# Chapter 30
# Interpreting Brain Waves

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## ABSTRACT

*BCI (Brain-Computer Interface) gives you the power to manipulate things around you just by thinking of what you want to do. It allows your thoughts to be interpreted by the computer and hence act upon it. This could be utilized in helping disabled people, remote controlling of robots or even getting personalized systems depending upon your mood. The most important part of any BCI application is interpreting the brain signalsasthere are many mental tasks to be considered. In this chapter, the authors focus on interpreting motor imagery tasks and more specifically, imagining left hand, right hand, foot and tongue. Interpreting the signal consists of two main steps: feature extraction and classification. For the feature extraction,Empirical Mode Decomposition (EMD) was used and for the classification,the Support Vector Machine (SVM) with Radial Basis Function (RBF) kernel was used. The authors evaluated this system using the BCI competition IV dataset and reached a very promising accuracy.*

## INTRODUCTION

Our brains contain neurons that work each time we think, move, feel or remember something. That work is carried out by electrical signals that zip from neuron to neuron. The paths through which these signals move are insulated.However, some of the signals still manage to escape. Scientists can detect those signals using electrodes. There are many types of sensors that are used in BCI research; the most common are shown in Figure 1. Scientists can also interpret what these signals mean and use them to direct a device of some kind (Grabianowski, 2007).

A brain–computer interface (BCI), sometimes called a mind-machine interface (MMI), direct neural interface (DNI), synthetic telepathy interface (STI) or brain–machine interface (BMI), is defined as a direct

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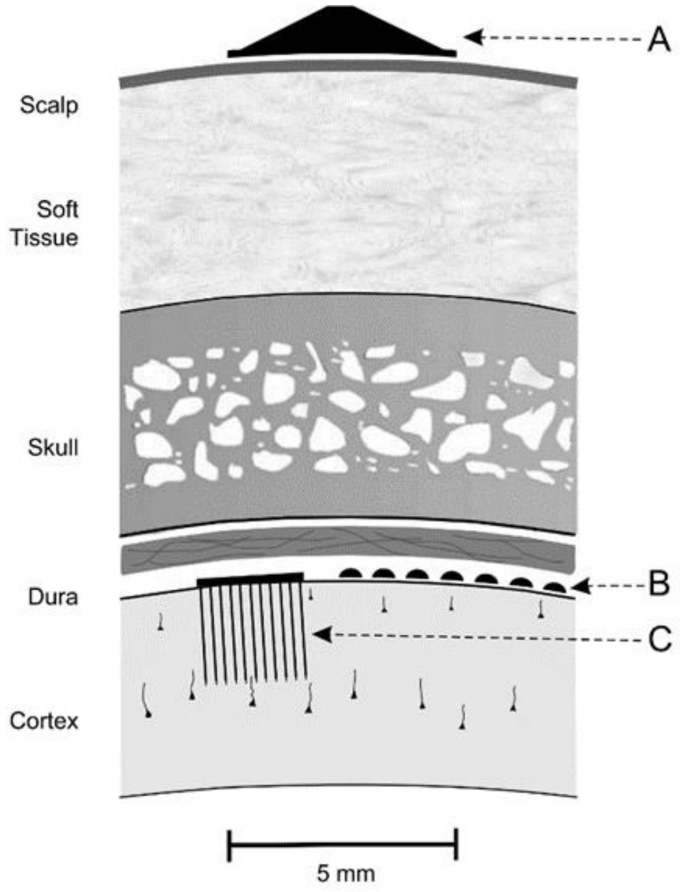
*Figure 1. Different types of sensors most commonly used in BCI research*
*A: Electrodes are placed non-invasively on the scalp(electroencephalography (EEG)) B: Electrodes are placed on the surface of the brain (electrocorticography (ecog)) C: Electrodes are placed invasively within the brain (single-neuronrecordings) Wolpaw, 2006.*




communication pathway between the brain and an external device. BCIs are often directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions(Brain–computer interface, 2014).

BCI is not restricted to humans. Several laboratories have managed to record signals from monkey and rat cerebral cortices to operate BCIs to produce movement. Monkeys were able to navigate computer cursors on screen and to command robotic arms to perform simple tasks simply by thinking about the task and seeing the visual feedback (Miguel et. al., 2001).

There are several applications that could make use of this data such as: Assistive technology, virtual reality (Leeb et al., 2007), game controlling (Scherer et al., 2007) and robotics (Plant, Ponnapalli, & Southall, 2007; Satti, Coyle, & Prasad, 2011). The authors are interested in understanding these waves to be able to use them as an input to other systems. Several studies have been made in this field with varying results.

The authors will focus on the features extraction and classification of the motor-imagery tasks. A motor based BCI translates the subject's motor intention which is reflected in the EEG recorded from the scalp into a control signal.Motor imagery is the mental representation of the performance without