COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Hani Alnami

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

"Real-time Highway Traffic Flow and Accident Severity Prediction in Cluster-Based Vehicular Networks Using Distributed Machine Learning and Big Data Analysis"

November 10, 2022, 1:00 P.M.
Engineering East, Room: EE405
777 Glades Road
Boca Raton, FL
Zoom Meeting
Meeting ID: 665 412 6834
Passcode: XRKQt2

DEPARTMENT:
Electrical Engineering and Computer Science.

ADVISOR:
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PH.D. SUPERVISORY COMMITTEE:
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ABSTRACT OF DISSERTATION

In recent years, Florida State recorded thousands of abnormal traffic flows on highways that were caused by traffic incidents. Highway traffic congestion costed the US economy 101 billion dollars in 2020. Therefore, it is imperative to develop effective real-time traffic flow prediction schemes to mitigate the impact of traffic congestion. In this dissertation, we utilized real-life highway segment-based traffic and incident data obtained from Florida Department of Transportation (FDOT) for real-time incident prediction.

We used eight years of FDOT real-life traffic and incident data for Florida I-95 highway to build prediction models for traffic accident severity. Accurate severity prediction is beneficial for responders since it allows the emergency center to dispatch the right number of vehicles without wasting additional resources.

Furthermore, this dissertation proposes a system for predicting traffic flow in a vehicular network cluster-oriented environment. We start with mining real-life FDOT traffic and incident data that consist of four years of traffic records. Then, we build random forest and decision tree models to predict traffic flow. The models are trained on the first three years' data and validated on the last year's data.

A traditional or centralized machine learning approach faces a number of challenges due to the sheer volume of traffic data that need to be processed in real-time. Thus, it is not scalable and lacks fault tolerance and data privacy. This dissertation proposes a distributed machine learning scheme to predict highway traffic flows in real-time. The proposed system is cluster-oriented to utilize the FDOT highway segment-based dataset. We train and validate a local Random Forest Regression (RFR) model for each vehicles' cluster (highway-segment) using six different hyper parameters. Due to the variance of traffic flow patterns between clusters, we build a global Distributed Machine Learning Random Forest (DMLRF) regression model to improve the system performance for abnormal traffic flows. Kappa Architecture is utilized to enable real-time prediction. The system performance is evaluated in terms of Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), R-squared (R^2), and Adjusted R-Squared (AR^2). The proposed scheme demonstrates high accuracy in predicting abnormal traffic flows while enhancing

scalability and data privacy.

BIOGRAPHICAL SKETCH
B.S., Jazan University, Jazan, Saudi Arabia, 2013
M.S., Florida Atlantic University, Boca Raton, Florida, 2018
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CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2019 - 2022

Qualifying Examination Passed: Spring 2019

Published Papers:

Alnami, Hani M., Imad Mahgoub, and Hamzah Al–Najada. "Highway accident severity prediction for optimal resource allocation of emergency vehicles and personnel." *2021 IEEE 11th Annual Computing and Communication Workshop and Conference (CCWC)*. IEEE, 2021.

Alnami, Hani M., Imad Mahgoub, and Hamzah Al-Najada. "Segment Based Highway Traffic Flow Prediction in VANET Using Big Data Analysis." *2021 IEEE Symposium Series on Computational Intelligence (SSCI)*. IEEE, 2021.

Alnami, Hani M., Imad Mahgoub, and Hamzah Al-Najada. "Real-time Highway Traffic Flow Prediction In Cluster-Based Vehicular Networks Using Distributed Machine Learning and Big Data Analysis." IEEE Transactions on Intelligent Transportation Systems, 2022. (Submitted).