Photonic Sensor Based Real-Time and Low-Noise IoT-Enabled Brain-Computer Interface (BCI)

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In Brain-Computer Interface (BCI) applications, it is important that the method of retrieving signals from the brain should not cause scalp irritation, is not excessively heavy, have long latency or any characteristics that further reduce the comfort level of the subject rather than improving it. Photonic sensing is an ideal candidate for satisfying these criteria while also creating a much more effective alternative to the traditional Electroencephalography (EEG). Fig. 1 presents a schematic representation of the proposed Brain Computer Interface (BCI) system architecture based on photonic sensing. In the figure, V_0 and t_0 represent the initial condition of the photonic sensor at zero voltage and zero second, respectively, and V represents Voltage at any given time t.

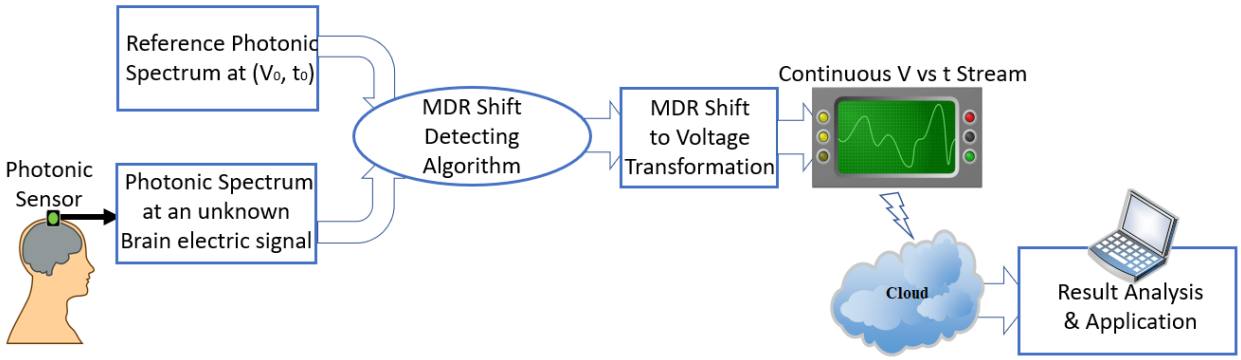

Figure 1: Proposed Photonic Brain-Computer Interface (BCI) Architecture

In this work, we developed a photonic sensor and a model for real-time monitoring of the electric field in a self-organizing manner using a photonic micro-resonator as the sensing element with a novel linear-time complexity emission spectrum denoising algorithm. The micro-resonator used for this work is a chemical combination of Norland Blocking Adhesive (NBA-107) and Di-4-ANEPPS ($C_{28}H_{36}N_2O_3S$) at a predetermined ratio. The applied principle is based on the Whispering Gallery Mode (WGM) or Morphology Dependent Resonance (MDR) but in a continuous, uninterrupted way that directly mimics the ceaseless release of electric pulses from different parts of the brain. Having a pre-existing, tested and reliable system of tracking and interpreting a continual flow of electric field, with marginal Mean Absolute Percentage Error (MAPE) and a seamless integration to the cloud can lead to the development of an effective Brain Computer Interface (BCI) system.