Curriculum vitae

## PERSONAL INFORMATION

# Fakrul Islam Tushar

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- $R^G$ https://www.researchgate.net/profile/Fakrul_Islam_Tushar

## EDUCATION & INTERNSHIP

**15/10/2019-Present**

### Research Associate
### Carl E. Ravin Advanced Imaging Laboratories (RAI Labs), Duke Radiology, Duke University Medical Center

Primarily engaged in research, computer-aided diagnosis and healthcare innovation using machine learning, neural networks, and image analysis driven solutions.

**Current Projects:** 1) Exploring the limits of weak supervision for medical imaging data.
2) Developing a universal disease classifier using body CT.
3) 3D dense segmentation based fusion network for weakly-supervised multi-label classification of chest-CT.
4) Classification of radiology reports using CNN.
5) Classification of DCIS using different institutional data.

**1/09/2017–30/06/2019**

### ERASMUS+ Joint Master Program in Medical Imaging and Applications

University of Burgundy (France), University of Cassino and Southern Lazio (Italy), University of Girona (Spain), Duke University (USA).

- **Earned 30 ECTS at University of Burgundy (first semester)** included courses Medical Sensors, Image processing, Digital Signal Processing, Software Engineering and Applied Mathematics.

- Projects: 1) Quantification of trabeculae inside the heart from MRI using fractal analysis.
2) Content aware image resizing using seam carving.

- **Earned 30 ECTS at University of Cassino and Southern Lazio (second semester)** included courses Pattern Recognition, Advanced Image Processing, Software Engineering, Medical robotics, Parallel processing, and Distributed Programming.

- Projects: 1) Implementation of reusable module for skin lesion segmentation.
2) Cyclical learning rates for training CNN with unbalanced datasets.

- **Earned 30 ECTS at University of Girona (third semester)** included courses Medical Registration and applications, Medical Image Segmentation and applications, Computer aided surgery and medical robotics, Computer aided Diagnosis, and E-health.

- Projects: 1) Automatic brain tissue segmentation using 3D CNN.
2) Skin lesion classification and segmentation using CNN.

- **Department of Radiology, Division of Carl E. Ravin Advanced Imaging Laboratories, Duke University Medical Center (master thesis).**

Master thesis: Weakly supervised multi-organ multi-disease classification of body CT scans.

- **CGPA: 7.96 on a scale of 10.**

**23/07/2018–09/09/2018**

### Summer Internship

Department of Radiology, Division of Carl E. Ravin Advanced Imaging Laboratories, Duke University Medical Center

- **Projects:** 1) Image Registration as data augmentation for XCAT.
2) Classification of chest CT using case-level weak supervision in 2D.

**11/01/2013–30/09/2016**

### BSc in Electrical and Electronic Engineering

American International University Bangladesh (AIUB), Dhaka (Bangladesh)

- Earned 145 credit included elective in "Biomedical Instrumentation Measurement and Design" and "Power system Protection".
- Undergraduate project title**:** Development of a multichannel modular universal biopotential amplifier trainer (RTR Module).
- **CGPA: 3.82 on a scale of 4.**

## PUBLICATIONS

- **F.I. Tushar** *et al.,* "Weakly Supervised Multi-Organ Multi-Disease Classification of Body CT Scans," *arXiv* preprint, *arXiv*: 2008.01158, 2020.
- **F. I. Tushar**, B. Alyafi, M. K. Hasan and L. Dahal, "Brain Tissue Segmentation Using NeuroNet With Different Pre-processing Techniques," *2019 Joint 8th International Conference on Informatics, Electronics & Vision (ICIEV) and 2019 3rd International Conference on Imaging, Vision & Pattern Recognition (icIVPR)*, Spokane, WA, USA, 2019, pp. 223-227, doi: 10.1109/ICIEV.2019.8858515.
- *A. Saha, ***F. I. Tushar***, K. Faryna, V. M. D'Anniballe, R. Hou, M. A. Mazurowski, G. D. Rubin M.D., J. Y. Lo, "Weakly supervised 3D classification of chest CT using aggregated multi-resolution deep segmentation features." *Proc. SPIE 11314, Medical Imaging 2020: Computer-Aided Diagnosis*, 1131408, 2020. **(* Author with equal contribution)**
- K. Faryna, **F. I. Tushar**, V. M. D'Anniballe, R. Hou, G. D. Rubin M.D., J. Y. Lo, "Attention-guided classification of abnormalities in semi-structured computed tomography reports." *Proc. SPIE 11314, Medical Imaging 2020: Computer-Aided Diagnosis*, 113141P, 2020.
- R. Tang, **F. I. Tushar**, S. Han, R. Hou, G. D. Rubin, J. Y. Lo, "Classification of chest CT using case-level weak supervision," Proc. SPIE 10950, Medical Imaging 2019: Computer-Aided Diagnosis, 1095017 (13 March 2019); doi: 10.1117/12.2513576
- M. K. Hasan, L. Dahal, P. N. Samarakoon**, F. I. Tushar**, R. Martí, "DSNet: Automatic dermoscopic skin lesion segmentation.", *Computers in Biology and Medicine*, Vol. 120, 2020, 103738, ISSN 0010-4825.
- S. I. Khan, **F. I. Tushar**, M. A. I. Rokan, R. Chowdhury, "Development of a Modular Biopotential Amplifier Trainer for Biomedical Instrumentation Laboratory Experiments.", *Science Journal of Circuits, Systems and Signal Processing,* Vol. 7, No. 2, 2018, pp. 48-59. doi: 10.11648/j.cssp.20180702.12.

## RESEARCH EXPERIENCE

## Carl E. Ravin Advanced Imaging Laboratories, Duke University Medical Center (Master Thesis)

| 11/03/2019-26/07/2019 | **Weakly-supervised multi-organ multi-disease classification of body CT scans.** |
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- In this project, our goal was to investigate using only case-level labels extracted automatically from radiology reports to construct a multi-organ, multi-disease classifier for CT scans with deep learning method.
- We proposed a rule-based algorithm that can extract case-level labels from the unstructured CT reports. We hypothesize this as process of weak supervision and classification model will learn disease patterns from these case-level labels.
- For segmentation, we have trained a segmentation model in semi supervised manner with ground truth label and pseudo labels for unannotated data, to be able to segment the thorax of a chest CT in diseased scenario. This segmentation step supports the navigation of the targeted organ in the classification task.
- We developed weakly supervised 3D multi-disease classifiers for lungs, liver and kidneys. Our weak supervision is based only on the radiology reports using the rule-based model, without requiring human experts to ever look at any images.
- **Preprint:** https://arxiv.org/abs/2008.01158
- **Code:** 3D Segmentation Module: https://github.com/fitushar/DenseVNet3D_Chest_Abdomen_Pelvis_Segmentation_tf2
  All models' weights and code will be made publicly available upon publication (https://gitlab.oit.duke.edu/railabs).

| 11/03/2019-26/07/2019 | **Weakly supervised 3D classification of chest CT using aggregated multi-resolution deep segmentation features.** |
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- In this project, we propose a classifier that leverages the semantic structural concepts learned via multi-resolution segmentation feature maps, to guide weakly supervised 3D classification of chest CT volumes.
- Comparative analysis was drawn across two different types of feature aggregation to explore the

vast possibilities surrounding feature fusion.

- **Proc.** *SPIE Medical Imaging 2020: Computer-Aided Diagnosis:* https://doi.org/10.1117/12.2550857
- **Video Presentation:** https://doi.org/10.1117/12.2550857
- **Code:** https://github.com/fitushar/WeaklySupervised-3D-Classification-of-Chest-CT-using-Aggregated-MultiResolution-Segmentation-Feature

## University of Girona

**13/12/2018-25/01/2019**

### Automatic Brain Tissue Segmentation using 3D fully convolutional network

- Using a publicly available dataset from Grand Challenge on MR brain image segmentation workshop, a 3D fully convolutional network was trained for segmenting the brain tissues into mainly three regions (WM, GM and CSF).
- Compared different preprocessing pipelines and pre-training strategies.
- **Proc.** *3rd International Conference on Imaging, Vision & Pattern Recognition (icIVPR):* 10.1109/ICIEV.2019.8858515
- **Code:** https://github.com/fitushar/Brain-Tissue-Segmentation-Using-Deep-Learning-Pipeline-NeuroNet

**13/12/2018-25/01/2019**

### Skin Lesion classification and Segmentation using Deep CNN with Transfer Learning.

- The idea of the project is to apply 2D U-net to segment the RIO using the publicly available data from ISIC challenge 2017 and classification of the segmented region for classification of lesion.
- Segmentation part is completed using 2D U-net, later transfer learning with vgg16 is applied for classification.

## Carl E. Ravin Advanced Imaging Laboratories, Duke University Medical Center (Summer Internship)

**23/07/2019-09/09/2018**

### Image Registration as data augmentation for XCAT

- In this project XCAT data is been used. XCAT has 50 Cases and their corresponding labels (31 Male and 19 Female Cases). Main idea of this project was making some new data using simple registration technique from existing CT data. This could be a possible alternative of arbitrary augmentation such as flip, rotation, zoom etc.
- A simple but powerful non-rigid registration technique B-spline was used.
- **Code:** https://github.com/fitushar/Registration-as-Data-Augumentation-for-CT--DATA

**23/07/2019-09/09/2019**

### Classification of Chest CT Using Case-level Weak Supervision

- Using work focused on developing weekly supervised deep-learning model for classification of 2D chest CT slices. The work included pre-processing of data, selection of ROI slices and exploring the outcomes from the commonly used CNN models. The effects of different pre-processing on classification were also explored.
- **Proc.** *SPIE Medical Imaging 2019: Computer-Aided Diagnosis:* https://doi.org/10.1117/12.2513576
- **Video Presentation:** https://doi.org/10.1117/12.2513576
- **Code:** https://github.com/fitushar/Classification-of-chest-CT-using-caselevel-weak-supervision

## University of Cassino and Southern Lazio

**04/04/2018-30/06/2018**

### Implementation of a reusable module for automated skin lesion segmentation and classification

- Using the publicly available data from ISIC challenge 2017 in this project we applied a power foreground extraction technique called GrabCut for automatic skin lesion segmentation in HSV colour space with minimal human interaction.
- Pre-processing was performed for removing hair, dark circles, mark stains and other noise by applying morphological and impainting operation. On average, 0.71 Jaccard Index was achieved

on 1000 images from ISIC challenge 2017 training dataset.

- **Preprint:** https://arxiv.org/abs/1810.00871
- **Code:** https://github.com/fitushar/Skin-lesion-Segmentation-using-grabcut

**04/04/2018-30/06/2018**

### Cyclical Learning Rates for Training CNN with unbalanced datasets

- As the learning rate is one of the most important hyper-parameters to tune for training CNNs. In this work, a powerful technique to select a range of learning rates for a neural network named cyclical learning rate was explored with two different skewness degrees. It is an approach to adjust where the value is cycled between a lower bound and upper bound. CLR policies are computationally simpler and can avoid the computational expense of fine tuning.
- Experiments shown that changing the learning rate during the training phase provides by far better results than fixed values with similar or even smaller number of epochs.
- **Preprint:** 10.13140/RG.2.2.28455.80806
- **Code:** https://github.com/fitushar/Cyclical-Learning-Rates-for-Training-Neural-Networks-With-Unbalanced-Data-Sets

## University of Burgundy

**17/09/2017-21/8/2018**

### Quantification of trabeculae inside the heart from MRI using fractal analysis.

- In this project, we demonstrated the fractal dimension (FD), manual & semi-automated segmentation of the Magnetic Resonance Imaging (MRI) of the heart that quantify the amount of trabeculae inside the heart.
- Fractal Dimension (FD) was calculated for the complexity quantification of the trabeculae using box counting method and morphological operation (thresholding, binarization and edge labelling).
- Snake model approach has been used for the active contour segmentations of the heart MRI images.
- Three different Graphical User Interfaces (GUIs) were implemented for computing FD, manual & semi-automated segmentation.
- **Preprint:** https://arxiv.org/abs/1810.04637
- **Code:** https://github.com/fitushar/Quantification-of-Trabeculae-Inside-the-Heart-from-MRI-Using-Fractal-Analysis

**17/09/2017-08/01/2018**

### Content aware image resizing using seam carving

- In this project, a content aware image resizing (CAIR) was implemented in MATLAB environment. Sobel operator was used for calculating the gradient of the image. Dynamic programming was used to find the optimal seam. Additional functionality like object removal and object protection was achieved by manipulating the energy map of the image.
- Graphical User Interface (GUI) was developed to perform above functionality.
- **Report & Code:** https://github.com/fitushar/SeamCarving_Content-Aware-Image-Resizing

## American International University Bangladesh

**10/1/2016-16/8/2016**

### Undergrad Final Year Project: Development of A Multichannel Modular Universal Biopotential Amplifier Trainer (RTR Module).

- Background studies included existing biopotential lab equipment and their prices, students' experiences in biopotential instrumentation and measurement labs.
- Designed and implemented reconfigurable low cost biopotential amplifier trainer for academic use.
- Designed acquisition system for the RTR module usable through MATLAB.
- In process of setup the trainer module in biopotential instrumentation measurement lab at AIUB.
- Surveyed and analysed the students' feedback post-using the RTR module.
- Undergrad project included a scientific written project book and a poster.

**2016**

### Mobile Application Development: ASHA- A Solution to Help Autism

- Acted as a team leader of team RTR at IEEEmadC competition.
- Developed a mobile application which could provide information about significant verbal and

behavioural signs of autism in children of different age groups with aim that early detection can bring many lives to normal.

- Contributed to the research and documents related with the signs detection and graphical interfaces of the app.

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## RESEARCH SKILLS

**Programming skills:**
**Deep Learning Libraries**
**Software**

- **Python, MATLAB, R**
- **Tensorflow, Keras, DLTK, Niftynet**
- **AutoCAD, SPICE, EAGLE, Arduino IDE, Proteus, PSpice, Multisim, Adobe Photoshop, Illustrator, After Effects, Lightroom.**

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## CO-CURRICULAR EXPERIENCE

**02/2016-02/2017**    **Chair, Chapters and AG development**

IEEE AIUB Student Branch, Dhaka (Bangladesh)

- Set objectives and planned activities and resources to achieve a goal.
- Initiated 23 events for students consisted workshops and seminars on step fields and real-life engineering challenges.
- Successfully improved membership drives up to 50%, from 210 to 320 members in 2016.

**02/2016–02/2017**    **Vice Chairperson**

IEEE Microwave Theory and Techniques Society AIUB SB Chapter

- Planned events to Build interest in microwave related research.
- Successfully organized 3 workshops and 1 seminar on microwave related fields.

**02/2016–02/2017**    **Vice Chairperson**

IEEE Industry Application Society AIUB SB Chapter, Dhaka (Bangladesh)

- Collaborated with industries and organized 4 industrial tours for students.
- Organized 4 workshops on stem fields, such as MATLAB, Building wiring, Arduino, and PCB fabrication.
- Awarded "Exemplary New IAS Student Chapter 2016".

**01/2016–03/2016**    **Youth Leader (Teacher)**

Literacy Through Leadership (LTL), Dhaka (Bangladesh)

In collaboration with Teach For Bangladesh, contributed total 78 hours in 13 weeks' period, 6 hours per week to improve 40 underprivileged Primary School students' english reading and writing skill.

**2015–2016**    **IEEE Day Section Ambassador 2015 & 2016**

IEEE

- Contacted with organizational unit (section, student branch, affinity group etc.) chairs and informed them about IEEE Day.
- Communicated with Ambassador Lead on progress of planning events.

**01/2015–12/2015**    **Executive Member**

IEEE AIUB Student Branch

- Responsible for advertising all branch activities involving public relations with other faculties and the students.

**01/2014–12/2014**    **Volunteer**

IEEE AIUB Student Branch

- Worked with Ex-com members and volunteers in planning and implementing promotional events.

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## HONOUR & MEMBERSHIP

**HONOUR AND AWARD**

- **Erasmus Mundus Joint Master (EMJMD) Scholarship** for Master's in Medical Imaging and Applications, covering full tuition fees and monthly stipend (42,000 EUR).
- **Master Thesis Grant** (5000 EUR) from **Carl E. Ravin Advanced Imaging Laboratories, Duke University Medical Center.**
- Academic Honour "**Cum Laude**" for Academic Excellences at AIUB's 17th Convocation.
- "**DEAN'S Award**" for undergrad final year project, securing **2nd place** out of 180 project/thesis for the year 2016 at AIUB.
- **Half Scholarship** (4500 EUR) from AIUB to complete the Undergraduate degree.

## REFERENCE

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**November 9,2020.**

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**Signature**                              **Date**