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 in revision stages in *IEEE Transactions on Big Data*)

SERVICES

Reviewer: IEEE Communications Magazine, ISQED, Cluster Computing Journal, FGCS.

Mentor and Cybersecurity Experiment Designer: PACT Program.

REFERENCES

Dr. Salim Hariri
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