COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Mustafa Shuqair

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

"An Adaptive Deep Learning Framework for Enhanced Monitoring Systems Performance in Biomedical Applications"

November 8, 2024, 2:30 p.m.
Engineering East, Room 303
777 Glades Road
Boca Raton, FL

DEPARTMENT:
Electrical Engineering and Computer Science

ADVISOR:
Behnaz Ghoraani, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Behnaz Ghoraani, Ph.D., Chair
Michael DeGiorgio, Ph.D.
Ramin Pashaie, Ph.D.
Xiangnan Zhong, Ph.D.

ABSTRACT OF DISSERTATION

An Adaptive Deep Learning Framework for Enhanced Monitoring Systems Performance in Biomedical Applications
Deep learning strategies combined with wearable sensors have advanced the capabilities of monitoring systems in biomedical applications, offering precise and efficient solutions for diagnosing and managing diseases. However, applying these systems faces several challenges. One of the challenges is the diminishing performance when these systems encounter new data with more complex patterns than those seen before. Another challenge is the limited availability of labeled data, on which deep learning-based systems depend highly. Additionally, obtaining high-quality labeled data to train deep learning models is often expensive, requiring significant time and resources. Another significant challenge is ensuring the practicality, accessibility, and convenience of the monitoring systems.
This dissertation proposes an innovative deep learning framework to overcome these challenges and improve system generalization performance in classification and regression tasks, specifically monitoring patients with neurological disorders like Parkinson's. The framework follows three primary research tracks. Track I: Learning and adapting to the underlying dynamics of the data by integrating Reinforcement Learning and anomaly analysis principles to tackle the challenge of encountering new complex data patterns. Track II: Reducing dependency on labeled datasets by autonomously extracting valuable representations from unlabeled data from various domains, comprehending the data's frequency components change over time to enrich information extracted from the data, and better understanding spatial and temporal data dimensions through sequence modeling using a proposed Mutli-shared-task Self-supervised Multichannel Convolutional Neural Network Long Short-term Memory methodology. Track III: Optimizing machine learning and wearable sensor configurations effectively to ensure the monitoring systems' convenience, practicality, and applicability in real-world scenarios.
The proposed framework was evaluated using four real-world datasets, including two private datasets from individuals with Parkinson's disease and two publicly available datasets from healthy individuals (MHEALTH and PAMAP2). The results demonstrated the framework's ability to enhance the monitoring system's classification and regression outcomes, outperforming state-of-the-art methods while addressing their limitations. These findings contribute to advancing more adaptive and efficient monitoring systems in biomedical applications, ultimately promoting improved patient care and outcomes.

BIOGRAPHICAL SKETCH
Born in Amman, Jordan
B.S., Al-Balqa' Applied University, Amman, Jordan, 2007
M.S., Universität Siegen, Siegen, North Rhine-Westphalia, Germany, 2014
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2024

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2020 - 2024

Qualifying Examination Passed: Spring 2021

Published Papers:

1. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. "Reinforcement Learning-Based Adaptive Classification for Medication State Monitoring in Parkinson's Disease." *IEEE Journal of Biomedical and Health Informatics* (2024).
2. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. "Multi-Shared-Task Self-Supervised CNN-LSTM for Monitoring Free-Body Movement UPDRS-III Using Wearable Sensors." *Bioengineering* 11, no. 7 (2024).
3. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. "Incremental learning in time-series data using reinforcement learning." In *2022 IEEE International Conference on Data Mining Workshops (ICDMW)*, pp. 868-875. IEEE, 2022.
4. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. " Shared-task Self-supervised Learning for Estimating Free Movement Unified Parkinson's Disease Rating Scale III." *2024 46th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*. IEEE, 2024.
5. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani "Advancing Parkinson's Disease Management through Multi-Shared-Task Self-Supervised Signal Processing." *2024 58th Asilomar Conference on Signals, Systems, and Computers*. IEEE, 2024.
6. Shay Reardon, Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. " Wearable Sensor Configurations for Effective Tremor Assessment in Parkinson's Disease." *2024 46th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*. IEEE, 2024.
7. Marjan Nassajpour, Mustafa Shuqair, Amie Rosenfeld, Magdalena I. Tolea, James E. Galvin, and Behnaz Ghoraani. "Objective estimation of m-CTSIB balance test scores using wearable sensors and machine learning." *Frontiers in Digital Health* 6 (2024): 1366176.
8. Marjan Nassajpour, Mustafa Shuqair, Amie Rosenfeld, Magdalena I. Tolea, James E. Galvin, and Behnaz Ghoraani. "Smartphone-Based Balance Assessment Using Machine Learning." *2024 46th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*. IEEE, 2024.
9. Marjan Nassajpour, Mustafa Shuqair, Amie Rosenfeld, Magdalena I. Tolea, James E. Galvin, and Behnaz Ghoraani. "Integrating Wearable Sensor Technology and Machine Learning for Objective m-CTSIB Balance Score Estimation. " *2024 46th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*. IEEE, 2024.
10. Mustafa Shuqair, Joohi Jimenez-Shahed, and Behnaz Ghoraani. " Leveraging Multi-task Self-supervised Learning for Remote Health Monitoring of Parkinson's Disease Patients *Scientific Reports* (Under Review).