Signal

Signal: A signal is defined as any physical quantity that varies with time, space, or any other independent variable or variables. Mathematically, we describe a signal as a function of one or more independent variables. Signal serves as carriers of information between communication devices. They can convey different types of information depending on the application required. For example, the functions

$$S_1(t) = 5t$$

$$S_2(t) = 20t^2$$

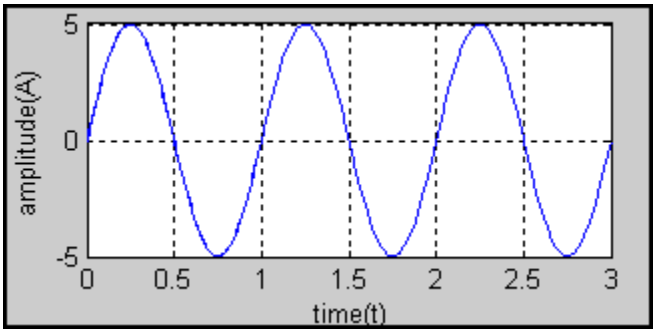
$$S_3(t) = sin(t) + sin(2t) + sin(3t)$$

where t is independent variable and $S_1(t)$, $S_2(t)$, $S_3(t)$ are dependent variable.

Another example, consider the function

$$s(x, y) = 3x + 2xy + 10y^2$$

The function describes a signal of two independent variables x and y that could represent the two spatial coordinates in a plan.



Examples of Signals

- Human voice and sound waves.
- Voltage in electrical circuits
- Room temperature controlled by a thermostat system
- Position, speed, and acceleration of an aircraft
- Force measured with force sensors in robotic systems
- Electromagnetic waves used to transmit information in wireless computer networks
- Digital photographs
- Digital Music Recording.

What is a System?

In signals and systems, a system can be defined in a number of ways as –

- A system is defined as a physical device that can produce an output or response for the given input.
- A system can also be defined as a set of elements which are connected together and generates an output signal corresponding to an input signal.

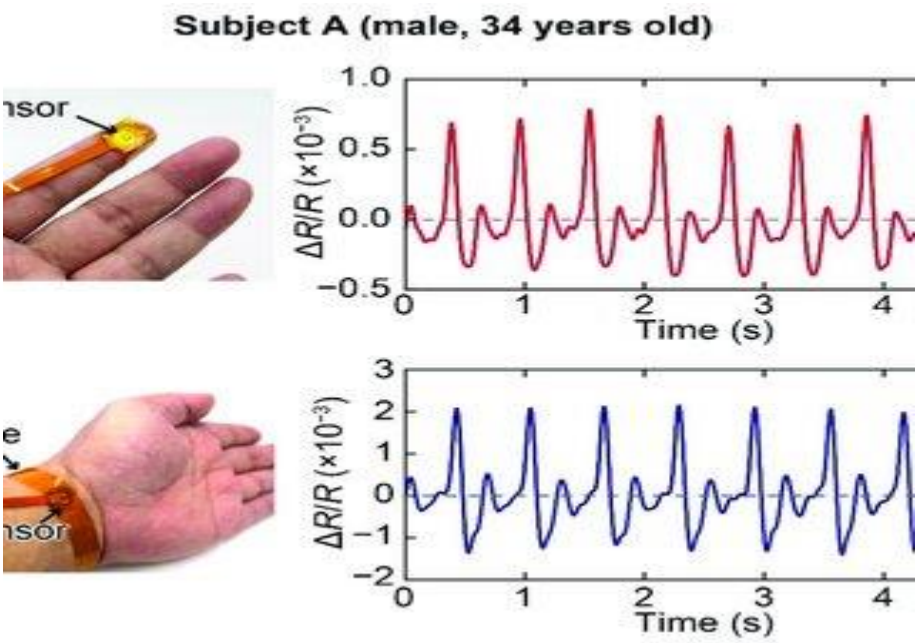
For example, a filter used to reduce the noise and interference corrupting a desired information-bearing signal is called a system. In this case the filter performs some operation(s) on the signal, which has the effect of reducing (filtering) the noise and interference from the desired information-bearing signal.

1. Continuous-time and Discrete-time system
2. Stable and Unstable system
3. Memory and Memoryless system
4. Invertible and Noninvertible system
5. Time-variant and Time-invariant system
6. Linear and Nonlinear system
7. Causal and Noncausal system

Photoplethysmography (PPG)

Photoplethysmography (PPG) is a simple optical technique used to detect volumetric changes in blood in peripheral circulation. It is a low cost and non-invasive method that makes measurements at the surface of the skin.

The technique provides valuable information related to our cardiovascular system. Recent advances in technology has revived interest in this technique, which is widely used in clinical physiological measurement and monitoring.



Uses of PPG

Medical devices based on PPG technology are widely used in various applications in the clinical set up.

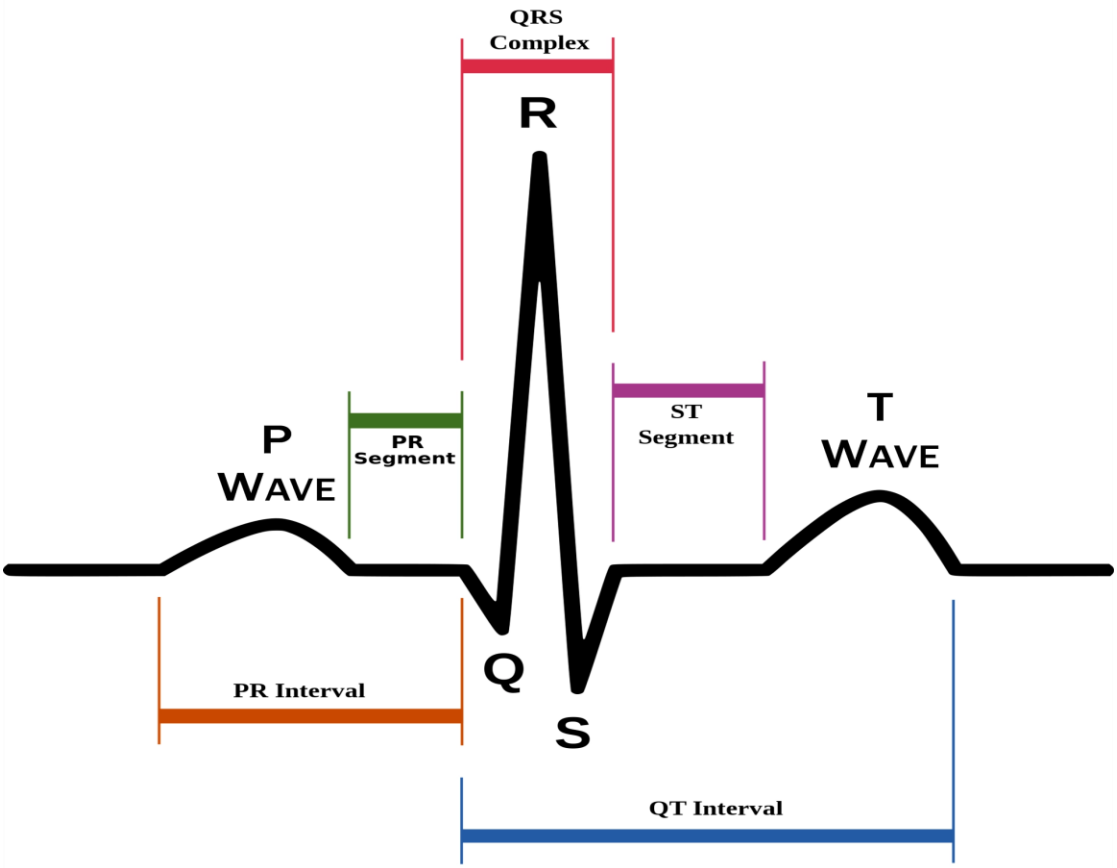
Specific applications include the following:

- Clinical physiological monitoring

- Blood oxygen saturation
- Blood pressure
- Cardiac output
- Heart rate
- Respiration
- Vascular assessment
- Arterial disease
- Arterial compliance and ageing
- Venous assessment
- Endothelial function
- Microvascular blood flow
- Vasospastic conditions
- Autonomic function monitoring
- Vasomotor function and thermoregulation
- Blood pressure and heart rate variability
- Orthostasis
- Other cardiovascular variability assessments

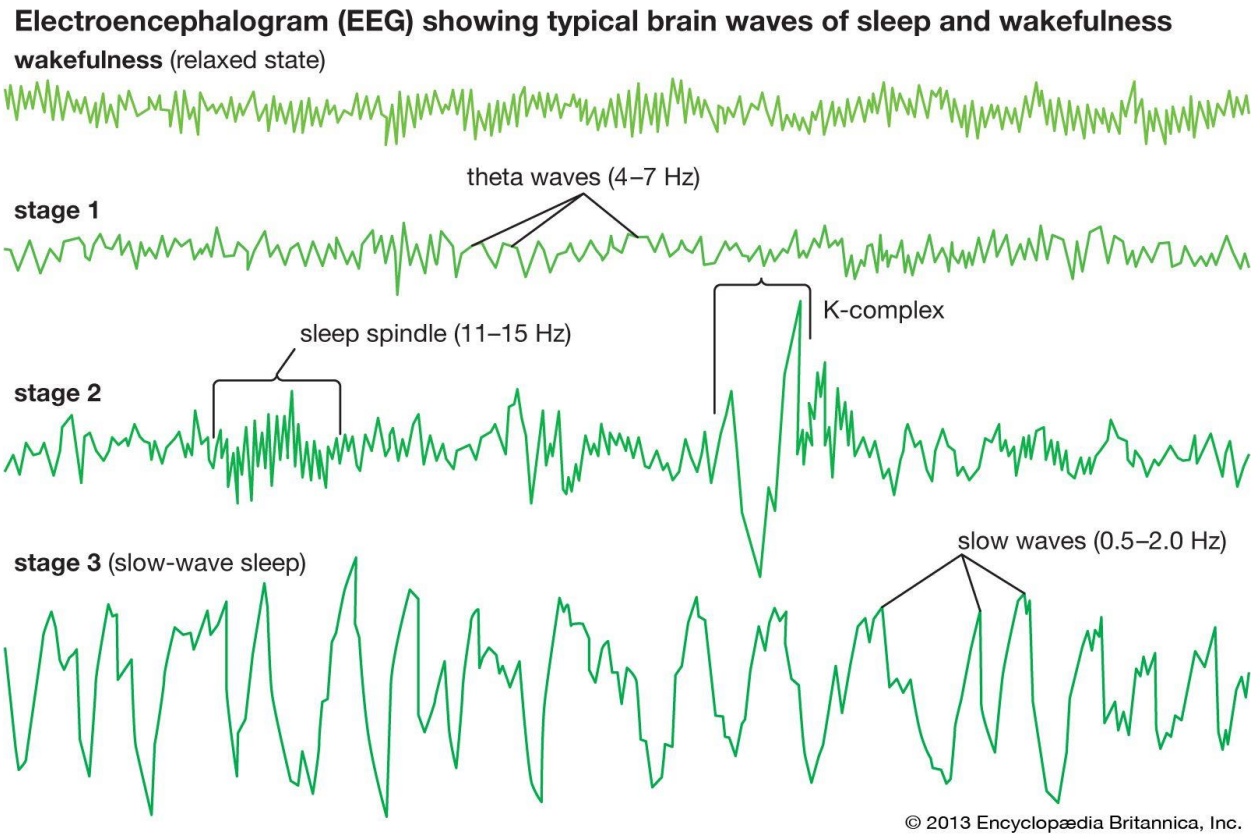
Electrocardiography (ECG)

Electrocardiography is the process of producing an **electrocardiogram** (**ECG**), a recording of the heart's electrical activity through repeated cardiac cycles.[4] It is an electrogram of the heart which is a graph of voltage versus time of the electrical activity of the heart[5] using electrodes placed on the skin. These electrodes detect the small electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat). Changes in the normal ECG pattern occur in numerous cardiac abnormalities.



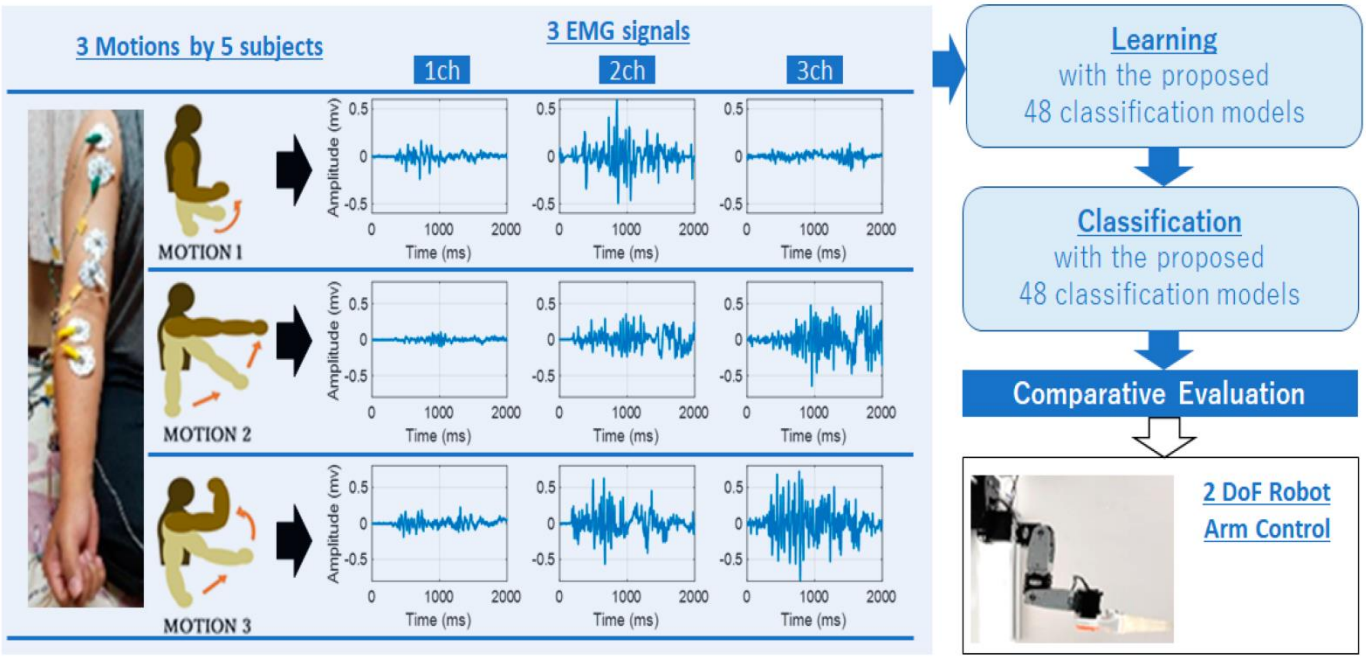
Electroencephalography (EEG)

Electroencephalography (**EEG**) is a method to record an electrogram of the spontaneous electrical activity of the brain. The biosignals detected by EEG have been shown to represent the postsynaptic potentials of pyramidal neurons in the neocortex and allocortex.



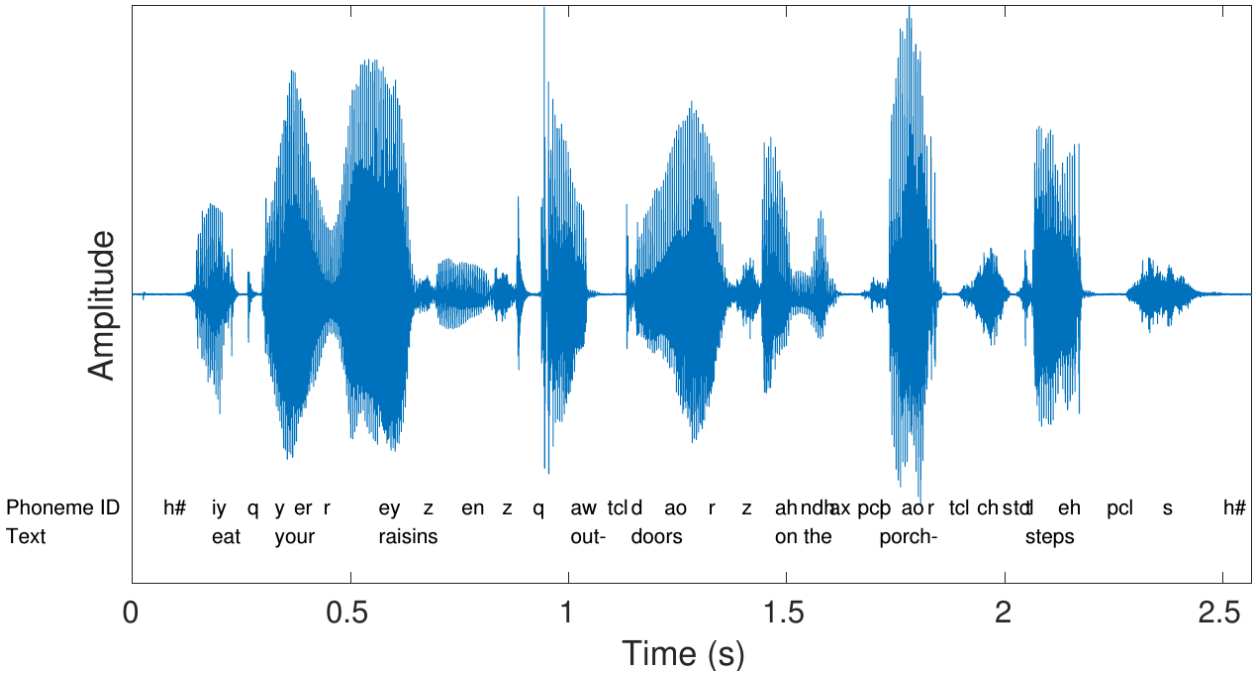
Electromyography (EMG)

Electromyography (**EMG**) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an **electromyograph** to produce a record called an **electromyogram**. An electromyograph detects the electric potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect abnormalities, activation level, or recruitment order, or to analyze the biomechanics of human or animal movement.



Speech signals

Speech signals are sound signals, defined as pressure variations travelling through the air. These variations in pressure can be described as waves and correspondingly they are often called sound waves. In the current context, we are primarily interested in analysis and processing of such waveforms in digital systems. We will therefore always assume that the acoustic speech signals have been captured by a microphone and converted to a digital form.



Radar and Sonar Systems

- Radar and sonar systems use signals to sense and locate objects.
- When the output object is interrupted or intermittent by any other object after that the return signal is analyzed to obtain information.

Medical Imaging

- To detect the human body so many new medical imaging technologies (such as MRI and CT scans) use the signals
- Signals are in the form of electromagnetic waves. So, they are manipulated to produce diagnostic images

Communication Systems

- Signals are serving as data in communication systems.
- In Telephone and wireless communication is based on the signal Transmission.