The possibility of establishing a direct communication and control channel between the human brain and computers or robots has been a topic of scientific speculation and even science fiction for many years. Brain-computer interfaces (BCIs) allow their users to communicate or control external devices using brain signals rather than the brain's normal output pathways of peripheral nerves and muscles. A BCI recognizes the intent of the user through the electrophysiological or other signals of the brain. Electrophysiological signals may be recorded over the scalp, underneath the scalp, or within the brain; other types of physiological signals may be recorded by magnetic sensors or other means. In real time, a brain signal is translated into output commands that accomplish the desire of the user.

NOTE- At present, there are over 400 groups worldwide engaging in a wide spectrum of research and development programs, using a variety of brain signals, signal features, and analysis and translational algorithms

**Applications of BCI –**

1. **Communication –**

This technology can be used for people who cannot speak up and are locked in. Distinguished from one another by the specific electrophysiological features measured, three types of EEG-based BCI systems have been tested in human subjects for the purpose of communication, specifically those based on: 1) Slow Cortical Potentials (SCPs); 2) SensoriMotor Rhythms (SMRs); and 3) P300 event-related potentials .

SCPs are slow voltage changes in cortex. They occur over 0.5–10.0 sec and are among the lowest-frequency features of EEG. Negative shifts of SCPs represent cortical activation associated with movement or other functions, while positive SCP shifts accompany reduced cortical activation. With extensive training, sometimes months, the user learns to control SCP positive or negative voltage shifts. The BCI translates these voltage shifts into vertical movement of a cursor or an object on a computer screen. By this means, binary selection or control can be achieved.

Typically, the SMRs are recorded over sensorimotor cortex and the features useful for BCI are the μ rhythm (8-12 Hz) and the β rhythm (18-26 Hz). Typically, changes in μ and β rhythms are associated with movement, sensation, and motor imagery. The rhythms decrease or desynchronize with movement or its preparation, and increase or synchronize after movement and with relaxation. However, people can learn to use motor imagery, rather than actual movement, to change SMR amplitudes, and can use that control to operate a BCI. Work in several laboratories has shown that an SMR-based BCI can enable basic word processing and icon selection.

P300 even-related brain potential are used to indicate the response to a salient or infrequent stimulus within a stream of frequent standard stimuli. Detected in EEG recordings over the central and parietal regions, the P300 signal is a positive deflection of brain wave at a latency of about 300 msec. The stimuli used in most P300 BCI systems reported to date are visual. Because the P300 response occurs normally, use of a P300 BCI does not require substantial training. This quality, combined with the relative ease of acquisition of brain signals by EEG, makes a P300-based BCI potentially very practical for clinical use.

1. **Movement control –**

Restoration of motor control in paralyzed patients is another key application of BCI. BCI systems might be able to support multidimensional control of the movement of motor neuroprosthesis or an orthotic device such as a robotic arm. BCI-driven wheelchairs for paralyzed people has become a very useful application of BCI where a patient who previously was restrained from any kind of movement now has ability to move around freely on a wheelchair that to just by thinking.  Directional commands are detected by EEG and were then applied to direct control of the wheelchair.

1. **Environment Control –**

BCI-based environmental control could greatly improve the quality of life of severely disabled people. People with severe motor disabilities are often home-bound. Effective means for controlling their environments (e.g., controlling room temperature, light, power beds, TV, etc.) would increase their well-being and sense of independence. With unified control through EEG-based BCI technology, the user is able to operate remotely domestic devices such as neon lights and bulbs, TV and stereo sets, a motorized bed, an acoustic alarm, a front door opener, and a telephone, as well as to monitor the surrounding environment through wireless cameras.

1. **Neurorehabilitation –**

In addition to their uses for communication and control, BCI systems also have potential to serve as therapeutic tools to help people whose neuromuscular function has been impaired by trauma or disease to relearn useful motor function. Neurorehabilitation using BCI systems promotes functional recovery and may improve quality-of-life (QoL). This specific application of BCI systems seeks to augment current rehabilitation therapies by reinforcing and thereby increasing effective use of impaired brain areas and connections. This approach to rehabilitation was first evaluated with MEG signals in people with strokes, and found cortical reorganization after BCI-based training.

1. **Game Industry –**

Video Game running on BCI is another demanding application. This takes the game industry to a next level in which the person has to control the game play via their thoughts. Not only physically challenged people get the benefits but it also open doors of new domain of entertainment for every category of people (from kids to adults).