Weihao Yuan

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EDUCATION & WORK

2016.09- Hong Kong University of Sci & Tech Hong Kong, China

- PhD Candidate in Robotics Institute, Department of Electronic & Computer Engineering
- Research Area: Deep Reinforcement learning, Robot Motion Planning, 3D Vision Depth Estimation
- Supervisor: Michael Yu Wang Co-supervisor: Qifeng Chen

2018.03-2018.09 KTH Royal Institute of Technology Stockholm, Sweden

- Visiting researcher in Robotics, Perception and Learning Lab, Centre for Autonomous Systems, School of Electrical Engineering and Computer Science.
- Supervisor: Danica Kragic

2017 Spring & Fall Teaching Assistant in Dept. ECE, HKUST Hong Kong, China

- Machine Learning and Information Processing for Robotic Perception (ELEC4010K), working with Prof. Ming Liu
- Control System Design (ELEC4010G), working with Prof. Li Qiu

2012.09-2016.06 Zhejiang University Hangzhou, China

- Bachelor of Engineering in Automation, Minor in Finance
- **GPA**：3.91/4 **Rank**：6/142

PROJECT EXPERIENCE

2019.12- A Unified Framework for Self-supervised Object Tracking and Segmentation

- Supervised object tracking, detection or segmentation suffer from laborious annotation work. On the contrary, we are employing the internal relationship in these task and underlying structure of images to do a self-supervised framework.

2019.03-2019.11 Unsupervised Learning for Stereo matching with Multiscopic Images

- We propose a new self-supervised framework for stereo matching utilizing multiple images captured at aligned camera positions. A cross photometric loss, a self-supervision loss, and a new smoothness loss are introduced to assist the network to learn to estimate the disparity map end-to-end without ground-truth depth information. Trained with only the indoor synthetic images, our network can perform better than all previous unsupervised methods in unseen outdoor KITTI dataset.

2018.12-2019.07 Towards Learning to Detect and Predict Contact Events on Vision-based Tactile Sensors

- We propose to classify and predict tactile signal using deep learning method, seeking to enhance the adaptability of the robotic grasp system to external disturbances. We develop a deep learning framework and collect tactile image sequence with vision-based tactile sensor, FingerVision. The neural network is integrated into a FingerVision-based robotic grasping system to detect the current and predict the future grasping state, e.g. rolling, slipping or stable contact.

2018.10-2019.06 MFuseNet: Robust Depth Estimation with Learned Multiscopic Fusion

- We design a multiscopic vision system that utilizes a monocular camera to acquire accurate depth estimation. Unlike multi-view stereo with images captured at unconstrained camera poses, the proposed system controls the motion of the camera to capture a sequence of images in horizontally or vertically aligned positions with the same parallax. We propose a new heuristic method and a robust learning-based method to fuse multiple cost volumes between the reference image and its surrounding images. Trained with the synthetic dataset we built, our method outperforms previous stereo and multiscopic approaches.

2018.06-2019.09 Sorting Cluttered Tabletop Using Improved Monte Carlo Tree Search

- In industrial environments, there are many tasks about sorting and rearranging different kinds of objects. Inspired by AlphaGo, we propose an improved MCTS to do this. We use the results of a classical MCTS to train a policy network and then use the network to guide the tree search.

2018.03-2018.09 Manipulation Using Deep Reinforcement Learning in Topology Space

- We model a whole arm manipulation task about holding as a deep reinforcement learning problem in order to provide a behavior that can directly respond to external perturbation and target motion. To improve the performance of deep learning in robotics application, we propose a new state as the input of the networks the topology representation. This state allows transferring the learned policy to various shapes, sizes and poses because they are the same in topology space. Compared to RGB image state or pose coordinates state, it can better describe the interaction state between the robot and environments.

2017.03-2018.05 Rearrangement Using Deep Reinforcement Learning and Transfer Learning

- In contrast to classic methods which can only handle static scene, as explicitly modeling the physical environment is not always feasible and involves various uncertainties, we learn a nonprehensile rearrangement strategy with deep reinforcement learning in simulation and then transfer the knowledge to reality. We propose potential field-based heuristic exploration and reply buffer curation to assist the training and propose a transfer method in Q-space to fill the gap between simulation and reality. The real robot handles the dynamic scene well with our approach.

2015.12-2016.05 Intelligent Forging Production Line with Industrial Robots Graduation Project

- Built a sensing system to acquire clear images of high-temperature forging; designed an algorithm to compute its size and pose for robot manipulation; developed the industrial software for the factory.

2014.05-2015.05 On-Road Lane Detection System Based on Machine Vision Member

- Detect the structured and unstructured road edge based on the gradient of brightness and the RGB information of the road to assist the driving of a Fuel Cells Go-Kart.

2013.09-2014.05 Ninth Robot Contest of Zhejiang Province Team leader

- Finished goalie task and shooting task. (4 tasks in total in the robot soccer game)
- Participated in designing the algorithm of path planning task and positioning task and got the second prize.

AWARDS & HONORS

2018	Overseas Research Awards, HKUST
2016	Outstanding Graduates of Zhejiang Province (and Zhejiang University)
2015	Excellent Student Awards; Alibaba New Media Scholarship
	Scholarship for Excellence in Research and Innovation
2014	First-Class Scholarship for Outstanding Students (Top 3%); Supcon Scholarship

SELECTED PUBLICATION

[1] **Weihao Yuan**, Michael Y. Wang, Qifeng Chen, “Self-supervised Object Tracking and Segmentation with Cycle-consistent Siamese Networks”, submitted to IROS 2020.

[2] **Weihao Yuan**, Yazhan Zhang, Bingkun Wu, Michael Y. Wang, Qifeng Chen, “Stereo Matching by Self-supervision of Multiscopic Vision”, submitted to ECCV 2020.

[3] **Weihao Yuan**, Rui Fan, Michael Y. Wang, Qifeng Chen, “MFuseNet: Robust Depth Estimation with Learned Multiscopic Fusion”, IEEE International Conference on Robotics and Automation (ICRA), published in IEEE Robotics and Automation Letters (RA-L), 2020.

[4] Yazhan Zhang, **Weihao Yuan**, Zicheng Kan, Michael Y. Wang, “Towards Learning to Detect and Predict Contact Events on Vision-based Tactile Sensors”, Conference on Robot Learning (CoRL), 2019. **Oral Presentation** (acceptation rate: 5.3%).

[5] **Weihao Yuan**, Kaiyu Hang, Danica Kragic, Michael Y. Wang, Johannes A. Stork, “End-to-End Nonprehensile Rearrangement with Deep Reinforcement Learning and Simulation-to-Reality Transfer”, Robotics and Autonomous Systems (RAS), 2019.

[6] **Weihao Yuan**, Kaiyu Hang, Haoran Song, Danica Kragic, Michael Y. Wang, Johannes A. Stork, “Reinforcement Learning in Topology-based Representation for Human Body Movement with Whole Arm Manipulation”, IEEE International Conference on Robotics and Automation (ICRA), 2019.

[7] **Weihao Yuan**, Johannes Andreas Stork, Danica Kragic, Michael Yu Wang, Kaiyu Hang, “Rearrangement with Nonprehensile Manipulation Using Deep Reinforcement Learning”, IEEE International Conference on Robotics and Automation (ICRA), 2018.

原玮浩

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教育 & 工作

2012.09-2016.06　　工学学士，浙江大学　　中国 杭州

- 主修：自动化　辅修：金融学
- GPA：4.50/5　专业排名：6/142

2017 春学期&秋学期　　助教，电子计算机系，香港科技大学　　中国 香港

- 协助刘明教授负责课程：机器人感知中的机器学习与信息处理（ELEC4010K)
- 协助邱立教授负责课程：控制系统设计（ELEC4010G)

2018.03-2018.09　　访问学者，瑞典皇家理工　　瑞典 斯德哥尔摩

- 在电子工程和计算机科学系，自动化中心，机器人感知与学习实验室做访问学者，与 Danica Kragic 教授一起工作，负责用强化学习解决机械臂运动规划问题的项目

2016.09-　　博士，香港科技大学　　中国 香港

- 在电子与计算机系 机器人实验室攻读博士学位
- 研究方向：深度强化学习，机械臂运动规划，三维视觉深度估计
- 导师：王煜（Michael Yu Wang)　　联合导师：陈启峰

项目经历

2013.09-2014.05　　浙江大学大学生机器人竞赛暨浙江省邀请赛(仿真组)　　队长

- 基于浙大机器人足球队的平台，负责四个任务中守门员任务和最佳射门点任务的算法设计和程序编写，参与设计路径规划和匹配点跑位的算法，最终带领队伍获得二等奖

2014.05-2015.05　　基于机器视觉的道路实时检测系统

- 参与完成了燃料电池卡丁车的机器视觉路况识别系统，设计并编写了基于亮度变化梯度的道路边缘提取程序和基于 RGB 三通道色彩模型的道路区域提取程序，以辅助驾驶

2015.12-2016.05　　工业机器人智能化锻造生产线的机器视觉研究与软件开发　　毕业设计

- 建立了可以获取高温锻件清晰图片的感知系统；设计了可以获取锻件大小和姿态的算法，以便于后续机械臂操作；开发了相应软件，以使整个锻造生产线实现完全自动化

2017.03-2018.05　　基于深度强化学习和迁移学习的非抓取机械臂操作

- 传统的机械臂运动规划算法一般会显式地对物理环境建模，但这在很多时候是不可行的，且往往会引入各种不确定性。与此不同，我们尝试在仿真器里用深度强化学习学习一种非抓取的动作策略，然后用迁移学习把学到的知识迁移到现实应用中。为了改进强化学习，我们提出一种基于势能场的启发式探索（heuristic exploration）和回放缓存管理（reply buffer curation）以提高学习速率和效果。为了填补仿真与现实的差异，我们提出一种新的在 Q 空间中的迁移学习方法。在使用了这些方法后，真实的机器人可以顺利地用手臂移动桌面物体以完成重新布置的任务，甚至可以很好地应对动态操作环境，因为运动规划的速度非常快，这对传统算法是非常困难的。

2018.03-2018.09　　拓扑空间中基于强化学习的机械臂运动规划

- 在这项工作中，我们使用强化学习对使用整只手臂的操作（whole arm manipulation）进行建模和学习，从而可以快速规划运动，应对动态的目标物体和外界变化。为了使强化学习更好地应用于机器人运动规划，我们提出了一种全新的状态描述作为网络的输入——拓扑表征（topology representation)。这种拓扑描述可以表征物体的相对位置关系和缠绕关系，与其他算法中使用的 RGB 图像输入或者位置坐标输入相比可以更好地描述机器人与外界环境的交互关系，并且可以将学习到的运动策略无缝迁移到不同形状、大小、姿态的操作物体上，因为在拓扑空间中它们并没有太大差异。

2018.06-2019.09　　AlphaSort：使用改进的蒙特卡洛树搜索来进行多物体移动的运动规划

- 在工业环境中，有很多任务需要机器人将大量多个物体同时移动到指定位置，杂乱无章的物体互相碰撞和阻挡，给机械臂操作带来困难。受到 AlphaGo 的启发，我们设计了一种改进的蒙特卡洛树搜索来解决这个任务。我们利用经典蒙特卡洛树搜索的结果来训练一个策略网络，然后用这个网络来引导树搜索，从而使蒙特卡洛树搜索在这一任务上的应用成为可能，高效且高成功率地完成了这一任务。

2018.10-2019.06　　MFuseNet：一种融合 Multiscopic 视觉信息的深度估计网络

- 我们设计了一种全新的视觉系统——Multiscopic Vision。传统的多目视觉系统中，每张照片是从随意的位置拍

摄的。与此不同，在 Multiscopic 系统中，我们拍摄一系列在水平方向或垂直方向对齐、共面且视差相同的照片，也就是说摄像头位置是受到约束的，这样在匹配像素点的时候可以引入很多约束，从而提高匹配精度，进而大大提高深度估计的精度和鲁棒性。与立体视觉（stereoscopic vision）类似，利用这些约束条件，我们提出了一种启发式的图割算法（graph cuts）和一种基于神经网络的深度算法来融合中间图与上下左右图之间匹配得到的多个损失量。同时为了训练这个网络，我们利用 3D 渲染引擎合成了一个全新的 multiscopic 大型数据集，这个数据集可以用于更广泛的任务，如多目图像增强、超分辨率、多视角图像合成等。在公开数据集 Middlebury 上，我们算法的表现超过了之前的双目和多目算法，尤其在困扰双目算法的无纹理区域、反光区域和遮挡区域。

2018.12-2019.07　　在高维视觉触觉传感器中学习检测和预测机械手与物体接触状态

- 为了增强机器人抓取系统对外界干扰的抵抗能力，我们提出使用深度学习的方法来理解高维触觉传感器信号，以辨识和预测机械手末端接触物体的状态。我们设计了一个新的网络架构，并且利用基于视觉的高维触觉传感器（FingerVision）收集传感器图像信号来构建一个训练数据集。经过训练，辨识网络和预测网络被嵌入到机器人抓取系统中来检测当前抓取状态并且预测之后的抓取状态，如滚动、滑动、剪切、稳定等，从而可以让机械手及时地调整动作以实现更鲁棒的抓取。

2019.03-2019.11　　在多目图像中无监督地学习立体深度估计

- 我们提出了一个全新的自监督学习立体匹配深度估计的架构。这个架构使用了在对齐位置拍摄的多目图像（multiscopic images）。我们设计了三个损失函数在没有真实深度的情况下端到端地学习如何估计深度图：交叉光度损失函数、自监督损失函数和平滑损失函数。使用我们用 3D 渲染引擎合成的室内数据集进行简单训练，这个网络在室外 KITTI 数据集上的表现就超过了之前的无监督方法，无需在 KITTI 或类似数据上进行微调，展现了惊人的泛化能力和稳定的高性能表现。

2019.12-　　CycleSiam：一个自监督学习物体追踪和视频分割的统一架构

- 物体追踪、检测或分割的监督学习长期受到繁重的标注工作的困扰。因此，我们尝试利用这些任务的内在关系和图像的深层结构来构建一个统一的自监督学习架构。

奖项荣誉

2014　优秀学生一等奖学金（Top 3%）；　中控奖学金
2015　优秀学生奖学金；浙报-阿里巴巴新媒体奖学金；研究与创新奖学金
2016　浙江大学优秀毕业生，浙江省优秀毕业生
2018　香港科技大学海外研究奖

论文发表 (selected)

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[4] Yazhan Zhang, **Weihao Yuan**, Zicheng Kan, Michael Y. Wang, “Towards Learning to Detect and Predict Contact Events on Vision-based Tactile Sensors”, Conference on Robot Learning (CoRL), 2019. **Oral Presentation** (acceptation rate: 5.3%).

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