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Currently, there are nearly three million people in the United States who suffer from epilepsy. Some of these epileptic seizures can be harmful to the patient and to those around them. In addition, medical help such as medication or an ambulance is expensive, especially if it is needed on a regular basis. Fear of the next seizure is a major issue for patients. Consequently, ORNL has developed the SeizAlert technology, which presently predicts an impending seizure up to 5.3 hours before its onset with an accuracy of 93%. The goal of my research is to improve this forewarning further, because false alerts of a seizure can also incur high medical costs. The present SeizAlert technology removes eye-blink (and other muscular) interference from the scalp EEG, converts the artifact-filtered data into discrete values, and creates unique brain states, $y(i)$. The ingenuity of this research takes advantage of these time-sequential, discrete brain states, $y(i)$ and $y(i + \mu)$, as nodes, and dynamical transitions, $y(i) \rightarrow y(i + \mu)$, as links between the nodes. These nodes and links form a network or "graph" (in mathematical jargon). This specific project will apply advanced graph-theoretic analysis to improve the accuracy of the seizure prediction. A mathematical (time-delay embedding) theorem by Flavius Takens guarantees that this approach can capture the system dynamics in a sufficiently high dimensional space. Consequently, success for epilepsy forewarning from brain waves implies that the technology can analyze appropriate data to predict other unexpected occurrences, such as bridge failures, machine failures, and heart attacks.

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