College of Engineering and Computer Science
Office of the Dean
777 Glades Road, EE96, Room 308
Boca Raton, FL 33431
561.297.3400

Announces the Ph.D. Dissertation Defense of

Raghdah Saemaldahr

for the degree of Doctor of Philosophy (Ph.D.)

"DEEP LEARNING-ASSISTED EPILEPSY DETECTION AND PREDICTION"

September 23, 2024, 11 a.m. to 12:30 p.m.
Zoom Meeting
https://fau-edu.zoom.us/j/89261401438?pwd=pKij9RpP8ztwqgVe2KTsas11Sd1jol.1
Meeting ID: 892 6140 1438
Passcode: mpH6qJ

DEPARTMENT:
Department of Electrical Engineering and Computer Science

ADVISOR:
Mohammad Ilyas, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Mohammad Ilyas, Ph.D., Chair
Shihong Huang, Ph.D.
Maria Petrie, Ph.D.
Dingding Wang, Ph.D.

ABSTRACT OF DISSERTATION
Deep Learning-Assisted Epilepsy Detection and Prediction

Epilepsy is a multifaceted neurological disorder characterized by superfluous and recurrent seizure activity. Electroencephalogram (EEG) signals are indispensable tools for epilepsy diagnosis that reflect real-time insights of brain activity. Recently, epilepsy researchers have increasingly utilized Deep Learning (DL) architectures for early and timely diagnosis. However, designing epilepsy detection, prediction, and forecasting is challenging due to data diversity, scarcity, and privacy concerns without impacting accuracy. This dissertation initially designs diversity-enhanced data augmentation to avert data scarcity and inter-patient variability constraints for multiclass epilepsy detection. The potential features are extracted by enabling a graph theory-based approach for analyzing the inherently dynamic characteristics of augmented EEG data. It utilizes a novel temporal weight fluctuation method to recognize the drastic temporal fluctuations and data patterns realized in EEG signals. Designing the Siamese neural network-based few-shot learning strategy offers a robust framework for multiclass epilepsy detection.

The subsequent contribution overcomes data scarcity, diversity, and privacy challenges in epileptic seizure prediction. It enables Federated Learning (FL) architecture to enhance the generalization capability by utilizing numerous seizure patterns across diversified and globally distributed epileptic patients. By capturing the patterns, the hybrid model potentially offers superior prediction accuracy by integrating a spiking encoder with graph convolutional neural networks. The preictal probability of each local model then aggregates the weights of the local medical centers with the global FL. Furthermore, applying the adaptive neuro-fuzzy inference system ensures a patient-specific preictal probability by combining the local model with patient-specific clinical features.

The final design of epileptic seizure forecasting utilizes the capabilities of Self-Supervised Learning (SSL) to overcome the limitations of annotated EEG data. This SSL model improves the training efficiency in massively arriving EEG data streams. Dual-feature embedding

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enhances the learning ability of the SSL model. A lightweight prediction utilizes the embeddings from the pretext task for epilepsy forecasting in the downstream task with the association of discrepancy-based correlative EEG samples-based replay buffer modeling and replay sampling.
In summary, this dissertation uses a combination of DL algorithms to enhance the accuracy of epilepsy detection, prediction, and forecasting by addressing the limitations in the existing approaches for effective patient management.

BIOGRAPHICAL SKETCH
Born in Medina, Saudi Arabia
B.S., Taibah University, Medina, Saudi Arabia, 2012
M.S., Nova Southeastern University, Fort Lauderdale, Florida, 2018
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2024

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2019 - 2024

Qualifying Examination Passed: Spring 2019

Published Papers:

Saemaldahr, R., Thapa, B., Maikoo, K., Fernandez, E. B.,"Reference Architectures for the IoT: A Survey", In the 5th International Conference of Reliable Information and Communication Technology (IRICT), 2020.

Alanazi, M., Saemaldahr, R., Ilyas, M., "Effectiveness of Machine Learning on Human Activity Recognition Using Accelerometer and Gyroscope Sensors: A Survey", In the 26th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI), 2022.

Saemaldahr, R., Alanazi, M., Ilyas, M., "Evolving Deep Learning Models for Epilepsy Diagnosis in Data Scarcity Context: A Survey", In the 45th International Conference on Telecommunications and Signal Processing (TSP), IEEE, 2022.

Saemaldahr, R. and Ilyas, M., "An Epilepsy Detection Model Based on EEG Signals: A New Approach", In the 26th World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI), 2022.

Saemaldahr, R., Alanazi, M., Ilyas, M., "Addressing Inter-Patient Variability in EEG: Diversity-Enhanced Data Augmentation and Few-Shot Learning-based Epilepsy Detection", In the International Conference on Healthcare Engineering (ICHE), IEEE, 2022.

Saemaldahr, R. and Ilyas, M., "Patient-specific Preictal Pattern-aware Epileptic Seizure Prediction with Federated Learning", Sensors MDPI Journal, 2023.

Alanazi, M., Saemaldahr, R., Ilyas, M., "Emphasize Human Activity Recognition through Smartphone Inertial Sensors with ML Approach", Engineering, Technology & Applied Science Research Journal, 2023.

Saemaldahr, R. and Ilyas, M., "Dual EEG Feature Representation with Self-supervised Transfer Learning For Epileptic Seizure Forecasting", IEEE Access Journal, 2024 (submitted)