Mohammad Wali Ur Rahman

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RESEARCH INTERESTS

Artificial Intelligence, Data Science, Machine Learning, Neural Networks, Natural Language Processing, Wireless Networks, Internet of Things, Cybersecurity, Embedded Systems, Robotics.

EDUCATION

PhD. in Electrical and Computer Engineering **Aug '23 - Present**
Department: Electrical and Computer Engineering
Minor: Systems and Industrial Engineering
Expected Graduation: Fall 2025
The University of Arizona, United States of America

MS in Electrical and Computer Engineering **Aug '21 - Dec '23**
Department: Electrical and Computer Engineering
The University of Arizona, United States of America

B.Sc. in Electrical and Electronic Engineering **Jan '15 - Aug '19**
Major: Electronics, Minor: Computer Science
BRAC University, Dhaka, Bangladesh

WORK EXPERIENCE

Graduate Research Assistant **Aug '21 - Present**
Autonomic Computing Lab, The University of Arizona
Funded by: NSF Cloud and Autonomic Computing Center (CAC), NSF Center for Wireless Innovation towards Secure, Pervasive, Efficient, and Resilient Next G Networks (WISPER)

- Developing AI-based Reputation Management Systems using Network Analysis Algorithms and Transformer models.
- Developing Topic Intelligence Management System for SEO using Semantic Deep Embedded Clustering and Multi-agent based Generative AI system
- Developing RAG-enhanced Generative AI applications for Communication Standard Compliance Checks, ensuring interoperability of information.

Project Member **Jan '24 - Jun '24**
InSuRE Program
Project Funded by: National Security Agency (NSA)

- Simulated network scanning and covert channel communication in IPv6 on virtual machines with advanced encryption techniques.
- Collected and analyzed covert network traffic data using machine learning algorithms for multiclass classification tasks.

SKILLS

Programming Language: Python, C, C++, Java, JavaScript
Deep Learning Framework: Tensorflow, PyTorch, Keras, Skorch
ML Algorithms: SVM, Random Forest, XGBoost, DBScan, GMM
Deep Learning Frameworks: CNN, RNN, LSTM, ResNet, BERT, Llama, GPT, Claude, Mistral, RAG
AI Developer Platform: WandB, LangChain, Huggingface Inference API, LlamaIndex, Ollama
Cloud Platform: AWS
Parallel Processing: Cuda, MPI
Model Compression Techniques: Quantization, Pruning, Knowledge Distillation
Database Management System: ChromaDB, PostgreSQL, Pinecone, MongoDB
MLOps: Docker, Kubernetes, Git
Operating Systems: Windows, Kali, Ubuntu

RESEARCH EXPERIENCE

Search Engine Optimization using Topic Intelligence Management System *(Ongoing), funded by NSF-WISPER* [poster1] [poster2]

- Leveraging NLP and machine learning to enhance SEO with a topic intelligence management system.
- Utilized Semantic Deep Embedded Clustering and Google Ads API for topic clustering and popularity scoring, while multi-agent Generative AI was employed to dynamically generate domain dictionaries for importance scoring and detailed search result analysis.
- SDEC clustering improved text clustering accuracy by 4.37%, multi agent debate based query resolution system achieved 87% accuracy in NL2VIS task; the project was commercialized, resulting in a $500k sale.

AIRMS - An Artificial Intelligence Based Reputation Management System [poster]

- Developing an AI-driven system to analyze and score reputation based on social media interactions.
- BERT was used to process natural language data, combined with machine learning and social network analysis algorithms (K-shell decomposition, Eigenvector Centrality) to quantitatively assess reputation-affecting factors.
- Achieved a 5.8% improvement in accuracy, 26.9% improvement in balanced accuracy, and 21.8% improvement in F-score for the reputation polarity detection task.

RAG-Enhanced Generative AI for Communication Standards Compliance Verification *(Collaboration with Joint Interoperability Test Command (JITC)), funded by NSF-CAC*

- Developed an AI-based system utilizing Retrieval-Augmented Generation (RAG) and multi-agent debate to verify communication data compliance with government standards.
- Leveraged generative AI to automate the detection of semantic and compliance errors in Link 16 messages, enhancing the accuracy through a multi-agent debate approach.

SeVA: Senior Virtual Assistant for Healthcare *(Ongoing collaboration with Banner Medical Center)*

- *Developing SeVA (Senior Virtual Assistant) with integrated Generative AI specialized in senior nursing, enabling personalized care and proactive health monitoring.*
- *Implementing advanced feature extraction techniques utilizing information theory, statistical analysis, signal processing, and Poincaré plots to identify potential health risks and ensure comprehensive monitoring.*

Quantized Transformer Language Model Implementations on Edge Devices *[slides]*

- *Implementing quantized NLP models on edge devices to balance performance with model size and privacy.*
- *Applied TensorFlow Lite and mobileBERT for model conversion and quantization, significantly reducing model size.*
- *Successfully converted a BERT based NLP model to a 160x smaller size and deployed a resource-constrained edge device, demonstrating the feasibility of advanced NLP in low-power environments.*

PUBLICATIONS

M. W. U. Rahman, R. Nevarez, L. T. Mim & S. Hariri. Multi-Agent Actor-Critic Generative AI for Query Resolution and Analysis. (Accepted for Publication in *IEEE Transactions on Artificial Intelligence*)

M. W. U. Rahman, M. M. Abrar, S. Shao, P. Satam, S. Salehi, & S. Hariri, (2023, February). Quantized Transformer Language Model Implementations on Edge Devices. In *22nd Edition of International Conference on Machine Learning and Applications, 2023 (ICMLA)*.

M. W. U. Rahman, S. Shao, P. Satam, S. Hariri, C. Padilla, Z. Taylor & C. Nevarez, (2022, December). A BERT-based Deep Learning Approach for Reputation Analysis in Social Media. In *2022 IEEE/ACS 19th International Conference on Computer Systems and Applications (AICCSA) (pp. 1-8). IEEE*.

M. Wali-ur-Rahman, S. I. Ahmed, R. Ibne Hossain, T. Ahmed & J. Uddin, "Robotic Arm with Proximity and Color Detection", *2018 IEEE 7th International Conference on Power and Energy (PECon), Kuala Lumpur, Malaysia, 2018, pp. 322-326.*

M. W. U. Rahman, R. Nevarez, & S. Hariri. SDEC: Semantic Deep Embedded Clustering (Paper submitted in *IEEE Transactions on Knowledge & Data Engineering*)

SERVICES

Reviewer: ISQED, Cluster Computing Journal.

Mentor and Cybersecurity Experiment Designer: PACT Program.

REFERENCES

Dr. Salim Hariri
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Dr. Pratik Satam
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Ric Nevarez
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