

# Dr. M. Usman Maqbool Bhutta

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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 full 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

COO

- 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).

Central, HK

Jan 2018 - Jan 2021

## 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.

Islamabad, PK

Feb 2013 - Aug 2015

Islamabad, PK

May 2012 - Feb 2013

Islamabad, PK

Dec 2009 - Mar 2010

## Academic

### Department of Computer Science

Lecturer (Visiting)

Teaching MCS and BS-CS courses

BZU-Sahiwal, Pakistan

Feb 2016 - Jun 2016

### Department of Physics

CTI

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

GPSC Sahiwal, Pakistan

Oct. 2015 - May. 2016

### Department of Electronics

Instructor

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

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

HKUST, Hong Kong

Sep 2016 - Jun 2021

**Thesis:** "Towards A Swift Multiagent SLAM System For Large-scale Robotics Applications", June 17, 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

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

Sep 2007 - Jun 2010

### B.Sc. in Mathematics and Physics

Bahauddin Zakariya University, Multan Pakistan

- Grade: 1st Division

BZU, Pakistan

Sep. 2005 - Aug. 2007

## 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

Tianjin, China

### [IEEE-CYBER 2018]

### 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

July, 2021	<b>Educational Technology Innovation: Gold Award</b> , The Teaching and Learning Innovation Expo, CUHK	CUHK, Hong Kong
July, 2021	<b>Pedagogical Innovation: Silver Award</b> , The Teaching and Learning Innovation Expo, CUHK	CUHK, Hong Kong
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
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>Instuctor 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

RA-L	<b>Referee Service</b> , IEEE Robotics and Automation Letter	2022
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	2022, 21-18
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

### Journal Publications

<b>Robust mobile robot navigation in cluttered environments based on hybrid adaptive neuro-fuzzy inference and sensor fusion</b>	<i>Journal (IF: 8.8+)</i>
Muhammad Husnain Haider, Zhonglai Wanga, Abdullah Aman Khan, Hub Ali, Hao Zheng, Shaban Usman, Rajesh Kumar, M. Usman Maqbool Bhutta, Pengpeng Zhi	Aug 2022
2022 Journal of King Saud University-Computer and Information Sciences.	
<b>MAFNet: Segmentation of Road Potholes with Multi-modal Attention Fusion Network for Autonomous Vehicles</b>	<i>Journal (IF: 5.3+)</i>
Zhen Feng, Yanning Guo, Qing Liang, M. Usman Maqbool Bhutta, Hengli Wang, Ming Liu, and Yuxiang Sun	Aug 2022
2022 IEEE Transactions on Instrumentation & Measurement	
<b>Why-So-Deep: Towards Boosting Previously Trained Models for Visual Place Recognition</b>	<i>Journal (IF: 5.4+)</i>
M Usman Maqbool Bhutta*, Yuxiang Sun, Darwin Lau and Ming Liu	Jan 2022
IEEE Robotics and Automation Letters (RA-L)/ICRA, 2022	
<b>Loop-box: Multi-Agent Direct SLAM Triggered by Single Loop Closure for Large Scale Mapping</b>	<i>Journal (IF: 11.7+)</i>
M Usman Maqbool Bhutta*, Manohar Kuse, Rui Fan, Yanan Liu and Ming Liu	Oct 2020
2022 IEEE Transactions on Cybernetics	
<b>Efficient Reset Design Techniques</b>	<i>Journal Paper</i>
Qamar, Zoha, Bushra Yaseen, and Usman Maqbool	2015
Published in Science International Lahore	
<b>Conference Proceedings</b>	
<b>Autonomous Mobile Robot Navigation using Adaptive Neuro Fuzzy Inference System</b>	<i>Conference Paper</i>
Muhammad Husnain Haider and Hub Ali and Abdullah Aman Khan and Hao Zheng and M. Usman Maqbool Bhutta and Shaban Usman and Pengpeng Zhi and Zhonglai Wang	May 2022
2022 International Conference On Innovations And Development Of Information Technologies And Robotics (IDITR), 2022	
<b>Scale-Adaptive Pothole Detection and Tracking from 3-D Road Point Clouds</b>	<i>Conference Paper</i>
Wu, Rigen and Fan, Jiahe and Guo, Libo and Qiao, Lei and Bhutta, M. Usman Maqbool and Hosking, Brett and Vityazev, Sergey and Fan, Rui	Aug 2021
2021 IEEE International Conference on Imaging Systems and Techniques (IST), 2021	

## Smart-Inspect: Micro Scale Localization and Classification of Smart Phone Glass Defects for Industrial Automation

M Usman Maqbool Bhutta\*, Shoaib Aslam, Peng Yun, Jianhao JIAO and Ming Liu

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020)

Conference Paper

Oct 2020

## Multiple Lane Detection Algorithm Based on Optimised Dense Disparity Map Estimation

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)

Conference Paper

Dec 2018

## PCR-Pro: 3D Sparse and Different Scale Point Clouds Registration and Robust Estimation of Information Matrix For Pose Graph SLAM

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 **Best Student Paper Finalist Award**.

Conference Paper

Jul 2018

## An intelligent approach for robust detection and recognition of multiple color and font styles automobiles license plates: A feature-based algorithm

M Usman Maqbool Bhutta\*, Hasan Mahmood, and Haroon Malik

Published in IEEE International Conference on Audio, Language and Image Processing (ICALIP 2014).

Conference Paper

Jan 2015

## Patent

### Semi-Supervised Learning Approach for Smart Phone Glasses Defect Inspection

Muhammad Usman Maqbool Bhutta, Jianhao Jiao, Peng Yun, Yuan Wang, Xuebin Sun, Ming Liu

U.S. Provisional Patent Application No. 62/974,937, Filing Date 01/06/2020.

US Patent

Jan 2020

### Automatic Surface Defect Detection System for Smart Phone Glass Based on Deep Learning

Yuan Wang, Jianhao Jiao, Peng Yun, Muhammad Usman Maqbool Bhutta, Xuebin Sun, Ming Liu

U.S. Provisional Patent Application No. 62/974,938, Filing Date 01/06/2020.

US Patent

Jan 2020

## References

### Prof Darwin Lau

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### Dr. Cesar Dario Cadena Lerma

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