Effective Analytic and Remotely Monitoring Smart Drug Delivery System based on IoMT with KNN classifier of Epilepsy Patients

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Abstract: Chronic, non-communicable brain disorder, epilepsy is one of the most severe neurologic disorders. Worldwide, about 50 million individuals (2.5 percent) have Epilepsy, rendering it one of the world's most severe neurological disorders. [1]. About 80% of individuals with epilepsy work in countries with small to modest income. A medically refractory solution for the seizure control for a large fraction of affected patients. Here we explain the IMoT structure for a single drug delivery network. This has resulted in injection of drugs when seizure seizures have been identified. A powerful micro-pump electromagnetically powered with a polydimethylsiloxane (PDMS) diaphragm was used to distribute the drug. Simulink ® and ThingspeakTM were the prototype for the solution. The findings of the simulation reveal that the device proposed preserves high precision performance while substantially reducing power usage (8-26 %)..

Keywords: Epilepsy, IoMT, Seizure control, seizure identification, electromagnetic actuation, drug delivery system(DDS), Electroencephalogram (EEG), K-Nearest Neighbor classifier

1. Introduction

Epilepsy is a basic (neurological) condition of the nervous system where irregular brain function triggers hallucinations or episodes of odd behavior , emotions or even lack of awareness. Around 2% of human peoples worldwide suffer from epilepsy. Seizures could be controlled by surgery and the medications of Anti-epileptic drugs (AEDs). [2]

In only a minority of patients, AED can be successfully stopped. Early postoperative seizures are not managed by a third of the patients that are chronic and focal gliosis or dysplasia predisposes them to seizure recurrence. This procedure is suitable for a relatively limited number of patients with epilepsy. The replacement strategy is then appropriate, which can offer an efficient method for seizure control. [4] [3]

The mechanism for medication administration where we suggest a coma will be identified and inserted an AED in a specified brain area. This receptive, targeted injection increases the therapy and provides a positive epilepsy outcome. The system can be linked worldwide to other medical devices through the IoMT. [5] IoMT allows smart remote control services and collaborative health-care data collection. The present paper recommends a well-disposed DDS device that can injected drugs into the epileptogenic region during the injection of seizures. [6] Photo. 1 displays the planned medication distribution system's block diagram.

To the Authors' understanding, the purpose has not been discussed previously by any empirical study. As fellows, this article must be comprehensive: We address this paper's novel addition in Section 2. Section 3- short reviews of previous research. Section 4 offers an description of the drug distribution process. Section V addresses the application and testing of the program introduced in Section VI. This paper ends with a review and guidance on potential study areas. [7]

Fig. 1 Drug Delivery System(DDS) Structure Diagram.

2. Novel Contribution Of This Paper

In this article, the IoMT Impressionable Drug Delivery System (DDS) is suggested to provide improved detection precision and simultaneous injection of drugs. These researches are a novel support.

1) In the past decade, the effective time frequency method Discrete Wavelet Transform (DWT) is commonly used in computer-aided signal analysis in Epileptic Electroencephalography (EEG), for example, seizure

prediction. Some of the main challenges in DWT implementations is the DWT conditions, which are empirically or randomly selected in recent works, leading to increased seizure detection accuracy as opposed to the previous process.

2) In a used system that has operated only a high voltage for both piezoelectric and electrostatic actuation. For an electromagnetic actuation, the required membrane displacement needs a lower power voltage. So this process reduced the power consumption and also its helps medical application those used in low power.

3) The proposed device has a rating of improved definition, detection precision, lower power usage, and worldwide connectivity. It’s having a remotely accessible and analyzable feature to monitoring the patient's data and system performance.

4) The suggested IoMT framework facilitates remote health monitoring of patients with epilepsy, enabling significant improvements in epilepsy patients quality of life.

3. Reelated Prior Academic Studies

In a study of epilepsy patients & researchers have given reports over the ongoing research activities & problems facing during the medical time seizure identification, control, detection, and prediction are the main areas. [8] In cases of medicine-resistant systems, many more interventional devices found by the researchers. [9] That kind of device has been suggested for the control of seizures based simulation through electrical, drug delivery system or focal cooling method. Many patients do not address this problem because of the impact of the duration of electrical stimulation, suggesting that an alternative approach is necessary. [10] [11]

Focused regulated drug delivery to cure diseases located on a tissue or organ has been introduced. Such devices are introduced directly to the site and include the optimal dosage for a long time, thus reducing the systemic delivery of the toxic substance. Controlled drug delivery systems have focused on extended-release oral formulations and the systemic delivery of small drugs and peptides. But that's shows positive outcomes for seizure control. An electrophoretic pharmaceutical delivery device based on the OEIP pump that provides efficient spatiotime control for the distribution of medicines. By comparison to many medicinal devices, the ion pump operates across an ion exchange layer, electrophoretically circulating ions, but simply providing an fascinating drug, and not a solvent. OEIPs have shown great promise for biological interaction. In the suggested distribution of medications to the identified brain region.[15] The customizable equipment tool indicates the regulation of epilepsy by direct injection of an AED into a particular region of the brain. An outstanding medication delivery system in the electromagnetic managers was provided with a micro pump. At low power consumption, the system has a high precision output compared with piezoelectric micro-pumps. [13]

Monitor and track unsafe seizures and send an warning asking for help from a caregiver. This also measures spikes in the conductance of the scalp, an sign of nervous system disturbances that are caused during an epileptic attack. Such spikes in electrical activity occurring in the brain which can be assessed non-invasively on the skin surface. [14] The smart watch Embrace tracks such electrical signals along with 3-axis accelerometer data and uses a patented algorithm to identify when someone has a seizure.

The Medical Things Internet (MTI) consists of a combination of electronic equipment and software that can link to IT networks in the area of health care through networking technology.

By connecting patients with their physicians, they can reduce burden on health care facilities and exchange clinical information through a safe network. In 2016 , the global market for IoMT reached $22.5 billion; it is forecast at an annual growth rate of 26.2 percent at $72.02 billion by 2021, according to Frost and Sullivan analyses. [15]

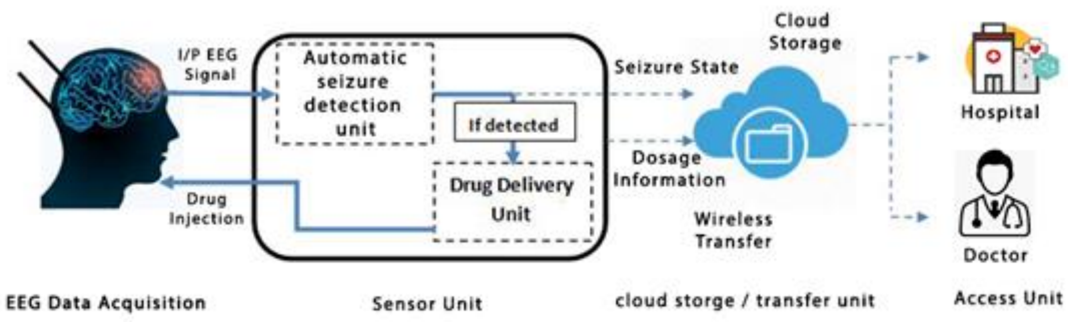


Fig.2 Clinical Information method architecture (IoMT) Proposed

4. The Proposed Drug Delivery System

In initially processing of EEG signals has to decompose with the use of DWT. From the objective of the survey statistical, separated from the decomposed EEG and that will be an input of the k-NN classifier for detection. In a processing time of classification if a seizure is detected, at that moment AEDs come to action to stop and control the propagation of seizure to the operation of injected into the target area. With an automatic convulsion and seizure detection, our proposed IoMT monitoring system could monitor the performance of the solution while injecting drug. In fig. 2 shows a Clinical Information method architecture (IoMT) Proposed. Fig. 3 shows a flowchart of the system and then Fig. 4 given the architecture of the proposed system.

Subsystem for automatic seizures detection

The automated seizure ID module (Fig. 4) includes the following sub-units: DWT Split-in Datasets, Function Extraction Module, Stream Selection Module and K-Nearest Neighbor Classifier. The decomposed DWT produced EEG signals and TF position. Statistical items from each sub-band are stripped out, including a K-NN classification.

1) DWT Extraction: The DFT provides the advantages of TF venue. It is important for the research phase of non-stationary and dynamic EEG signals. Within a filter row, the decomposition signal is carried out. The following sub-band frequencies have been assigned to the series: A4 (0–5.47Hz), D4 (5.47–10.80Hz), D3 (10.80–21.8Hz), D2 (21.8–43.7 Hz) and D1 (43.7–87.0Hz). [16]

2) K-Nearest Neighbor Classifier: there are two phases of classifiers has used in this unit testing and training. A distinct dataset of EEG used for the testing phase and training phase. [20] At its center, the difference or resemblance between the examples evaluated and the training examples is primarily calculated.

Experimental findings indicate that K-NN classification efficiency is greatly based on the used distance and the tests reveal considerable differences in the output of various distances. [9]

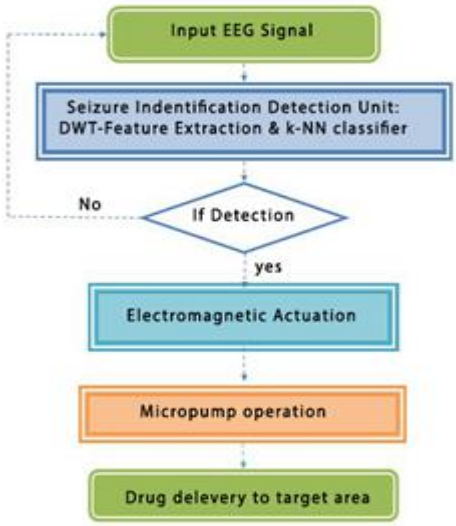


Fig. 3 – Flowchart of proposed system

Drug Delivery subsystem (DDS)

Micro pumps in flowing Fig were seen in our suggested automated product supply. 5 An Electromagnetic Auctioned Micro pump (EAVM) has been used and has a special characteristic in contrast to other micro pumps.

a) It needs a lower actuation voltage for electromagnetic actuation compared to other mechanisms used for actuation. b) It having a higher deflection. c) During the actuation gives faster response. d) it works higher actuation force.

e) EVAM makes the structure of a simplified and reliable model.

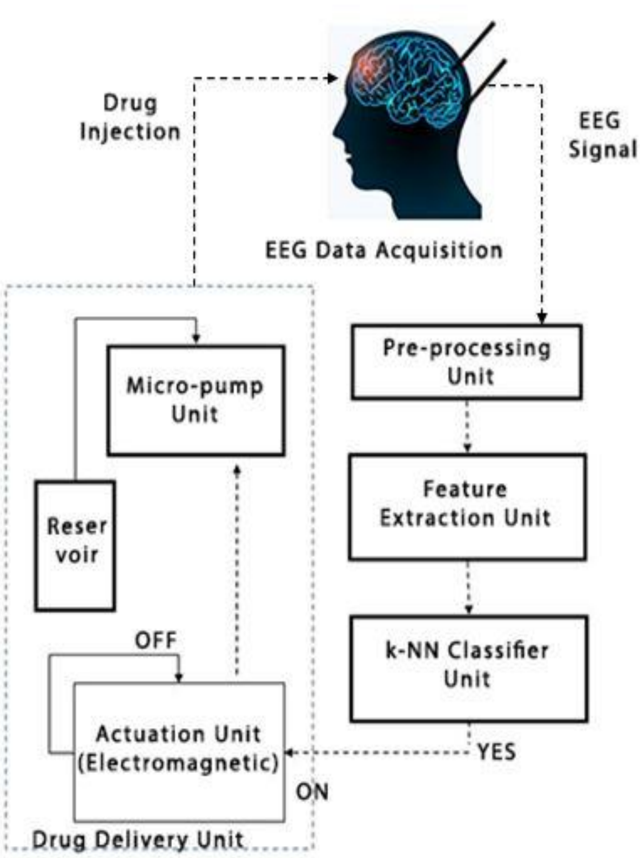


Fig. 4 - Architecture of proposed system

If a voltage is added to the wire, the micro pump is running. The belt developed an electromagnetic force (EMF) magnetic field. That EMF helps to operate the membrane and pump chamber. The membrane drives periodically towards up and down direction and the pump chamber change the volume. The power between a belt and a permanent magnet is indicated by [13]

$$Fz=Pr\int\_Tm \ Sm \ \delta Hz/\delta z \ dz. \quad ..... (1)$$

Here,

Hz - Vertical spindle magnetic field

Pr - The magnet's remnant

Sm- Magnetic field layer

Tm- Magnetic strength

To calculate the Maximum deflection of diaphragm [14]

$$Wmax = F \ d2 / 256\pi M. \quad ..... (2)$$

Where F is an example of the strength of the membrane; d is a diaphragm; M is a flexurity of the diaphragm.

$$M = Et \ 3/12(1 - v \ 2),$$

Where E is the elastic modulus, v refers to the Poisson proportion and t to the thickness of the diaphragm. The flow rate is instead [15]:

$$Q = 2\Delta V \ f \ (\eta \ 1/ \ 2 - 1) \ / \ (\eta \ 1/ \ 2 - 1) \quad ....(3)$$

Where f the frequency of the pump is. ~V is the reference volume for each stock and then the strokeproduction.

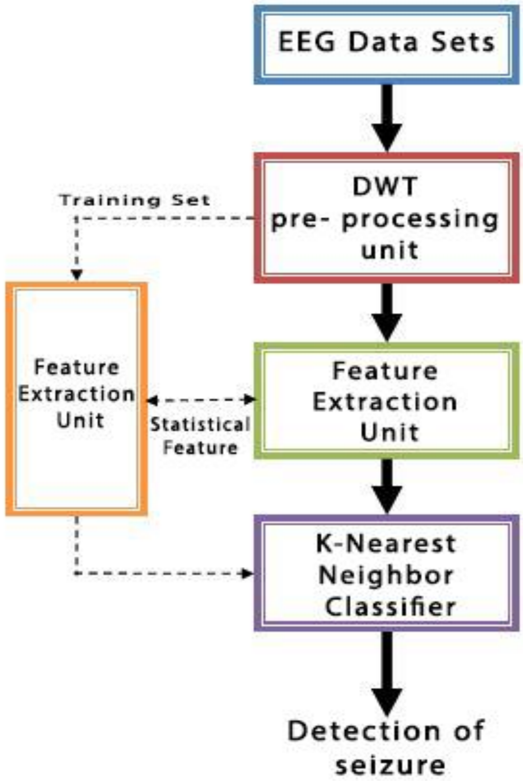


Fig. 5 - Proposed Seizure Detection System Layout

5. Implementation And Testing Of The Framework

Simulink® is implemented in the same kind of system.IN the operation of discrete wavelet transform (DWT) EEG signals have decomposed and processed. After that signal submitted to the feature extraction unit. The K-Nearest Neighbor classifier applied for extract features for detection seizure. We took EEG data from the open-source website. That dataset was given to the K-NN classifier, we found after the progress 82% of the dataset was trained and 18% of the dataset could be trained. [17]

At the time of classification, the test points shall be assigned to the seizure detection classifier. Our proposed model provides 98.25% accuracy in classification for the interictal and standard Vs. Ictal EEG. While detection of seizure, the unit of drug delivery system comes to the activation mode in the meantime coil acts as an electromagnet. [18] This allows the results of the spear, the permanent magnet and the transmission voltage to be determined for the EMF. The required deflection of the EMF and diaphragm geometry was determined. [21] We are using ThingSpeakTM for IoMT process execution. ThingSpeakTM is an open-source code framework for IoMT applications. [19]

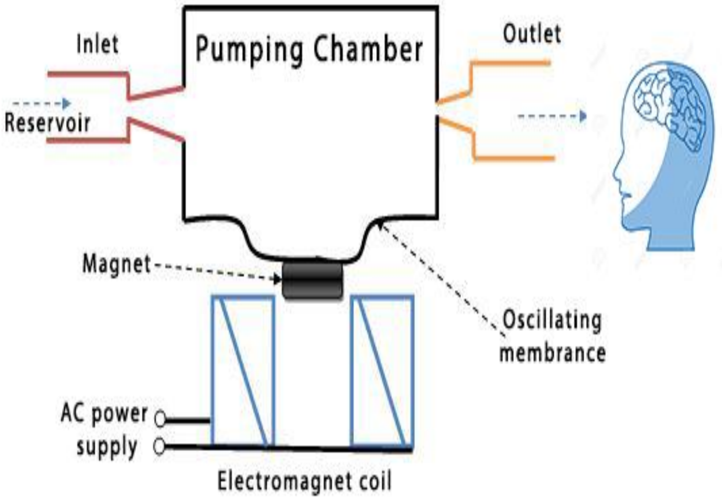


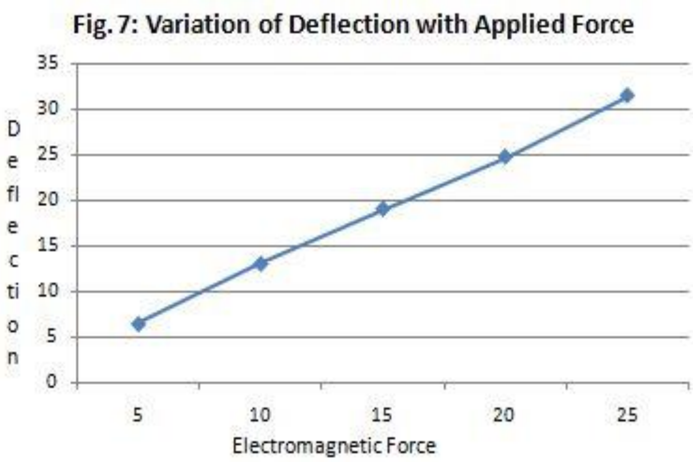
Fig. 6 Operation of EVA Micro pump.

The angle of the permanent magnet to the electromagnetic is 1.8 mm while the EMF becomes the key component of the coil switch, The present added and the magnet property irreversible. The properties defined in the PDMS diaphragm are in Table-I.

TABLE I: Specification of Micropump

Parameters	Value	Unit
Frequency	120	Hz
Voltage	5	Volts
Distance between magnet & coil	1.8	mm
Pump camber distance	4.5	mm
Membrane thickness	94	µm
Elastic modules	820	Kpa
Coil turn	120	-

The EMF required to achieve a 15um diaphragm deflection is 32.8 UN. Chart. 7 Indicates the variance with consequence of the applied force of the diaphragm displacement.



The variance of the input voltage flow rate was evaluated from the simulation tests. The chart indicates that the flow rate decreases linearly with the voltage supply. [16] Membrane and input voltage could be the same type of linear growth.

Fig. 8 means the variation of membrane deflection with the cousin of the volumetric flow rate. [22] That approach helps to reduce the amount of power consumption. Our proposed system helps to reduce up to 12 -26 % compared to earlier work.

6. Conclusions

We propose an IoMT model auto-medicine distribution network with K-NN seizure identification classification and an electromagnetic micropump medication delivery device in this article. Simulink ® was used for framework testing and operating model implementation. Our proposed system-level simulation model has given a very detailed definition, detection and lower power consumption. Our proposed model supports physicians who treat epilepsy with the remote monitoring system. We will implement the proposed system in future research into live applications and certain other diseases of diseased patients.

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