**Statement of Purpose**

In the TV series, *Love, Death, and Robots*, **Zima**, a great artist, traced his genealogy back to his origin before his death, uncovering his update and evolve from a hard-coded underwater robot. I have always held a deep fascination with intelligent robots and expected to see their revolutionary effects on our society. Thus, this utopian sci-fi story, freely depicting the future for robots with consciousness from a unique perspective, stimulated my imagination on how smart robots will interact with this world and assist humans to do repeated works. In order to dig deeper into this field, I have been committed to improving my computer science skills and conducting research on robotics using AI technologies, especially for deep reinforcement learning (DRL).

To start with, as an undergraduate at UESTC Yingcai Honors College, I took part in a variety of projects in electrical engineering and computer science. Among them, I was particularly inspired by my undergraduate thesis project. We were aiming to realize a map-based localization system for indoor construction robots. With a literature review, I chose to work on *Active Neural Localization* - extended *Bayesian Filter* with *Asynchronous Advantage Actor-Critic (A3C)* algorithm to localize the agent faster by interacting with its nearby environment without repeating or inefficient explorations. Meanwhile, for better adaptability, I chose the 3D simulator, *VizDoom* to train the neural network, redesigned the agent’s behaviors, and built its new APIs. However, there still were problems affecting the localizer’s performance — this system was fragile to environments’ variations with the inputs of images. Comparatively, distance information was easier to obtain and was steadier which wouldn’t be influenced by varying effects in an image like light conditions. In the end, the localizer achieved a commendable performance which greatly contributed to the lab’s indoor robotics projects. The rigorous processes — studying the existing literature, designing the experimental settings, method improvements ­­­— all helped me develop a solid academic methodology, which would undoubtedly benefit me in my future research endeavors.

Driven by curiosity on robots’ control, I also joined Tencent Robotics X Lab as a machine learning intern. They designed and produced quadruped robots that are capable of walking on a few specific surfaces. Nevertheless, to deploy it into capricious real-world applications, a robust controller is of great concern for the lab. With abundant training data, a DRL-based controller is usually competent for robustness. Nonetheless, it introduced another problem instead, *sim-to-real* gaps into the system — it’s rather hard to transfer the trained DRL model from the simulator to the real-world — which has been the major challenge for DRL-based controllers’ deployment for legged robots. Thus, I was focusing on solving them on an algorithmic level. Firstly, by randomizing the dynamic parameters (friction, inertia and etc.) of each training episode in the simulator, the collected training data variety has been enriched. The simulated robot could encounter various dynamic settings, like slippery or rough ground, heavier or lighter body, and generalize its walking policy. Secondly, I proposed and implemented a *Domain Adaptation* approach: the robot perceives the dynamics during the movements and uses the predicted dynamic parameters to produce more adapted walking policies. With the proposed method, the DRL network was qualified for the capricious circumstances in the real world and the quadruped robot could walk well at last.

During the internship, I not only gained valuable knowledge in AI and robotics but have also become proficient in essential tools like Git, Docker and etc. They have tremendously improved my efficiency. Moreover, I built up a sense of *Minimum Viable Product (MVP)*: by modularizing and splitting challenging complicated tasks, I solved the s*im-to-real gap* problem in a more organized way.

Impressed by the two amazing projects, I have been determined to continue independent robotics and AI researches. Consequently, I have taken charge of an underwater robot’s navigation project at Dartmouth College. Compared with the ground and aerial robots, Autonomous Underwater Vehicles (AUVs) require expensive sensors with higher precision to complete sophisticated jobs. Therefore, it’s very meaningful that I developed a low-cost underwater navigation system.

The system consisted of two components: depth estimation of monocular images as well as the robot’s goal-oriented navigation employing depth predictions. Firstly, the inherent pixel-wise problem was already quite difficult to address, but the effect of water on light propagation made the task even more challenging. As a result, I changed the value of each pixel in RGB images according to the law of light propagation in water and distance information from the corresponding RGB-D images. With the processed dataset, the pre-trained network got better performance. Secondly, it was necessary to take into account the goal position and obstacle avoidance of the robot at the same time. The key was to balance the two aims and avoid falling into *local optima* – the neural network only focuses on one task but ignores the other one. Finally, by designing a reasonable network’s structure and using a smooth reward function, the system achieved the objectives that it navigates an AUV to the wanted goal positions and avoids nearby obstacles in the water. By performing quantitative experiments, the proposed navigator’s high efficiency has been demonstrated. And field experiments in a swimming pool also showed its robustness and reliability. The autonomously swimming robot reminded me of the wise robot artist, **Zima** and strengthened my aspiration to engage in future creations on more intelligent robots.

The highly interdisciplinary nature of robotics requires its practitioners to possess broad intellectual dimensions and a comprehensive understanding of the domain. But among the subareas, the most exciting topic has always been developing and exploring intelligence for the robots with AI algorithms, while computer science is their foundation. As one of the strongest universities in the world, University of Edinburgh is at the forefront of CS and AI while this program provides diversity and interdisciplinary studies in these fields. I’m especially intrigued by the research projects of Chris Lu, using multi-modal data for robot-environment interaction. Therefore, I genuinely hope to have the opportunity to join the excellent academic community at Edinburgh School of Informatics. I also plan to pursue a Ph.D. or enter a company for the development of intelligent mobile robots after graduation. I’m confident that I’ll be a qualified candidate. Holding this belief, I look forward to contributing to the projects and research here with my ability, insight, and passion. Hereby, your favorable consideration would be much appreciated.