MD GOLAM SARWAR MURSHED

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SUMMARY

I have expertise in both fundamental and applied AI/ML research with a focus on developing efficient and scalable deep learning systems. With a strong publication record, 5 years of industrial experience at Samsung R&D, and expertise in resource-aware deep learning, I have successfully applied my deep learning skills to robotics and biometrics domains. Notable accomplishments include developing CRFSEG algorithms for fingerprint segmentation, authentication, and template security, as well as developing EdgeLite resource-aware deep learning models for resource-constrained onboard devices.

ACADEMIC EMPLOYMENT

Assistant Professor, Computer Science **August 2023 -**
University of Wisconsin-Green Bay

EDUCATION

Clarkson University, Potsdam, New York **July 2023 (expected)**

- **Doctor of Philosophy (Ongoing)**, Department of Electrical and Computer Engineering
- Dissertation: Efficient Deep Learning in resource-constrained settings

Clarkson University, New York **Aug 2018 - Aug 2020**

- **Master of Science**, Department of Electrical Engineering
- Research Topic: Machine Learning at the network edge

Chittagong University of Engineering & Technology, Chittagong, Bangladesh **Mar 2009 - Sep 2013**

- **Bachelor of Sciences (Honours)**, Department of Computer Science & Engineering
- Thesis: Web-page Classification through Text Summarization.

RESEARCH INTERESTS

- Machine Learning, Deep Learning, Computer Vision, Biometrics, Software Engineering, Edge Computing, Cybersecurity

BOOK CHAPTERS

1. M. G. Sarwar Murshed, James J. Carroll, Nazar Khan, and Faraz Hussain, "Efficient deployment of deep learning models on autonomous robots in the ROS environment", Springer, Advances in Intelligent Systems and Computing, 2022, https://doi.org/10.1007/978-981-16-3357-7_9.
2. Edward Verenich, M. G. Sarwar Murshed, Nazar Khan, Alvaro Velasquez, and Faraz Hussain, "Mitigating the Class Overlap Problem in Discriminative Localization: COVID-19 and Pneumonia Case Study", Springer, Explainable AI Within the Digital Transformation and Cyber-Physical Systems, 08 May 2021, https://doi.org/10.1007/978-3-030-76409-8_7.

JOURNALS AND CONFERENCES

Google Scholar statistics total of **290** citations as of July 21st, 2023.

1. M.G. Sarwar Murshed, Keivan Bahmani, Stephanie Schuckers, Faraz Hussain, "Deep Age-Invariant Fingerprint Segmentation System", arXiv, 2023, https://arxiv.org/abs/2303.03341.

2. M. G. Sarwar Murshed, S. M. Safayet. Hossain, Aksel Seitllari, Kibria K. Roman, "A vision-based system for road crack detection using hybrid deep learning architecture", ASCE International Conference on Transportation & Development, 2023.

3. M. G. Sarwar Murshed, R. Kline, K. Bahmani, F. Hussain, and S. Schuckers, "Deep Slap Fingerprint Segmentation for Juveniles and Adults", 2021 IEEE International Conference on Consumer Electronics-Asia (ICCE-Asia), 2021, pp. 1-4, https://doi.org/10.1109/ICCE-Asia53811.2021.9641980.

4. M. G. Sarwar Murshed, C. Murphy, D. Hou, N. Khan, G. Ananthanarayanan, and F. Hussain, "Machine Learning at the Network Edge: A Survey", ACM Computing Surveys, vol. 54, no. 8, Oct. 2021. https://doi.org/10.1145/3469029.

5. M. G. Sarwar Murshed, J. J. Carroll, N. Khan, and F. Hussain, "Resource-aware On-device Deep Learning for Supermarket Hazard Detection", 2020 19th IEEE International Conference on Machine Learning and Applications (ICMLA), 2020, pp. 871-876, https://doi.org/10.1109/ICMLA51294.2020.00142.

6. B. Zhang, M. G. S. Murshed, F. Hussain, and R. Ewetz, "Fast Resilient-Aware Data Layout Organization for Resistive Computing Systems", 2020 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), 2020, pp. 72-77, https://doi.org/10.1109/ISVLSI49217.2020.00023.

7. E. Verenich, A. Velasquez, M.G. Sarwar Murshed, F. Hussain, "FlexServe: Deployment of PyTorch Models as Flexible REST Endpoints", 2020 USENIX Conference on Operational Machine Learning (OpML 2020), https://www.usenix.org/conference/opml20/presentation/verenich

8. M.G. Sarwar Murshed, E. Verenich, C. Gende, J. J. Carroll, N. Khan, and F. Hussain, "Hazard Detection in Supermarkets using Deep Learning on the Edge", 3rd USENIX Workshop on Hot Topics in Edge Computing (HotEdge 2020) [poster]

9. E. Verenich, A. Velasquez, M.G. Sarwar Murshed, and F. Hussain, "The Utility of Feature Reuse: Transfer Learning in Data-Starved Regimes", https://arxiv.org/abs/2003.04117

SOFTWARE SKILL HIGHLIGHTS

- **Languages:** Python, C, C++, JAVA, UNIX Shell Scripting
- **AI frameworks:** TensorFlow, PyTorch, Keras, Detectron2
- **Data analysis tools:** NumPy, Pandas, Matplotlib, Seaborn, Sklearn
- **Cloud platform:** AWS
- **Version control system:** Git
- **Project management:** JIRA, Agile Project Management System
- **Build automation tools:** SCons, Gradle, Maven, Ant
- **Productivity tools:** Microsoft Office, Google Suite, Slack, Zoom, Asana
- **Soft skills:** Leadership, Communication, Presentation, Teamwork, Business acumen, Creativity, Innovation

RESEARCH EXPERIENCE

Oriented bounding boxes for precise object detection

- Developed an advanced Oriented Regional Proposal Network (O-RPN) for precise localization of rotated objects.
- Achieved a Mean Absolute Error (MAE) value of 18 pixels in precise object localization within a dataset of 133k images through the integration of O-RPN into Faster R-CNN, surpassing the performance of both the NFSEG model (186 pixels) and Verifinger (31 pixels).
- Reduced angle prediction error by 26 degrees compared to NFSEG and 3 degrees compared to Verifinger by applying O-RPN, showcasing the effectiveness of the implemented approach.

Deep learning-based slap fingerprint segmentation and matching

- Developed the CRFSEG (Clarkson Rotated Fingerprint Segmentation) model utilizing the O-RPN and Mask R-CNN architecture for accurate segmentation of slap fingerprints.
- Attained fingerprint matching accuracy of 97.17% across 414 thousand adult and juvenile fingerprints, by utilizing the robust and age-invariant CRFSEG model, surpassing NIST NFSEG (80%) and VeriFinger (94%).

– Fine-tuned the CRFSEG model for accurate segmentation of fingerprints from contactless finger photos captured at a distance, eliminating the necessity of physical contact with a fingerprint scanner.

EdgeLight model, a small deep network for resource-constrained devices

– Developed lightweight deep learning model, EdgeLite, for supermarket safety, utilizing pruning and compression.
– EdgeLite outperformed other state-of-the-art models by achieving 92.37% accuracy in the grocery hazard dataset, while demonstrating comparable energy consumption, memory usage, and inference time, making it practical for resource-constrained hardware deployment.

Resource-aware deep learning on ROS (Robot Operating System) environment

– Developed EasyDLROS, an open-source framework for the deployment of pre-trained deep learning models on autonomous robots, addressing challenges in integrating hardware and models within ROS.
– Successfully deployed and evaluated seven pre-trained deep learning models for hazard detection on supermarket floors using EasyDLROS in a simulated environment, demonstrating the effectiveness of EasyDLROS.

Enhancing explainability of DL Models for Overlapping Classes through Discriminative Localization

– Introduced a method to improve Class Activation Maps (CAMs) for overlapping classes, enhancing the accuracy of explainability by computing directed differences in scaled activation and precisely visualizing important regions.
– Utilized this method to improve early detection and diagnosis of COVID-19 and pneumonia.
– Developed a visualization technique that accurately delineates spatial regions in an image, highlighting the most relevant areas for classification even when CAMs for multiple classes exhibit significant overlap due to shared features.

Fingerprint Template Security: Universal enrollment using biometric PKI

– Developed new metrics to assess the security of stored biometric templates in collaboration with Verizon Inc.
– Improved the accuracy of Verizon's biometric PKI software up to 20% by addressing challenges such as incomplete images and non-dynamic algorithm parameters.
– Implemented a fully homomorphic encryption (FHE) system for biometric template protection.

Road health assessment using deep learning

– Developed deep learning models for precise detection, classification, quantification, and segmentation of road cracks in real-world images.

Samsung Iotivity, recommendation system, and S Health project

– Improved a machine learning technique (K-means) to categorize apps for user recommendations.
– Designed and developed the Device to Device (D2D) communication, cloud communication, and security test system of the IoTivity framework.
– Designed, and implemented the build system of the IoTivity test project.

TEACHING EXPERIENCE

- Fall 2019: Teaching Assistant for EE 262: Introduction to Object-Oriented Programming and Software Design at Clarkson University
- Spring 2019: Teaching Assistant for EE 260/360: Embedded Systems/Microprocessors at Clarkson University
- Fall 2018: Teaching Assistant for EE 262: Introduction to Object-Oriented Programming and Software Design at Clarkson University

INDUSTRIAL EXPERIENCE

Lead Engineer **September 2013 - July 2018**
Samsung R&D Institute, Bangladesh
Project: IoTivity (www.IoTivity.org - An open Linux Foundation Project for the Internet of Things)

- Designed and developed the build systems for the IoTivity framework

- Developed different APIs for the Iotivity and Samsung SHealth framework
- Evaluated the performance of Device to Device (D2D) Communication, Cloud Communication, and Security system of the IoTivity project
- Designed and developed background API for IoT automatic test software, different web application, and robot automation test cases
- Developed test app (C++, Java) based on IoTivity device communication and security protocol
- Designed and implemented auto code coverage framework for quality assurance of IoTivity project
- Designed and implemented memory leak tools for the IoTivity project

Research Collaborator **Fall 2020 - Present**
Verizon wireless

- Developing deep learning-based biometrics recognition and template protection systems for multiple modalities including face, finger, and iris.
- Deploying Fully Homomorphic Encryption (FHE) on biometric template protection systems

STUDENT MENTORSHIP

- Rashik Shadman (Ph.D.), Syed Konain Abbas (Ph.D.), Afzal Hossain (Ph.D.), Conrad Gende (Undergrad)

ACADEMIC SERVICES

- Reviewer of AI Conferences and Journals: Journal of Network and Computer Applications(JNCA) 2022, IEEE International conference on web services(ICWS) 2022, Joint International Conference on Data Science & Management of data (CODS-COMAD) 2021, IEEE SERVICES 2021
- Graduate researcher at Center for Identification Technology Research - CITeR
- Collaborating: Verizon wireless and Badger Technologies as a research assistance

INTERNSHIP EXPERIENCE

Badger Technologies
July 2020- August 2020
Working Area: Deep learning on autonomous robots in the ROS environment.

Semicon PVT. LTD
January 2013-February 2013
Working Area: Mobile App Development, IT system Management.

RESEARCH GRANTS

I contributed to writing proposals in response to a variety of funding opportunities.
Current Research

1. **Robust Contactless Fingerprint Processing Tool**
   - PI Name: Faraz Hussain, Daqing Hou
   - Name of Funding Organization: CITeR
   - Date: 15 May 2022
   - Period of Grant Award: 1 Year
   - Title of Project: Robust Contactless Fingerprint Processing Tool
   - Role on Project: Wrote the proposal, developed software to complete the preliminary experiments and generated preliminary results, and will complete all milestones proposed in the proposal through collaboration with PIs.
2. **Fingerprint image segmentation using deep learning**
   - PI Name: Faraz Hussain, Stephanie Schuckers
   - Name of Funding Organization: CITeR

- Date: 15 January 2021
- Period of Grant Award: 2 Years
- Title of Project: Fingerprint Segmentation for Juveniles and Adults
- Role on Project: Wrote the proposal, developed software to complete the preliminary experiments and generated preliminary results through collaboration with another student, and will complete all milestones proposed in the proposal by collaborating with PIs and students.

Completed Research

1. **Fingerprint template security**

   - PI Name: Stephanie Schuckers, Faraz Hussain, Mahesh Banavar, Chen Liu
   - Name of Funding Organization: Verizon wireless
   - Date: 15 May 2020
   - Period of Grant Award: 2 Year
   - Title of Project: Fingerprint Template Security: Enabling Cloud-Based Biometric Solutions through High Performance, Secure Matching
   - Role on Project: Wrote the proposal, completed all milestones proposed in the proposal through collaboration with PIs, and helped to write an extension of the proposal.

2. **Evaluate and test Robot Operating System (ROS) of the Marty Robot**

   - PI Name: Faraz Hussain, James Carroll
   - Name of Funding Organization: Badger Technologies
   - Date: 1 March 2020
   - Period of Grant Award: 1 Year
   - Title of Project: Evaluate and test the performance of ROS-based OS system for the Marty Robot
   - Role on Project: Developed software to complete the preliminary experiments and generated preliminary results, and completed all milestones set for this project through collaboration with PIs and students.

AWARDS AND HONORS

Professional and Academic

- Achieved Advanced Level in Software Capability Test arranged by Samsung Electronics Co Ltd.
- Achieved top 20% annual performance evaluation grade in 2 consecutive years 2014 & 2015 at Samsung Electronics Co Ltd
- University Merit Scholarship: Each year of Undergraduate Level, Chittagong University of Engineering and Technology, 2009-2013, Bangladesh

Programming

- Samsung internal programming contest- got an advanced level
- Inter-university programming contest(Chittagong Zone) - runner up
- Inter department programming contest (CUET) – runner up

LEADERSHIP AND VOLUNTARY ACTIVITIES

- Lead Engineer, Samsung R&D Institute of Bangladesh, IoTivty Group
- President, Bangladeshi Students' Association at Clarkson University
- Organized inter-university Programming contest in CUET, 2012

LANGUAGE SKILL

English (Full professional proficiency), Bengali (Native)

REFERENCES

Faraz Hussain, Assistant Professor, ECE, Clarkson University, Email: fhussain@clarkson.edu, Phone: 315/268-806