- **Diagnosis of Ophthalmological Conditions**: Used in diagnosing disorders like retinitis pigmentosa and tracking eye movement abnormalities.
- **Neurological Assessments**: Helps assess brainstem function and monitor eye movement disorders, such as nystagmus or saccadic disorders.
- **Human-Computer Interaction**: EOG is increasingly used in assistive technology to develop eye-controlled devices for individuals with disabilities.

Thermography and Temperature Signals

Description: Measures body temperature distribution, typically using infrared sensors.

Applications:

- **Detection of Infections**: Increased skin temperature can indicate inflammation or infection; thermography is used to screen for conditions like fever or localized infections.
- **Cancer Detection**: Thermography is used as a non-invasive method to detect abnormal heat patterns associated with cancers, particularly breast cancer.
- **Peripheral Vascular Disease**: Detects circulation problems in extremities, which can be due to arterial blockages or other vascular issues.
- **Rheumatology and Pain Management**: Thermography can help identify inflammation in joints and muscles, aiding in diagnosing and managing arthritis and other inflammatory conditions.

Clinical Decision Support and Telemedicine

Biosignals are increasingly integrated into telemedicine and remote patient monitoring systems.

Applications:

- **Remote Monitoring**: Vital signs (e.g., heart rate, oxygen saturation) can be monitored remotely for patients with chronic conditions.
- **Wearable Technology**: Devices that measure ECG, heart rate, and physical activity help manage conditions like atrial fibrillation, hypertension, and diabetes remotely.
- **AI and Predictive Analysis**: Machine learning algorithms use biosignal data to predict health trends, enhancing preventive care and decision support.

Thank You!