Brain-computer interfaces (BCI) translate electroencephalogram (EEG) signals from the human brain into device commands. BCI systems often require extensive subject preparation, including scalp abrasion, gel, and a multitude of wired electrodes. Dry and non-contact EEG electrodes, which do not require gel or even direct scalp coupling, have been considered as an enabling of practical, real-world, BCI platforms. This study presents an in-depth study directly comparing wet electrodes to dry and through hair, non-contact electrodes within a Steady State Visual Evoked Potential (SSVEP) BCI paradigm. The performance of using three different types of electrodes was demonstrated in a case study in which wearers’ EEG was used to directly dial 10-digit numbers.

A mobile, wireless SSVEP BCI framework serves as the basis for our experiments in this study. Visual evoked potential measurements serve as a convenient benchmark since SSVEP signals are well-defined and repeatable. Data taken with the three types of electrodes (wet, dry and non-contact) show the potential for dry electrodes to be fully usable for wireless BCI applications. While the signal quality from the integrated non-contact electrode still shows degradation as compared to its wet and dry counterparts, the experiments in this study further suggest the possibility of realizing a mobile, non-contact through hair BCI system.

Figure above shows the wireless dry/non-contact BCI system concept in this study. The BCI interface consists of a computer based visual stimulus program. SSVEP/EGG signals are acquired using dry/non-contact electrodes embedded within a headband over the hair in the occipital region. A high-resolution data acquisition system relays EEG telemetry to a cellular phone which decodes the SSVEP signals.

A comparative experiment was devised and performed on ten healthy subjects. Each subject gazed at a single SSVEP target stimulus, displayed on a CRT monitor, and the three sensors were arrayed in a triad over the occipital region as closely together as possible. The averaged correlation between the signals acquired by the wet and dry contact electrodes was 0.912±0.068, while the correlation between the signals from wet and non-contact electrodes was 0.7974±0.108. These tests demonstrated the feasibility of using dry electrodes to assess weak SSVEP signals.

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