

# Dr. M. Usman Maqbool Bhutta

POSTDOCTORAL FELLOW · DEPARTMENT OF MECHANICAL AND AUTOMATION ENGINEERING, CUHK, HK

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“Robotician + Entrepreneur”

## Summary

With the rise of autonomous systems, being a researcher and entrepreneur, my research direction is their deployment to the real world. For any autonomous mode of the robot, a 3D map is essential to navigate and operate at any place. I work to tackle the problems related to scale difference and loop closures for large scale 3D mapping. I've 7+ years of experience specializing in robotics R&D and project management. I previously owned an IT company, and I've been part of several startups since 2011. My profile can view here (<https://usmanmaqbool.github.io/>).

## Work Experience

### RESEARCH (COMPUTER VISION TECHNOLOGIES AND ROBOTICS SYSTEM)

#### C3 Robotics Laboratory (C3RL), Department of Mechanical and Automation Engineering

CUHK, Hong Kong.

POSTDOCTORAL RESEARCH FELLOW

May. 2021 - Present

- Supervisor: **Prof. Darwin Lau**, Director of C3 Robotics Laboratory (C3RL), The Chinese University of Hong Kong CUHK, Hong Kong..
- Research in AR/VR and inspection robotics for construction**

I'm working on several projects here

**AR/VR:** Research in AR/VR Platform design, multi-agent mixed reality, assistive prosthetics for the handicapped persons, teleoperated robots, human-robot interaction.

**Inspection:** Deep learning based research for the robotic presurface inspection for the construction.

**Multi-agent collaboration:** For indoor vegetation and painting robotics application.

#### Robotics and Multi-Perception Lab, Robotics Institute

HKUST, HK

PHD

Sep 2016 - Feb 2021

- PhD Supervisor: **Prof Ming Liu**, Director of Robotics and Multi-Perception Lab (RAM-LAB)
- Research Contributions as First Author**

**Place Recognition:** Our work makes a leap towards hierarchical deep learning-based place recognition for multiagent SLAM systems. We introduce a probabilistic layer to constrain the local representation along with the global representation of images. The global description of the pre-trained model and the local consistency introduced in our work enables the system to yield good performance at large-scale.

*Development Using:* MATLAB, Python, Jupyter, Nvidia CUDA, Docker, Deep learning, Matconvnet

**Multi-Agent SLAM:** I've produced Loop-box for the multi-Agent Direct SLAM Triggered by Single Loop Closure for Large scale semi dense 3D reconstruction /large-scale structure from motion. This work is accepted for publication in IEEE Transactions on Cybernetics (IF= 11+)..

*Development using:* C++ 11, ROS, OpenCV, OpenGV, Paraview, EVO, UGV, LSD-SLAM, Monocular Camera.

**SLAM:** I've worked mainly for the multi-agent SLAM system. To find the scale difference and excellent relative transformation between difference agents. I've produced **PCR-Pro** work. This work got best student paper finalist award at IEEE-CYBER 2018.

*Development using:* C++ 11, ROS, OpenCV, OpenGV, Paraview, EVO, Monocular Camera, Plotly

**Automation (Inspection):** For smartphone glass inspection, I've introduced **Smart-Inspect** work. This work is accepted in IROS 2020. The patent is also under-review in the US.

*Development using:* Python, Jupyter, Nvidia CUDA, K-Means, Docker, Machine learning (ML)

#### Autonomous Systems Lab (ASL)

ETH Zürich, Switzerland.

ACADEMIC GUEST

Oct. 2019 - Mar. 2020

- Supervisor: **Prof. Roland Siegwart**, Director of Autonomous Systems Lab (ASL), ETH Zürich, Switzerland.
- Co-Supervisor: **Dr. Cesar Dario Cadena Lerma**, Senior Researcher at ASL, ETH Zürich, Switzerland.
- Research in Place Recognition:** I've worked for making the better place recognition for the better scene understanding. Furthermore, I've also introduced light weight representation of key-frames for better channel utilization.

**Development using:** MATLAB, Python, Jupyter, Nvidia CUDA, Docker, Deep learning, Matconvnet

#### Department of Electronics

QAU, Pakistan

MPhil CANDIDATE

Mar. 2010 - Jun. 2012

- M.Phil. Supervisor: **Prof Hasan Mahmood**, Department of Electronics, QAU.
- Research in Image Processing (CNN):** I've introduced CNN-based license plate recognition of Pakistani's Cars. This work has been published in IEEE-ICALIP 2014.

### INDUSTRY AND ENTREPRENEURSHIP

#### Lisee Technology Corporation Limited

Central, HK

COO

Jan 2018 - Jan 2021

- Won funding support for company | TSSSU Support HK\$ 300,000 (Jun 19 - May 20).
- Indoor Navigation for Libray using Lisee Technology | PCF Support HK\$ 160,000 (Jun 18 - May 19).

## Friends Corporate Technologies

CEO

50+ Projects | Electronics/ Electrical Engineering, R&D, image processing, Web Applications Development, MVC Applications

## Federal Government of Pakistan

SCIENTIFIC OFFICER

Electronics/ Electrical Engineering, R&D, image processing

## Server4Sale, LLC

PHP DEVELOPER

Php web application development for Joomla and Zend frameworks.

## ACADEMIC

### Department of Computer Science

LECTURER (VISITING)

Teaching MCS and BS-CS courses

### Department of Physics

CTI

Teaching BS physics (Electronics related courses + Labs + Projects)

### Department of Electronics

INSTRUCTOR

'PHP Web Development' (a short course) offered in Department of Electronics, Quaid-i-Azam University, Islamabad, Pakistan.

Islamabad, PK

Feb 2013 - Aug 2015

Islamabad, PK

May 2012 - Feb 2013

Islamabad, PK

Dec 2009 - Mar 2010

BZU-Sahiwal, Pakistan

Feb 2016 - Jun 2016

GPGC Sahiwal, Pakistan

Oct. 2015 - May. 2016

QAU, Pakistan

Aug. 2010 - Dec. 2010

## Education

### Ph.D. in Robotics and AI at RAM-LAB, Robotics Institute

DEPARTMENT OF ELECTRONIC & COMPUTER ENGINEERING, THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- PhD Supervisor: **Prof Ming Liu**, Director of Robotics and Multi-Perception Lab (**RAM-LAB**)
- Exchange Supervisor: **Prof. Roland Siegwart**, Director of Autonomous Systems Lab (**ASL**), **ETH Zürich**, Switzerland.
- Exchange Co-Supervisor: **Dr. Cesar Dario Cadena Lerma**, Senior Researcher at ASL, **ETH Zürich**, Switzerland.
- Got PEEF CCMS PhD scholarship from Pakistan and overseas research award (ORA).
- Research: Multi-Agent SLAM System, Place Recognition, Autonomous Car and Deep Learning for automation industry. Hand on experience on RGB-D 3D reconstruction, Multi-view stereo, python and C++ development experience, multi-threaded coding. 3D mesh registration, paraview and parameterizations. Moreover, I've deep understanding of data structures and algorithms. Experience with software development on Linux open-source stack. Calculus, linear algebra and geometry related courses have been taken.

HKUST, Hong Kong

Sep. 2016 - Feb. 2021

### M.Phil. in Electronics

DEPARTMENT OF ELECTRONICS, QUAID-I-AZAM UNIVERSITY, ISLAMABAD, PAKISTAN.

- M.Phil. Supervisor: **Prof Hasan Mahmood**, Department of Electronics, QAU.
- Research: Signal and Image Processing
- Grade: A

QAU, Pakistan

Mar. 2010 - Jun. 2012

### M.Sc. in Electronics

DEPARTMENT OF ELECTRONICS, QUAID-I-AZAM UNIVERSITY, ISLAMABAD, PAKISTAN.

- **2nd position** in batch
- Projects: completed 9+ projects related to C++, Verilog/HDL and Micro-controller programming.

QAU, Pakistan

Mar. 2010 - Jun. 2012

### B.Sc. in Mathematics and Physics

BHAUDDIN ZAKARIYA UNIVERSITY, MULTAN PAKISTAN

- Grade: 1st Division

BZU, Pakistan

Mar. 2010 - Jun. 2012

## Presentation

### Teaching and Learning Innovation Expo 2021

POSTERS PRESENTATION

- 'Mixed Reality in Hands-On Learning of Robotics' by Xinyan Zhao, Sabrina Lam, M. Usman M. Bhutta, Darwin Lau and Jimmy Lee.
- 'Online Robotics Laboratory Framework for Interactive and Group Hands-On Learning' by Ken Hui, Ken Kwok, M. Usman M. Bhutta, Darwin Lau and Jimmy Lee.

CUHK, Hong Kong

Jul. 2021

### IEEE/RSJ International Conference on Intelligent Robots and Systems [IROS, 2020]

PRESENTOR AS AUTHOR

- Introduced **Smart-Inspect** for the micro scale localization and classification of smartphone glass defects for industrial automation.

Las Vegas, USA

Oct. 2020

## Technology Start-up Support Scheme for Universities (TSSSU)

HKUST, Hong Kong

PRESENTER AS COO LISEE TECHNOLOGY CORPORATION COMPANY LIMITED, HONG KONG.

Jan. 2019

- Introduced Lisee technology in front of selection committee panel and won TSSSU 2019-20 funding of the amount of HK\$300,000.

## IEEE Int. Conf. on CYBER Technology in Automation, Control, and Intelligent Systems [IEEE-CYBER 2018]

Tianjin, China

PRESENTER AS AUTHOR

Jul. 2018

- Introduced PCR-Pro for the estimation of information matrix and scale difference for pose graph SLAM.

## IET-Young Professionals Exhibition and Competition (IET-YPEC) 2018

CityU, Hong Kong

PRESENTER AS COO LISEE TECHNOLOGY CORPORATION COMPANY LIMITED, HONG KONG.

Jul. 2018

- Introduced Lisee technology at IET-YPEC 2018.

## Campus Challenge @ HKUST Transportation

HKUST, Hong Kong

PRESENTER AS PARTICIPANT

May 2018

- HKUST got 80+ proposals for this competitions, and arranged a roadshow. My proposal got selected for the audience award after getting maximum votes.

## High Tech Innovation and Entrepreneurship

HKUST, Hong Kong

PRESENTER AS ENTREPRENEUR

Dec. 2017

- Introduced my study related to the flying cars.

## World First Youth Robotics Developemnt Forum 2017

Shangri-La Shenzhen, China.

PRESENTER AS AUTHOR.

Nov. 2017

- Introduced my work related to multi-agent SLAM system.

## Honors & Awards

### INTERNATIONAL

July, 2018 **Best Student Paper Finalist Award**, IEEE Int. Conf. on CYBER Technology in Automation, Control, and Intelligent Systems

Tianjin, China

May, 2018 **Audience Award**, Campus Challenge - Transportation, HKUST

HKUST, HK

Nov, 2017 **Best Mapper Award**, Robotics and Multi-Perception Lab, HKUST

Shenzhen, China

May, 2017 **Completion Award**, The Graduate Teaching Assistant Training, HKUST

HKUST, HK

Dec, 2016 **Best External Award**, Robotics and Multi-Perception Lab, HKUST

Shenzhen, China

Nov, 2016 **Completion Award**, Author Workshop, Elsevier Publishing Campus

HKUST, HK

### DOMESTIC

Sep 2016 **CCMS PhD Scholarship**, Won Chief Minister Marit Scholarship (CCMS) scholarship award by Punjab Government (PEEF), Pakistan for pursuing my PhD studies at HKUST, HK

Lahore, PK

Sep 2013 **Participant**, Painting for peace (Pakistan-India-Afghanistan) event, a part of the Harmony initiative

Islamabad, PK

Apr 2013 **Participant**, Case Spark in business plan competition

Islamabad, PK

Apr 2013 **Participant**, Case EPICA

Islamabad, PK

Apr 2013 **Participant**, How to be a Better Playwright Workshop by PNCA and US Embassy Pakistan

Islamabad, PK

Oct 2012 **Participant**, Punjab Youth Festival

Lahore, PK

Oct 2011 **Participant**, Int'l Youth Conference and Festival

Islamabad, PK

Sep 2011 **Participant**, Asian Youth Conference and Peace Festival

Lahore, PK

Apr 2011 **Completion Award**, Acting and Directing Theater Workshop by PNCA and US Embassy Pakistan

Islamabad, PK

Dec 2011 **Participant**, National Drama Festival

Islamabad, PK

Dec 2010 **Instuctor of short Course**, PHP Web Development' at the Department of Electronics, QAU

Islamabad, PK

Apr 2013 **Completion Award**, Running River Rafting course by Adventure Foundation of Pakistan

Mansehra, PK

Apr 2013 **Completion Award**, Paragliding course by QAU Adventure Club

Islamabad, PK

Dec 2008 **Award of Honor**, Finance Secretary of Electronics Student Society (ESS) at QAU

Islamabad, PK

## Academic Activities

ICRA	<b>Referee Service</b> , IEEE/RSJ International Conference on Robotics and Automation	2021, -20
IROS	<b>Referee Service</b> , IEEE/RSJ RA-L and International Conference on Robotics and Automation	2021, -20, -19, -18
HKUST, HK	<b>Teaching Assistant</b> , EESM 5547 - Multimedia Signal Processing	Spr 2020, Spr 2019, Spr 2018
CASE	<b>Referee Service</b> , IEEE International Conference on Automation Science and Engineering	2019
HKUST, HK	<b>Teaching Assistant</b> , ELEC4820 - Medical Imaging	Fall 2018
HKUST, HK	<b>Teaching Assistant</b> , ELEC 1010 - Electronic and Information Technology	Spr 2017

## Skills

<b>Robotics and Computer Vision</b>	Ubuntu, ROS, PCL, Docker, Catkin, OpenCV, OpenGV, Ceres Solver, g2o, Libpointmatcher
<b>Machine Learning / Deep Learning</b>	Jupyter, Pytorch, Tensorflow, Keras, CUDA
<b>Programming</b>	Python, C/C++, Matlab, git, LaTeX, FPGA, Verilog
<b>Web</b>	mkdocs, Hugo, Jekyll, PHP, MYSQL
<b>Languages</b>	English, Urdu

## Research Publication

<b>Why-So-Deep: Image Correspondence Verification by Probabilistic Spatial Landmarks Elevation for Visual Place Recognition</b>	<i>Journal Paper</i>
M USMAN MAQBOOL BHUTTA*, YUXIANG SUN AND MING LIU The IEEE Transactions on Automation Science and Engineering(T-ASE)	Submitted
<b>Loop-box: Multi-Agent Direct SLAM Triggered by Single Loop Closure for Large Scale Mapping</b>	<i>Journal Paper</i>
M USMAN MAQBOOL BHUTTA*, MANOHAR KUSE, RUI FAN, YANAN LIU AND MING LIU IEEE Transactions on Cybernetics (IF: 11+)	Oct 2020
<b>Smart-Inspect: Micro Scale Localization and Classification of Smart Phone Glass Defects for Industrial Automation</b>	<i>Conference Paper</i>
M USMAN MAQBOOL BHUTTA*, SHOAB ASLAM, PENG YUN, JIANHAO JIAO AND MING LIU IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020)	Oct 2020
<b>Multiple Lane Detection Algorithm Based on Optimised Dense Disparity Map Estimation</b>	<i>Conference Paper</i>
HAN MA, YIXIN MA, JIANHAO JIAO, M USMAN MAQBOOL BHUTTA, MOHAMMUD JUNAID BOCUS, LUJIA WANG, MING LIU AND RUI FAN Accepted in IEEE International Conference on Imaging Systems and Techniques (IST 2018)	Dec 2018
<b>PCR-Pro: 3D Sparse and Different Scale Point Clouds Registration and Robust Estimation of Information Matrix For Pose Graph SLAM</b>	<i>Conference Paper</i>
M USMAN MAQBOOL BHUTTA* AND MING LIU Presented in IEEE Int. Conf. on CYBER Technology in Automation, Control, and Intelligent Systems (IEEE-CYBER 2018), and won <b>Best Student Paper Finalist Award</b> .	Jul 2018
<b>An intelligent approach for robust detection and recognition of multiple color and font styles automobiles license plates: A feature-based algorithm</b>	<i>Conference Paper</i>
M USMAN MAQBOOL BHUTTA*, HASAN MAHMOOD, AND HAROON MALIK Published in IEEE International Conference on Audio, Language and Image Processing (ICALIP 2014).	Jan 2015
<b>Efficient Reset Design Techniques</b>	<i>Journal Paper</i>
QAMAR, ZOHA, BUSHRA YASEEN, AND USMAN MAQBOOL Published in Science International Lahore	2015

## Patent

<b>Semi-Supervised Learning Approach for Smart Phone Glasses Defect Inspection</b>	<i>US Patent</i>
MUHAMMAD USMAN MAQBOOL BHUTTA, JIANHAO JIAO, PENG YUN, YUAN WANG, XUEBIN SUN, MING LIU TTC.PA.1315, US Provisional Patent Application (No. 62/974,937).	Jan 2020

## References

**Prof Darwin Lau**

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*Exchange Co-Supervisor*

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