This study is focused on the human-brain responses based on SSVEP paradigms using a low cost of brain-computer interfaces (BCIs). This research works on different empirical studies with respect to various stages analysis of non-stationary EEG signals based on several approaches. In general, the research goals are increasing and enhancing the substances of measurable SSVEP response by optimizing the stimulus paradigms, in order to achieve maximum cortical brain responses using different characteristics (such as frequency, colours, duty-cycle, regular/irregular, and patterns) to increase the numbers of BCI reaction-commands; increasing the numbers of reaction-commands provides new BCI applications. An adaptive algorithm beside stimulation design is used to overcome the problem of weak SSVEP oscillation responses. This algorithm uses multi-threading and parallel computing to extract features and computations from brain waveforms to reduce the execution time and computing resources. The experimental studies and stimulation setup stabilized production the provocation signals to represent consequence brain activities which rapidly change according to visual stimuli based on the prototype design. The assessment of the main hypothesis is giving promising results. The assessment includes following parts in which BCI systems are enhanced:

1. Optimise the EEG channels for gathering signals at sensory cortex occipital locations of the brain region leading to pre-design of new BCI based SSVEP paradigms that use a smaller number of unipolar EEG electrodes
2. Objectively measure the EEG signals to optimize the stimulation band frequency towards selection of the effect band that provides a higher amount of activities and responses in frequency-domain based SSVEP to minimize visual obstruction though evoke-process of SSVEP at different frequencies
3. Estimates the time delay limitation to understanding SSVEP signal based time dynamic analysis that leads to increase BCI active-commands and decrease attention using a three different colour stimulus to exploit the effect of brain influence with respect to phase shifts of each stimuli actions.

4. Achievements a robust response signals of SSVEPs based on diverse level duty-cycle of flickering stimulation which evokes brain activities by proposing instead a paradigm that is comfortable to BCI users; however, enhance the extracted feature by removing the artifacts using ICA technique and high response filter of FIR.

5. Evaluates to evoked strong measurable SSVEP signals using regular/irregular paradigms and multiple pattern stimulations, leading to a novel dynamic paradigm that increases reaction-command based BCI system.

6. Instead to decrease time of feature extraction, evaluate algorithm based on HPC with multi-thread processing depend on OpenMP lead to high speed computational on large amount of EEG dataset which is compare between four-filter types.