Statement of Personal Objectives

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Past study and research

The past research I've done at National Taiwan University (NTU) included Autonomous Mobile Robots (AMR), Unmanned Aerial Vehicles (UAVs), Propeller-Powered vehicles, and Billiard Cars. Besides, the contents below are my progress in some of them in a time order starting with the latest.

1. **Autonomous and Soft Robotics LAB (ASR)** - ME Dept. at NTU, Mar. 2023-Present

As I did in the former lab, I'm also researching AMR in ASR. Compared to one year ago, I have a deeper understanding of AMR, e.g., the concept of Simultaneous Localization and Mapping (SLAM), relative algorithms, and theories such as those for path planning, localization, and navigation.

Basically, I'm moving the current packages of our lab in the architecture of the Robot Operating System (ROS) to the new version ROS2. Since I'm still acquainting in ROS, it's still in progress.

2. **Intelligent Robot and Automation Lab (IR)** - EE Dept. at NTU, Mar. 2022-Aug. 2022:

IR lab is my enlightenment in Robotics. I was mainly responsible for mechanical design in previous projects before joining the lab. Therefore, I knew nothing about the SLAM algorithms, Raspberry Pi (RPI), and Linux (Ubuntu), it was challenging to research them. At that time, I spent months understanding these topics.

In the end, I made a mobile robot that can extract internal maps using the mapping algorithm Hector SLAM. Despite the process being so tough, I realized that it's exciting to learn new things every day, which is also one motivation that drives me to dedicate my future to studying Robotics.

3. **2021 Taiwan TDK 25th Robocon UAV group** – at NTU, Jul. 2021- Dec. 2021

In the team, I was responsible for mechanical design. Once we have a new idea or somewhere need to modify, I redesigned the configuration of our drone. Although we did simulations then, the actual result was always stochastic, thus the robot might sprint randomly because of overshooting of the motors, and it was DANGEROUS.

It's difficult for drones to fly automatically along the black line on the ground. The second difficulty is recognizing the light transforming different colors randomly to determine whether to stop or go. Fortunately, we won the Championship eventually. The prize in the competition acknowledged our effort and encouraged me to chase my dream on a rather challenging road.

Motivations

There are mainly three reasons for choosing Kyoto University, the country, the school, and the faculties. For all motivations below, I apply my Master's degree at Kyoto University.

First, I would like to explain why applying to Graduate school in Japan. Most of my clever friends at NTU go to the top university in the US directly after graduating. Considering the resources in the US, I also want to go there for research or work. However, I'm still young, naive, and eager to try something new.

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Tired of following the trend, I want to create my own way and become more competitive. After finishing my exchange student program in Japan, I determined to stay out of my comfort zone, e.g., countries speaking Chinese and English. Also, I like Japanese creativity. Studying in Japan would be a valued experience that makes me different or even stand out from other people if I go to the US in the future.

Secondly, the school motto of Kyoto University is Freedom of academic culture. I believe the Course for Systems Science at Kyoto University aligns with my goal and value because it is one of the leading institutes in Asia. Also, for researchers in Robotics, we need to think outside the box to develop user-friendly robots to improve our society.

Most importantly, many laboratories in the System science course fit into my field of interest, including Swarm Intelligence, Formation control, Robotics, and Machine Learning. Living in the Artificial Intelligence (AI) era, I aim to utilize this technology in Robotics to make robots cleverer, then coexist with all creatures, not just humans.

Aspirations for study (research proposal)

As I mentioned before, I want to integrate Robotics with AI. Thus, I choose to research the Quadruped robot as a quadruped can move to terrain that an AMR cannot do. To my knowledge, some institutions work well on quadrupeds. For instance, Spot and Mini Cheetah belong to Boston Dynamics and MIT CSAIL, respectively. Below I consider some advantages of Mini Cheetah and propose my plan for Quadruped, including its methodology, utilizations, and how to help us improve our societies, which will be invaluable to my research and future applications.

To start with, MIT showcased the learning-based method that outperformed the previous human-designed one. To my knowledge, the lab of Prof. Jun Morimoto in the Systems Science Course is also working on reinforcement learning for Quadruped, which is appealing to me.

There is a comparison of the learned controller and the human-designed one in the demo of Mini Cheetah. The learned controller can adapt the system behavior to diverse fields, such as gravelly hills or slippery ice, to prevent the robot from stumbling in those challenging terrain.

For methodology, we can use a simple neural network as the controller. Then, let the robot learn to run in a simulator and realistically overcome trouble in those situations.

Concerning an application for the robot, it can use as a rescue robot, which would play an important role in countries near seismic zone like Japan, Taiwan, and Turkey. In detail, integrating components with the robot, including thermal, temperature sensors, and manipulators, to support the rescue team's search for survivors under quake rubble within a crucial 72 hours.

Lastly, in addition to using AI in Quadruped, it can also apply to other robots, such as automobiles with swarm intelligence (AZUMA Laboratory) and formation control (Ohtsuka Laboratory). In conclusion, following my statement at first, I'm intent on combining Robotics and AI to make robots work better and benefit the world ultimately.