

# 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 place recognition, AR/VR and inspection robotics for construction

I'm working on several projects here

**Place Recognition:** Working on the light-weight representation of images and making better use of previously trained models.

**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

Islamabad, PK

CEO

Feb 2013 - Aug 2015

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

## Federal Government of Pakistan

Islamabad, PK

SCIENTIFIC OFFICER

May 2012 - Feb 2013

Electronics/ Electrical Engineering, R&D, image processing

## Server4Sale, LLC

Islamabad, PK

PHP DEVELOPER

Dec 2009 - Mar 2010

Php web application development for Joomla and Zend frameworks.

## ACADEMIC

### Department of Computer Science

BZU-Sahiwal, Pakistan

LECTURER (VISITING)

Feb 2016 - Jun 2016

Teaching MCS and BS-CS courses

### Department of Physics

GPGC Sahiwal, Pakistan

CTI

Oct. 2015 - May. 2016

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

### Department of Electronics

QAU, Pakistan

INSTRUCTOR

Aug. 2010 - Dec. 2010

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

## Education

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

HKUST, Hong Kong

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

Sep. 2016 - Feb. 2021

- 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.

### M.Phil. in Electronics

QAU, Pakistan

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

Mar. 2010 - Jun. 2012

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

### M.Sc. in Electronics

QAU, Pakistan

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

Mar. 2010 - Jun. 2012

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

### B.Sc. in Mathematics and Physics

BZU, Pakistan

BHAUDDIN ZAKARIYA UNIVERSITY, MULTAN PAKISTAN

Mar. 2010 - Jun. 2012

- Grade: 1st Division

## Presentation

### Teaching and Learning Innovation Expo 2021

CUHK, Hong Kong

POSTERS PRESENTATION

Jul. 2021

- '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.

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

Las Vegas, USA

PRESENTER AS AUTHOR

Oct. 2020

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

## 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 Development 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 | <b>Best Student Paper Finalist Award</b> , IEEE Int. Conf. on CYBER Technology in Automation, Control, and Intelligent Systems | Tianjin, China  |
| May, 2018  | <b>Audience Award</b> , Campus Challenge - Transportation, HKUST   | HKUST, HK       |
| Nov, 2017  | <b>Best Mapper Award</b> , Robotics and Multi-Perception Lab, HKUST  | Shenzhen, China |
| May, 2017  | <b>Completion Award</b> , The Graduate Teaching Assistant Training, HKUST  | HKUST, HK       |
| Dec, 2016  | <b>Best External Award</b> , Robotics and Multi-Perception Lab, HKUST  | Shenzhen, China |
| Nov, 2016  | <b>Completion Award</b> , Author Workshop, Elsevier Publishing Campus  | HKUST, HK       |

### DOMESTIC

|          |  |               |
|----------|--|---------------|
| Sep 2016 | <b>CCMS PhD Scholarship</b> , 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 | <b>Participant</b> , Painting for peace (Pakistan-India-Afghanistan) event, a part of the Harmony initiative   | Islamabad, PK |
| Apr 2013 | <b>Participant</b> , Case Spark in business plan competition   | Islamabad, PK |
| Apr 2013 | <b>Participant</b> , Case EPICA  | Islamabad, PK |
| Apr 2013 | <b>Participant</b> , How to be a Better Playwright Workshop by PNCA and US Embassy Pakistan  | Islamabad, PK |
| Oct 2012 | <b>Participant</b> , Punjab Youth Festival   | Lahore, PK    |
| Oct 2011 | <b>Participant</b> , Int'l Youth Conference and Festival   | Islamabad, PK |
| Sep 2011 | <b>Participant</b> , Asian Youth Conference and Peace Festival   | Lahore, PK    |
| Apr 2011 | <b>Completion Award</b> , Acting and Directing Theater Workshop by PNCA and US Embassy Pakistan  | Islamabad, PK |
| Dec 2011 | <b>Participant</b> , National Drama Festival   | Islamabad, PK |
| Dec 2010 | <b>Instructor of short Course</b> , PHP Web Development' at the Department of Electronics, QAU   | Islamabad, PK |
| Apr 2013 | <b>Completion Award</b> , Running River Rafting course by Adventure Foundation of Pakistan   | Mansehra, PK  |
| Apr 2013 | <b>Completion Award</b> , Paragliding course by QAU Adventure Club   | Islamabad, PK |
| Dec 2008 | <b>Award of Honor</b> , Finance Secretary of Electronics Student Society (ESS) at QAU  | Islamabad, PK |

## Academic Activities

|           |  |                              |
|-----------|--|------------------------------|
| TC        | <b>Referee Service</b> , IEEE Transactions on Cybernetics                                      | 2020, -21                    |
| ICRA      | <b>Referee Service</b> , IEEE/RSJ International Conference on Robotics and Automation          | 2022, -21, -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: Towards Boosting Previously Trained Models for Visual Place Recognition</b>  | <i>Journal Paper</i>    |
| M USMAN MAQBOOL BHUTTA*, YUXIANG SUN, DARWIN LAU AND MING LIU<br>IEEE Robotics and Automation Letters (RA-L), 2022   | Accepted                |
| <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<br>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<br>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<br>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<br>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<br>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<br>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<br>U.S. Provisional Patent Application No. 62/974,937, Filing Date 01/06/2020. | Jan 2020         |
| <b>Automatic Surface Defect Detection System for Smart Phone Glass Based on Deep Learning</b>   | <i>US Patent</i> |
| YUAN WANG, JIANHAO JIAO, PENG YUN, MUHAMMAD USMAN MAQBOOL BHUTTA, XUEBIN SUN, MING LIU<br>U.S. Provisional Patent Application No. 62/974,938, Filing Date 01/06/2020. | Jan 2020         |

## References

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### **Prof Darwin Lau**

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### **Dr. Cesar Dario Cadena Lerma**

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*Exchange Co-Supervisor*

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### **Prof Ming Liu**

ASSOCIATE PROFESSOR · DIRECTOR OF ROBOTICS AND MULTI-PERCEPTION LAB (RAM-LAB), DEPARTMENT OF ELECTRONIC  
AND COMPUTER ENGINEERING, HKUST, HK.  
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