Umair Ahmad Mughal

Ph.D. Candidate
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Educational Background

Ph.D. in Computer Science and Engineering 2021-to date
Tennessee Technological University, Expected June 2024 Tennessee, USA

Master of Science in Electrical and Computer Engineering 2020
INHA University Incheon, South Korea

Bachelor of Science in Electrical Engineering 2015
University of Engineering and Technology Peshawar, Pakistan

Research Interests

- Intersection of Cybersecurity, machine learning, and Data Science
- Deep Machine learning for data analysis and security enhancement
- Cellular Vehicle-to-Everything (C-V2X) Technology

Professional Experience

Graduate Research Assistant 2021-to date
Cybersecurity Education, Research and Outreach Centre (CEROC) Tennessee, USA

- Performed penetration testing on an actual drone system by executing False data injection, Replay, Evil Twin, and DoS attacks to identify the critical attack vectors.
- Designed and built a robust intrusion detection system using Graph Neural Network, CNN, LSTM, FNN, SVM, Random Forest, and sequential and ensemble algorithms such as bagging, boosting, and stacking.
- Collected data from the actual drone swarm system under cyberattacks and normal operations. Preprocessed the raw data, performed fusion of different data sources, and open sourced this dataset on IEEE DataPort.
- Identification of applications security vulnerabilities such as cross-site scripting, SQL injection, and DDoS attacks.

Research Scientist 2020-2021
Oceanic IT Convergence Research Centre Asan, South Korea

- Data analysis of underwater acoustic communication using machine learning for link adaptation and throughput.
- Collected underwater acoustic data in the Incheon Sea over 1km and 3km distances between Tx and Rx.
- Designed algorithms for autonomous underwater vehicle's (AUV) and embedded them to the AUV.

Graduate Research Assistant 2018-2020
Mobile Telecommunication Research Laboratory Incheon, South Korea

- Developed cellular vehicle-to-everything (C-V2X) simulator according to 3GPP Rel. 14 & 15.
- V2X Side-link & PC5 Interface (V2V, V2I), 5G-NR, and DSRC communication in vehicular environments
- Simultaneous Localization and Mapping (SLAM) technology for UAVs

Lab Engineer 2016-2018
Qurtuba University of Sciences and Technology Pakistan

- EE-391: Communication Systems
- EE-493: Computer Networks
- EE-271: Object Oriented Programming & Data Structure in C++

Junior Operation Engineer 2015-2016
Master Tiles & Ceramic Industries Limited Pakistan

- Ladder Logic programming for PLC designing for Ceramic Plant operation.
- Worked closely in operation for overall control system.

BSS Intern Engineer June 2014 - September 2014
Alcatel-Lucent ltd. Pakistan

- Worked at BSS-CMPak project in Operation and Maintenance department.
- Implements modifications for the BTS sites.

Certifications

- Penetration Testing, Incident Response and Forensics, IBM Cybersecurity Analyst Professional Certificate (Coursera)
- Security Risks in AI and Machine Learning: Categorizing Attacks and Failure Modes (LinkedIn)
- Cisco Networking Foundations: Wireless Networks, Services, Security, and Virtualization (LinkedIn)
- Software Development for Unmanned System, Drone Programming (Udemy)
- Generative AI with Large Language Models (Coursera)
- GPT-4 Foundations: Building AI-powered Apps (LinkedIn)
- LangChain for LLM Application Development (Deeplearning.ai)

Teaching Experience

Teaching Assistant (at Tennessee Technological University, USA)

- CSC-2310: Object Oriented Programming/Design in Python (Spring 2023)
- CSC-3410: Computer Org/Assembly Language Programming (Spring 2023)
- CSC-3410: Computer Org/Assembly Language Programming (Fall 2022)
- CSC-2310: Object Oriented Programming/Design in Java (Summer 2022)

Teaching Assistant (at Inha University, Korea)

- ECE: Advanced Wireless Communications (Spring 2020)
- ECE: Circuit Analysis-II (Fall 2019)
- ECE: Circuit Analysis-I (Spring 2019)

Instructor (at Qurtuba University, Pakistan) (2016-2018)

- EE-391: Communication Systems
- EE-493: Computer Networks
- EE-271: Object Oriented Programming & Data Structure in C++

Advising and Mentoring

- **John Richeson (MSc Student, Current):** Developing Intrusion Detection System against the Evasion Attacks on a UAV, Department of Computer Science, Tennessee Technological University, TN, USA.

- **Mike Soare (MSc Student, Current):** Reinforcement Learning to Attack Leader Drone in a Swarm, Department of Computer Science, Tennessee Technological University, TN, USA.

- **Nafis Ahmed (MSc Student, 2020):** Path Planning of the Unmanned Aerial Vehicles, Department of Electrical and Computer Engineering, Inha University, Incheon, Korea.

Publications

Journal

1. **U. A. Mughal** and M. Ismail, " Architecture Independent Intrusion Detection System for Swarm of Unmanned Aerial Vehicles", in *IEEE Transactions on Intelligent Transportations Systems* (2024). (Under Review) (Soon on github)

2. **U. A. Mughal**, Y. Alkhrijah, A. Almadhor, C. Yuen, " Deep Learning for Secure UAV-Assisted RIS Communication Networks", *Internet of Thing Magazine* (2024).Link (Accepted/in-press) (Soon on github)

3. S. C. Hassler, **U. A. Mughal**, and M. Ismail, "Cyber-Physical Intrusion Detection System for Unmanned Aerial Vehicles", in *IEEE Transactions on Intelligent Transportation Systems* (2023).Link (IF: 8.5) (code)

4. **U. A. Mughal**, J. Xiao, I. Ahmad, and K. H. Chang, "Cooperative Resource Management for Cellular V2I Communications in a Dense Urban Environment", *Vehicular Communications* 26 (2020): 100282.Link (IF=6.7) (code)

5. R. Narmeen, I. Ahmad, Z. Kaleem, **U. A. Mughal**, "Shortest Propagation Delay-Based Relay Selection for Underwater Acoustic Sensor Networks", in *IEEE Access*, vol. 9, pp. 37923-37935 (2021).Link (IF= 3.9)

6. **U. A. Mughal** and K. H. Chang, "UAVs path planning by particle swarm optimization based on visual-SLAM algorithm", In Intelligent Unmanned Air Vehicles Communications for Public Safety Networks, pp. 169-197., *Springer Nature*, 2022.Link (code)

Conference

7. **U. A. Mughal**, I. Ahmad, and C. Yuen, "Ensemble Learning-Based Intrusion Detection System for RIS-Assisted V2X Communication", *2024 IEEE 99th Vehicular Technology Conference (VTC2024-Spring)*, Singapore. (Under Review) (Soon on github)

8. **U. A. Mughal**, M. Ismail and S. A. A. Rizvi, "Stealthy False Data Injection Attack on Unmanned Aerial Vehicles with Partial Knowledge", *2023 IEEE Conference on Communications and Network Security (CNS)*, Orlando, FL, USA, 2023, pp.1-9.Link (code)

9. **U. A. Mughal**, S. C. Hassler and M. Ismail, "Machine Learning-Based Intrusion Detection for Swarm of Unmanned Aerial Vehicles", *2023 IEEE Conference on Communications and Network Security (CNS)*, Orlando, FL, USA, 2023, pp. 1-9.Link (code)

10. Nafis Ahmad, **U. A. Mughal**, and KyungHi Chang, "3D Path Planning of Unmanned Aerial Vehicles", *in Proc. KICS*, Feb. 2020.Link

11. **U. A. Mughal**, I. Ahmad, and K. H. Chang, "Cellular V2X communications in unlicensed spectrum: Compatible coexistence with VANET in 5G systems", *in Proc. JCCI 2019: 29th Joint Communication and Information Conference*, May 2019.Link

12. **U. A. Mughal**, I. Ahmad, and K.H. Chang, "Virtual cells operation for 5G V2X communications", *in Proc. KICS*, Feb. 2019.Link

Product and Simulator

- **Developed C-V2X Simulator and delivers to Korea's MSIT (Ministry of Science, Information, and Technology)** Performance Analysis System Level Simulator in LTE-V2X Network Environment", *INHA University Industry-Academia Cooperation Foundation*, Program No. C-2019-024785, 2019-09-05. (simulator code)

- **Developed Link Adaptation Simulator and handed over to the Oceanic IT Convergence Research Centre, Korea** System Level Simulator for Link-Adaptation for Next-Generation Underwater Acoustic Communications Networks. (simulator code)

- **Developed Dataset executing cyber-attacks on an actual drone system and published it open sourced.**
  Cyber-Physical Dataset for UAVs Under Normal Operations and Cyber-attacks [Download on IEEE DataPort] (github)

Skills

- Tools/software: MATLAB, Keras, TensorFlow, Scikit-learn, Pandas, Scapy, Docker, Git, Aircrack-ng, Nmap, Wireshark, Metasploit, kali linux, Jupyter notebook, VS Code, VS studio, Ardupilot, Arduino, and Q-Groundcontrol.
- Programming Languages: Proficient in Python, Assembly, Shell Scripting, Java, and C/C++.
- Cybersecurity Practices: Threat Modeling, Intrusion Analysis, Penetration Testing, Forensics, Identity and Access Management (IAM), Cloud Security, and Malware Analysis.

Honors and Awards

- Awarded with travel fund from Centre for Energy Systems Research (CESR),Tennessee Tech University, 2023
- Awarded with travel fund from College of Engineering, Tennessee Tech University, 2023
- Recipient of the Jungseok International Scholarship to pursue M.S. Studies at Inha University, Korea.
- Awarded with Fully funded Undergraduate Studies from Provincial Govt., under the KPK Govt. Talent Hunt Programs.
- Awarded with Laptop for best performance from the Provincial Chief Minister KPK, Ameer Haider Khan Hoti.
- Member Pakistan Engineering Council, Accreditation No. ELECT/52138.

Services and Activities

Reviewer

- Reviewer, Vehicular Communication, Elsevier Journal
- Reviewer, IEEE Networking Letters
- Reviewer, IEEE Internet of Things (IoT) Journal & Magazine (IoTM)

Other Services

- Leading Graduate and Undergraduate students' teams for 2024 Cybersecurity Competition which is to be in summer 2024.
- Vice President of the Computer Science Graduate Student Club, Tennessee Tech University. 2022 – Present
- Member of the Autonomous Vehicle Club, Tennessee Tech University. 2022 – Present
- Ambassador for the International Graduate Students, Inha University. South Korea, 2020
- Committee member of the International Student Lounge, Inha University. South Korea, 2020

Talks and Meetings

- Stealthy False Data Injection Attack on Unmanned Aerial Vehicles — November 2023
  Computer Science Graduate Student Seminar, *Tennessee Technological University* — TN, USA
- Machine Learning-Based Intrusion Detection for Swarm of Unmanned Aerial Vehicles — October 2023
  IEEE Communications and Network Security Conference — FL, USA
- Stealthy False Data Injection Attack on Unmanned Aerial Vehicles with Partial Knowledge — October 2023
  IEEE Communications and Network Security Conference — FL, USA
- Invited Talk: Adversarial attacks on a drone Swarm with practical Demo — October 2023
  CEROC Advisory Board Committee, *Tennessee Technological University* — *TN, USA*
- Vulnerabilities and Drone Hijacking Demo — September 2022
  Cyber Discovery Day, *Tennessee Technological University* — TN, USA
- Technologies and use cases for Cellular Vehicle-to-Everything (C-V2X) — April 2020
  Korea Telecom (KT) Corporation Research Centre — Seoul, Korea
- 5G-V2X for Intelligent Transportation Systems — February 2020
  Workshop, *Seoul National University* — Seoul, Korea
- 5G-V2X for Intelligent Transportation Systems — November 2019
  Information Technology Research Center (ITRC), *Ministry of Information Science and Technology* — Incheon, Korea
- Cellular V2X communications in unlicensed spectrum: Compatible coexistence with VANET in 5G systems — May 2019
  29th Joint Communication and Information Conference — Gangneung, Korea
- Virtual cells operation for 5G-V2X communications — February 2019
  Korea Communications Society Winter Conference — Yongpyeong, Korea

References

- **Muhammad Ismail,** (PhD. Advisor)
  Associate Professor of Computer Science Department
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- **Gerald Gannod**
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  Tennessee Technological University
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