

# FAIZAN MUHAMMAD

Robotics - Computer Vision - Augmented Reality - Software Engineering

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## EXPERIENCE

### Software Engineering Intern

#### CTRL Labs

📅 May 2019 – August 2019

📍 New York

- CTRL Labs is currently developing CTRL Kit: a non-invasive neural interface for general purpose human-machine interaction
- Mapped EMG-based neural signals to a hexapod robot to mimic user's hand state and play soccer
- Devised and prototyped experimental features for CTRL Kit to power physically contextualized interactions
- Working with the IP Lawyers to file four patents derived from the prototype and feature designs

### Robotics Research Assistant

#### Autonomous Intelligent Robotics Lab (AIR Lab)

📅 Jan 2018 – Ongoing

📍 Tufts University

- Proposed, designed and implemented an Augmented Reality interface for robots using Unity and ROS (supports Hololens, Android, iOS)
- The interface allows a user to visualize the robot's state, intent and plan as an added visual layer over the real world
- Designed and conducted pilot studies involving the use of this interface as a tool for Human-Robot Interaction
- Currently planning the logistics and structure of a full study based on the feedback from the pilot study

### Co-President

#### Tufts Robotics Club

📅 Apr 2018 – Apr 2019

📍 Tufts University

- Reformed club's internal dynamics to promote diversity, accessibility and member retention
- Led the design of a custom, modular club robot that could be specialized to several competitions (Trinity Firefighting, Harvard PacBot etc.)
- Trained and mentored new members, particularly in the areas of software development
- Active members doubled during the year which later created the most diverse Executive Board in club history

### Computer Vision Research Assistant

#### Center for Engineering Education and Outreach

📅 Dec 2016 – Aug 2017

📍 Tufts University

- Devised a programming paradigm for K-12 students to code robots using paper drawings (C++, OpenCV, LabView, Lego Mindstorms)
- Formulated a custom RESTful API for lab-based Internet of Things devices (C++, HTML, Arduino)
- Developed a teacher-assistance tool for digitization of classwork to promote discussion and collaboration (C++, OpenCV)

## EDUCATION

### BS Computer Science

#### Tufts University - School of Engineering

📅 Sept 2016 – May 2020

GPA: 3.94

**Senior Honors Thesis (Ongoing):** EMG-Based Demonstrations for Robot Learning (CTRL Labs Research Partnership)

**Senior Capstone Project (Ongoing):** Faster Factoring Algorithms through Quantum Annealing (IQC Sponsored)

**Activities:** HYPE! Mime Troupe, Fencing Club, Robotics Club

**Elective Courses:** Probabilistic Robotics

Autonomous Intelligent Robotics

Human Robot Interaction

Machine Learning

Computer Vision

Reinforcement Learning

## HONORS



#### Tufts Summer Scholar 2018

Received a grant to pursue the AR Interface research project at AIR Lab



#### Verizon 5G EdTech Challenge 2019

AR Interface was part of the winning proposal for the \$100K grant



#### Trinity College International Fire Fighting Robot Contest

Won the Olympiad in Senior Individual Category in 2018 and 2019



#### International Mathematical Olympiad 2016

Selected and participated as a member of the Pakistani Team

## SKILLS

C++

Python

C#

Golang

Matlab

C

VHDL

LabView

ROS

Unity

OpenCV

Git

Docker

English

Urdu

Punjabi

Hindi

## PROJECTS

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### EMG Based Demonstrations for Robot Learning

#### Senior Honors Thesis

Manipulating unique, unknown, fragile and deformable objects is a challenge for robots

Humans have a significantly better judgement of these properties and are able to manipulate such objects with relative ease

Using Surface Skin Electromyography to recognize human demonstrator's grip types and forces applied to the object

Using Reinforcement Learning to find the appropriate mapping between human demonstration and required robot action

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### Faster Factoring Algorithms through Quantum Annealing

#### Senior Capstone Project

Continuing the work done by my partner at the Institute for Quantum Computing (IQC) last summer (<https://arxiv.org/abs/1910.09592>)

Using Elliptic Curve Method and Number Field Sieve to represent factoring problems in Conjunctive Normal Form to be solved by a Quantum Annealer

We are hoping to obtain a speedup over classical approaches as potentially suggested by the theoretical estimates

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### Trinity College International Fire Fighting Robot Contest

#### Tufts Robotics Club

**2018:** Led the development of software architecture based on a central Raspberry Pi Zero interfaced with an Arduino Mega

**2019:** Led the full-stack development containing dedicated real-time subsystems running on Arduinos and a central Raspberry Pi 3B+ running ROS

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### Sound Based Robot Localization

#### Probabilistic Robotics Class

Used acoustic signatures in the form of Room Impulse Responses to classify spaces within an indoor environment. Intended to serve as an augmentation of a robot's navigation stack to provide a possible solution to the kidnapped robot problem (*Matlab*)

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### Clappy Bird

#### Digital Circuits Class

Recreated Flappy Bird video game on an FPGA using digital circuit design to maintain game state and render it on a VGA display. The system used clapping as the input to play the game. (*VHDL*)

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### Remote Virtual Reality for Service Robots

#### Autonomous Intelligent Robotics Class

Created a VR experience that lets a user see through the perspective of a remote service robot to support remote human takeover when something goes wrong (*Unity, ROS, C#, C++*)

## MEDIA&PUBLICATIONS

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#### Late Breaking Report, HRI 2019 - South Korea

Muhammad, F., Hassan, A., Cleaver, A., and Sinapov, J. "Creating a Shared Reality with Robots", *In Proceedings of Late-Breaking Reports Track at the 14th ACM/IEEE Annual Conference on Human-Robot Interaction, Daegu, Korea, Mar. 11-14, 2019.*



#### Featured Video - Future You @ NPR

"Digital Telekinesis For the Future You?" featured the hexapod project at CTRL Labs

<https://youtu.be/cdZLg4IORc0>



#### Featured Article - Tufts Now

"Hands-on Research for Undergraduates" featured my Tufts Summer Scholars research

<https://now.tufts.edu/articles/hands-research-undergraduates>



#### Featured Video - Tufts University

"Visualizing a Robot's Perspective of the World" featured our lab's aims, efforts and progress in the domain

[https://youtu.be/9\\_9RNRNd9y8](https://youtu.be/9_9RNRNd9y8)



#### Demos, Documentation, Code and More

For more details about me visit:

<https://faizan-m.github.io>