Zishuo Wang

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Research Interests

My current research topics cover 2D & 3D visual understanding, navigation, and autonomous system design. My research vision is to develop intelligent robots capable of perceiving and acting sensibly in dynamic, uncertain real-world environment.

Education

National University of Singapore *Aug 2022 - Jun 2024 (Expected)*
M.S. student in Computing (AI track), GPA: 4.67/5.0
Advisor: Prof. David Hsu

Harbin Institute of Technology *Aug 2018 - Jun 2022*
B.E. in Automation and B.E. in Artificial Intelligence, GPA: 90.57/100
Advisor: Prof. Huijun Gao

Research

Failure Recovery Framework for Robust Navigation with Learned Controllers *Jan 2023 – present*
Graduate RA with Prof. David Hsu — Adaptive Computing Laboratory, NUS

- Designed a comprehensive failure recovery framework consisting of perturb and ask for help, that empowers learned controllers to 1) sense anomalous situations, 2) recover themselves, 3) if they cannot recover, fail gracefully.
- Developed a controller capable of multi-behavior navigation and anomaly detection by adding a variational bottleneck into a off-the-shelf behavioral navigation controller.
- Employed the change of filtered Kullback–Leibler (KL) divergence over a sliding window duration as our anomaly metric.
- Utilized the anomaly metric to guide failure recovery in two ways: 1) use KL divergence to measure recovery success, 2) backpropagate the variational bottleneck then use Grad-CAM to obtain an anomaly localisation heatmap to guide the selection of recovery actions. (More in progress)

Hatch Identification Method for Bulk Carrier *Aug 2021 – Jun 2022*
Undergraduate RA with Prof. Huijun Gao — Research Institute of Intelligent Control and System, HIT

- Merged point cloud data collected from multiple lidars using geometric transformation matrix to reconstruct the entire ship and compute its pose. Built a ship part segmentation dataset with the reconstructed ship model.
- Designed a novel algorithm combining PointNet-based 3D point cloud segmentation with classical 2D image processing methods for hatch identification and localisation.
- Contributed to the perception module for the automatic loading of bulk materials at Tianjin Port, demonstrating the practical applicability of the developed approach.

Anti-photographic Detection Algorithm Based on Semi-supervised Learning *Aug 2021 – Jun 2022*
Undergraduate RA with Prof. Hongzhi Zhang — Center on Machine Learning Research, HIT

- Constructed an object detection dataset of photographic devices by crawling search engines and simulating photographic scenarios then trained a basic detection network based on FCOS.
- Fine-tuned and retrained the network based on pseudo-label algorithm, which improved the accuracy and robustness of the system, expanding the range of detectable devices.
- Developed a system with good generalisability and accuracy for detecting various photographic equipment, including different styles of phones, cameras, monitors, etc.

Project

Table Curling Robot *Sep 2020 – Sep 2021*
Project Lead; Advisor: Prof. Dandan Li — Nvidia A.I. & Control Research Center, HIT

- Devised hierarchical control strategy: High-level planning with vision and low-level PID steering control.
- Detected and localised the existing stones using an image processing algorithm including auto-perspective transformation, edge detection, and circle detection. Subsequent strategic maneuvers were planned in accordance with the spatial distribution of the stones within the house.
- Enabled the robot to autonomously return to the starting point by using a road-following algorithm based on Resnet18 which can predict the next direction, and accelerated the inference using TensorRT.

Biomedical Image Segmentation for Brain Tumour *July 2021 – Aug 2021*
Team Lead in Imperial data science summer school Data Science Institute, Imperial College London

- Proposed medical image segmentation approach for raw MRI dataset based on modified U-net.
- Performed data preprocessing and augmentation techniques on 3D MRI data to enhance model generalisation.
- Designed a loss function with dice coefficient, leading to a significant improvement of 16.3% in dice score on the validation set compared to the baseline. The project received an A grade at the summer school.

Intelligent Vision PTZ for Face Tracking and Alerting *Nov 2019 – Nov 2020*
Project Lead; Advisor: Prof. Jiawei Wang Center for Experimental Flight Vehicle Control Education, HIT

- Built a 2-Dof Vision PTZ with two servos for controlling the PTZ's pose and one camera for tracking the face.
- Implemented the Cascade Classifier algorithm for human face detection and applied a PD controller for accurate tracking.
- Face recognition. Extracted face descriptor from the detected face through Resnet34, comparing with a database for identification. The system alerted the user in case of a stranger and captured the face image, sending a message to the host.

Multi-legged Bionic Robot *Sep 2018 – Sep 2019*
Project Lead; Advisor: Prof. Jiawei Wang Center for Experimental Flight Vehicle Control Education, HIT

- Built a quadrupedal/hexapedal robot system capable of avoiding obstacles with ultrasonic distance measurer and following lines with gray-scale measurer based on Arduino.
- Developed a biomimetic gait control algorithm for legged locomotion and deployed it on a real robot.

Selected Awards and Honors

- 8841 Impact Scholarship *2021*
- Merit Student *2021*
- People's Scholarship *2020, 2021*
- Excellent Student Leader *2019, 2020*

Skills

- **Programming:** Python, C/C++, MATLAB, Verilog, HTML
- **Software & Tools:** ROS, PyTorch, OpenCV, AutoCAD, Multism, Altium Designer, ISE Design, Git, LaTeX
- **Hardware:** Multiple Motors and Sensors, Arduino, Raspberry Pi, Nvidia Jetson, Basic Mechanical Design
- **Languages:** Chinese: Native. English: IELTS: 7, GRE: 326+3.5