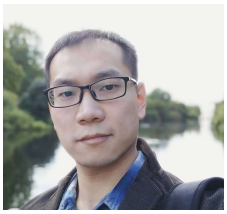
Handuo Zhang

Date of Birth: 28/05/1988 **Nationality:** Chinese



INFORMATION

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EDUCATION

NANYANG TECHNOLOGICAL UNIVERSITY (NTU)

PH.D IN ELECTRICAL & ELECTRONIC ENGINEERING
Expected Jun. 2020 | Singapore
Cum. GPA: 4.67/5.00

NORTHEASTERN UNIVERSITY

M.SC IN PATTERN RECOGNITION & INTELLIGENT SYSTEM
Finished Jun. 2013 | Shenyang, China
College of Information Science & Engineering
Major GPA: 3.94 / 4.0

BACHELOR'S DEGREE IN AUTOMATION
Finished in May 2011 | Shenyang, China
College of Information Science & Engineering

SKILLS

PROGRAMMING

Advanced:
C & C++ • Python • MATLAB • ROS • Pytorch

AWARDS

2013 National Graduate Scholarship

2012 2 times of school 1st-class scholarship.

2011 **1st Prize** for 8th National Graduate Mathematical Contest in Modeling.

2010 **Meritorious Winner** (First Prize) for 2010 American Mathematical Contest in Modeling.

EXPERIENCES

SHENYANG INSTITUTE OF AUTOMATION CHINESE ACADEMY OF SCIENCES — ASSISTANT RESEARCHER

Aug 2013 – Sep 2015 | Shenyang, China

- I was in charge of robot communication and localization system development for earthquake rescue purpose.
- During the two years, I took part in five projects and two of them are supported by nation-level projects.

NTU EEE ROBOTICS I LAB — PROJECT OFFICER

Sep 2015 – Jan 2016 | Singapore

- Worked in the cooperation lab with ST Engineering for the robot vision team to design and construct the hardware and software platform.
- Joined the project "Using Stereo vision System on a Fast Moving Unmanned Ground Vehicle" and mainly in charge of visual SLAM and sensor fusion based on stereo cameras.

PUBLICATIONS

(1) GMC: Grid Based Motion Clustering in Dynamic Environment
Handuo Zhang, K Hasith, H Wang, Intelligent System Confernece (IntelliSys), 2019.

(2) A consistent and long-term mapping approach for navigation
Handuo Zhang, K Hasith, H Wang, International Journal of Research in Advent Technology (IJRAT), 2019 (Accepted).

(3) A hybrid feature parametrization for improving stereo-SLAM consistency
Handuo Zhang, K Hasith, H Wang, International Conference on Control and Automation (ICCA), 2017.

(4) Ultra-wideband aided fast localization and mapping system
Chen Wang, **Handuo Zhang**, TM Nguyen, L Xie, International Conference on Intelligent Robots and Systems (IROS), 2017.

(5) Stereo vision based negative obstacle detection
K Hasith, **Handuo Zhang**, H Wang, ICCA, 2017.

(6) Multiple Object Tracking With Attention to Appearance, Structure, Motion and Size
K Hasith, H Wang, **Handuo Zhang**, IEEE Access, 2019.

(7) Heading Reference-Assisted Pose Estimation for Ground Vehicles
Han Wang, R Jiang, **Handuo Zhang**, SS Ge. IEEE Transactions on Automation Science and Engineering (T-ASE), 2018.

(8) Object co-segmentation via weakly supervised data fusion
Shiping Wang, **Handuo Zhang**, H Wang. Computer Vision and Image Understanding (CVIU), 2017.

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PROJECTS

1. STEREO VISION SYSTEM ON UGV

Cooperation with ST Engineering

2016 – 2019 | Singapore

See **project page: ugv_stereo.gitlab.io** for more details.

The project aims to develop and implement a high speed stereo vision system and apply it onto unmanned ground vehicles (UGV).

We deploy obstacle detection & tracking system (for objects 50 meters away), road feature detection (including lanes and curbs), and visual SLAM into a unified system to make UGV run at 60 km/h speed.

- SLAM under heavy traffic has translation RMSE 0.043% and rotation 0.41°.
- Object tracking TPR is 0.947, MOTA 0.915, ranking 4th in KITTI tracking benchmark.
- Object distance, size and bearing estimation mean error 1.58m, 1.25° and 0.45m.
- Lane & Curb detection TPR 98%.

In terms of SLAM, we have four contributions:

1. **Utilize a hybrid feature parametrization technique**.

   In outdoor scenes, we select remote features for rotation only estimation and alternately optimize rotation and translation to better handle fast rotation case.

   Moreover, we choose the features with the most contributions considering spatial and temporal factors to improve feature association accuracy.

2. **Add an option to fuse IMU or AHRS (attitude and heading reference system) sensors to reduce drift of pure visual SLAM**.

   We introduce a new auxiliary vertex of heading reference and construct a new graph optimization framework to make localization more accurate.

3. **Able to discover dynamic objects by using a grid-based motion clustering approach to filter out moving objects under heavy traffic environments**, based on the assumption of motion coherence of unified distributed features.

4. **Able to save and load previous visited pose graph map** with key frames and sparse 3D point clouds and conduct 6D optimization to make current localization more robust and accurate. The saving and loading of a 10 km trip map takes only 5 seconds by optimizing the serialization process.

In terms of robocentric mapping, we create a compact **object-level map representation by differentiating temporary movable objects and static landmarks and obstacles**.

By using object detection and motion hypothesis technology, we are able to extract movable objects and estimate their size, orientation and velocity individually to further abstract them into semantic cube models.

For static obstacles, we associate them with the estimated sparse feature points to help generate a 3D obstacle map which also contains localization information.

2. MULTI-CAM PANORAMIC STITCHING

Work done during Master's days

2012 – 2013 | China

- Panoramic image of vehicle surroundings in bird-eye view with 4 fisheye cameras.
- In charge of Mei camera calibration, un-distortion, and scene warping based on homogeneous matrix.