Fabiha Bushra

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Research Interests: AI Robotics, Deep Reinforcement Learning, Human-Robot Interaction, Computer Vision, Natural Language Processing

Education

Bachelor of Science in Electrical and Electronic Engineering *Dhaka, Bangladesh*
University of Dhaka *Apr 2022*

- **Cumulative CGPA:** 3.50/4.00
- **Major:** Computer , **Minor:** Communication

Research Manuscript

- [Under Review] **Bushra, F.**, Chowdhury, M. E. H., Sarmun, R., Kabir, S., Said, M., Zoghoul, S. B., Mushtak, A., Al-Hashimi, I., Alqahtani, A., Hasan, A. *Deep Learning in Computed Tomography Pulmonary Angiography Imaging: A Dual-Pronged Approach for Pulmonary Embolism Detection*. Expert Systems With Applications. [Submitted: 13 Sep 2023]

  Preprint available at: [arXiv:2311.05197]

Research Experience

Multimodal Semantic Image Segmentation with Hybrid Transformer as Encoder *Sep 2023-Present*
Continuing Research, In collaboration with Dr. Muhammad E. H. Chowdhury, Funded by Qatar University

- In this study, we utilize the **U-net** architecture for segmenting multimodal brain tumor MRI images. Our research direction focuses on the integration of Self-organized Operational Neural Networks (Self-ONNs) as decoder with **hybrid CNN-transformer** encoder.
- Our approach replaces traditional CNN layers with Self-ONN blocks in the decoder design, introducing network heterogeneity essential for extracting complex features in medical imagery. Further research is being conducted to assess the potential of incorporating Self-ONNs in the encoder design as well.
- The transformer-based encoder, with its innate global self-attention mechanisms, encodes tokenized image patches from CNN feature maps to capture **long-range contextual information**, while the Self-ONN decoder upsamples these features and integrates them with high-resolution CNN feature maps for leveraging low-level details.

Classifier-guided Detection using Deep Learning *Feb-Jul 2023*
In collaboration with Dr. Muhammad E. H. Chowdhury, Funded by Qatar University

- For the classification framework, a deep learning-based approach was proposed that leverages **local context** by utilizing an **attention mechanism** for improved diagnosis of Pulmonary Embolism (PE). This framework emulates the attention of a human expert by considering both global appearances and local lesion regions before forming a conclusive decision.
- Demonstrated major improvements over baseline models by incorporating the attention method on the classification framework; **improving AUROC by 8.1%** on a publicly available CTA dataset of PE.
- For the detection framework, "EfficientDet", "Faster R-CNN", and "YOLO" models were employed to localize PE. The mAP was further **improved by a 4.7%** increase through the implementation of model ensembling.
- To mitigate the false positives associated with the detection framework's high sensitivity, a post-processing step was employed utilizing the classifier's probabilistic inference to direct the detection outcomes. This approach optimized the precision-recall trade-off, fine-tuning detection performance based on adaptive confidence thresholds.

  Preprint available at: [arXiv:2311.05197]

Detection of Supermarket Products for a Batch-Billing Infrastructure *Sep 2021-Feb 2022*
Senior Thesis

- A computer vision-based billing system was proposed to expedite supermarket's checkout process by detecting and processing multiple products in real-time, contrasting with the traditional barcode scanning.
- A **two-tiered** approach, combining deep learning-based **object detection** with deterministic **pattern recognition**, was implemented to handle both weight-independent and weight-based products. To achieve real-time performance with an emphasis on minimizing billing latency, the YOLO architecture was chosen for its single-stage detection.
- Standard pre-packaged goods are immediately detected and billed at fixed prices, while weight-based products undergo a two-phase processing: initial detection by YOLO followed by **hybrid ArUco marker** decoding step to extract product ID and weight for dynamic price calculation.
- The detection models, trained on our custom-made dataset of 26 product categories sourced through **web scraping** were optimized with **synthetic image augmentation**, **genetic algorithm-based hyperparameter evolution**, and **ensembling** methods. The PyQt5 framework was used to create a **GUI-based interface** for the billing system.

  Github Repository: **github.com/fabihabushra/Computer_vision_based_check_out_system**

Datasoft Manufacturing & Assembly Inc. Limited - DMA *April-Dec 2021*
IoT Engineer, Research and Development Department

- **Telemedicine Project:** Developed the prototype of an **IoT-enabled** Blood Pressure Monitor that interfaces with a telemedicine platform, allowing for remote patient health monitoring by physicians during the COVID-19 pandemic.
- **Pisciculture Project:** Worked on developing an **IoT infrastructure** to continuously monitor and report aquaculture pond parameters, facilitating real-time data-driven decisions for pond management and worker notification.

Fabrication Laboratory, University of Dhaka (FAB LAB DU) *2018-19*
Undergraduate Research Assistant

- **Pet Robot:** Developed the **CAD model** for **robot locomotion** and **manipulation** using SOLIDWORKS. The **manipulator end effector** was designed in conjunction with the base chassis to enable the pet robot to fetch a ball.
- **Bipedal Robot:** Developed the **CAD model** and **simulation** of a **bipedal robot**.

Projects

AVR-Microcontroller Based Obstacle Avoiding and Line Follower Robot *2019*
Pre-programmed Robot, Independent Project

- An **AVR-Microcontroller** (Atmega32A) based robot was developed capable of following a black line on a white ground (or inverted colors) and avoiding obstacles in its path. **Sensorimotor skills** were developed by integrating IR sensors for environmental detection, enabling the robot with **autonomous navigation**.
- The primary circuit board and IR sensor module of the robot was simulated and custom-designed using **Proteus** and the CAD model was developed on **SOLIDWORKS**.

Object Pick-and-Place Robot *2019*
Pre-programmed Robot, Independent Project

- A pick-and-place robot was developed capable of detecting the color of the cube passing over a conveyor belt using the TCS3200 color sensor. The manipulator was finely tuned for **sensorimotor coordination**, allowing for **object sorting** by color.

Teleoperated Robot *2018*
Pre-programmed Robot, Independent Project

- A remote-controlled robot, tailored for the Robo Soccer contest, incorporated a NRF24L01 WiFi module for **wireless communication**. The robot's control mechanism was developed with a dual-axis locomotion system, integrating **sensorimotor synchronization** for real-time maneuvering.

Maze Solver Robot *2018*
Pre-programmed Robot, Independent Project

- Implemented the **recursive backtracking algorithm** on a line-following robot to solve mazes. The algorithm prioritized left-forward-right directional moves, enabling the robot to navigate mazes while incorporating **sensorimotor feedback** for decision-making processes.

Relevant Academic Coursework

Intelligent System	Linear Algebra	Statistics and Probability
Differential and Integral Calculus	Vector Analysis	Differential Equations
Control System	Signals and Systems	Numerical Technique Lab

Online Coursework

Coursera	**Institution**
Unsupervised Learning, Recommenders, Reinforcement Learning	Stanford University & DeepLearning.AI
DeepLearning.AI TensorFlow Developer Specialization	DeepLearning.AI
Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning	DeepLearning.AI
Convolutional Neural Networks in TensorFlow	DeepLearning.AI
Natural Language Processing in TensorFlow	DeepLearning.AI
Sequences, Time Series and Prediction	DeepLearning.AI

Research Grants

High Impact Grant (HIG)# QUHI-CENG-22/23-548 *2023*
Qatar University

- The grant supports my research on the development of deep learning-based algorithms for segmentations of brain tumors in medical images to enhance diagnostic precision and treatment planning.

High Impact Grant (HIG)# QUHI-CENG-23/24-216 *2023*
Qatar University

- The grant was conferred for my research on the development of innovative AI algorithms aimed at enhancing the diagnosis of Pulmonary Embolism through medical image analysis.

Mentorship & Volunteering Experience

IEEE Student Branch University of Dhaka *2018-19*
Executive Member

- As an executive member, the key responsibilities included formulating and organizing workshop training, seminars and talks.
- Created web contents for the educational events with the goal of inspiring students for active participation and growing their interests.

Fabrication Laboratory, University of Dhaka (FAB LAB DU) *2018-19*
Undergraduate Research Assistant

- Conducted foundational training workshops for mentoring students in the use of essential software and tools related to fabrication processes.

Relevant Skills

Programming Languages	Python, C, C++, MATLAB, MySQL, HTML, Assembly Language
Software & Tools	PyTorch, Tensorflow, SOLIDWORKS, Proteus (Circuit Simulation and Prototyping, PCB Design)
Development Boards	NodeMCU - ESP32,ESP8266; AVR MCU - ATmega328, ATmega328P, ATmega2560

Honors & Awards

2019

- Finalist, LFR Challenge, Techsurgence, Bangladesh University of Professionals — Dhaka, Bangladesh
- Participant, Industrial Automation Challenge, ROBO CARNIVAL, BUET — Dhaka, Bangladesh

2018

- **Champion**, Robo F1 Contest, Technovation, North South University — Dhaka, Bangladesh
- **Champion**, Robotics Contest, National Science Carnival, DRMC — Dhaka, Bangladesh
- 2nd Runner Up, Death Race Contest, ROBO FIESTA, BUET — Dhaka, Bangladesh
- Finalist, SeeGuider Contest, ROBOLUTION, MIST — Dhaka, Bangladesh
- Participant, LFR Challenge, Mecceleration, Islamic University of Technology — Gazipur, Bangladesh

2017

- **Champion**, Robo-Race Contest, DUSS Science Festival, University of Dhaka — Dhaka, Bangladesh
- Finalist, THE FURY ROAD Contest, Robofest, University of Dhaka — Dhaka, Bangladesh
- Finalist, LFR Challenge, Mecceleration, Islamic University of Technology — Gazipur, Bangladesh
- Participant, PathFinder Contest, ROBO CARNIVAL, BUET — Dhaka, Bangladesh
- Participant, Robomania V4.0, ESONANCE, Islamic University of Technology — Gazipur, Bangladesh
- Participant, Robo soccer/Robo wrestling Contest, Bit Arena V.2, North South University — Dhaka, Bangladesh
- Participant, Speed Battle Contest, DUET-TECHFEST, DUET — Dhaka, Bangladesh
- Participant, Poster Presentation, ROBOLUTION, MIST — Dhaka, Bangladesh
- Participant, Bangladesh Electronics Olympiad, University of Dhaka — Dhaka, Bangladesh