iDDS: An IoT based System for Refractory Epilepsy in Smart Healthcare

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Abstract: Smart health care is increasingly important due to the combined pressures of an increasing population, an increasing demand for excellent care and limited resources. A specific example of smart healthcare is the automated real-time control of epileptic seizures. Epilepsy is a neurological disorder characterized by recurrent seizures. A seizure consists of abnormal activity in the brain, which may result in loss of consciousness or convulsions. Approximately 1% of the world's population and 2.5 million people in the United States are suffering from epilepsy. Seizures can be controlled through anti-epileptic drugs (AEDs) and surgery. However, approximately one third of epilepsy patients do not respond to AEDs, and epilepsy surgery is suitable for a very small fraction of epilepsy patients. Hence, an alternative approach which can provide an effective solution for controlling seizures is necessary. A responsive and localized injection enhances the efficacy of drugs and provides an effective solution for epilepsy. Universal connectivity of the solution with other healthcare devices can be attained via the IoT.

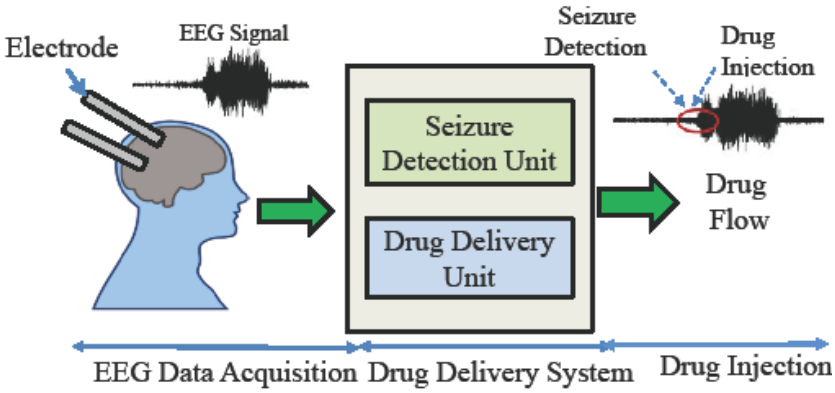

Fig 1. Model of the drug delivery system (DDS)

In this research, an electroencephalography (EEG) based unified drug delivery system (DDS) (Fig. 1) has been proposed which provides simultaneous seizure detection as well as drug injection in the Internet of Things (IoT) framework. The drug delivery system (DDS) consists of the following sub-units: seizure detection unit, and drug delivery unit. Seizure detection was performed in two stages. In the first stage, EEG signals were decomposed to several sub-bands and statistical features were then extracted from the decomposed sub-bands. In the second stage, the extracted features were applied to a k-NN classifier for seizure detection. The drug delivery unit consists of an actuator, a reservoir, and a micropump. An electromagnetically actuated valveless micropump (EAVM), with a diaphragm composed of Polydimethylsiloxane (PDMS), was used for drug delivery. The proposed system was implemented and validated using Simulink, ThingSpeak, and Arduino. The experimental results show that proposed system provides better detection accuracy and reduces power consumption by 10-30% compared to existing approaches, which makes it suitable for implantable biomedical applications.