DUO ZHANG

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EDUCATION

New York University
Master of Science in Courant Institute of Mathematical Sciences *2021/01-2022/12*
Shandong University
B.E. in Computer Science Department *2018/06-2020/06*
Undergraduate in Energy and Power Engineering Department *2016/09 - 2018/06*

WORKING EXPERIENCES

Copernicus Research Group, LightSpeed & Quantum Studio, Tencent America
Research & Development Intern *2022/06-Now*
Changhe Tu's lab, Interdisciplinary Research Center, Shandong University
Research Assistant *2020/06-2020/12*

RESEARCH EXPERIENCES

Copernicus Research Group, LightSpeed & Quantum Studio, Tencent America *2022/06-Now*
Research & Development Intern *Bellevue, WA, USA*

- **Provably Robust Semi-Infinite Program Under Collision Constraints via Subdivision**
  We present a semi-infinite program (SIP) solver for trajectory optimizations of general articulated robots. These problems are more challenging than standard Nonlinear Program (NLP) by involving an infinite number of non-convex, collision constraints. Prior SIP solvers based on constraint sampling cannot guarantee the satisfaction of all constraints. Instead, our method uses a conservative bound on articulated body motions to ensure the solution's feasibility throughout the optimization procedure. We further use subdivisions to adaptively reduce the error in conservative motion estimation. Combined, we prove that our SIP solver guarantees feasibility while approaching the critical point of SIP problems up to arbitrary user-provided precision. We have verified our method on a row of trajectory optimization problems involving industrial robot arms and UAVs, where our method can generate collision-free, locally optimal trajectories within a couple of minutes.

Daniele Panozzo and Lerrel Pinto's lab, CIMS, NYU *2021/09-Now*
Research Assistant *New York, NY, USA*

- **Teaching Robots How to Handle Deformable Objects**
  I created a series of openAI gym libraries and tutorials that integrated the PolyFEM (a physics simulator developed by Daniele's Group) to support reinforcement learning dealing with deformable objects. Besides coding, I set up a group of cameras to track the target objects and I also validated the feasibility of experiments we proposed on the real robot such as making the robot shoot a silicone rubber ball with a slingshot. This project is still in progress.

Changhe Tu's lab, Interdisciplinary Research Center, Shandong University *2020/01-2020/12*
Research Assistant *Qingdao, Shandong, China*

- **Grasp Planning as Infinite Programming Under Complementary Constraints**
  I was supervised by Prof. Xifeng Gao and Dr. Zherong Pan, and we propose an optimization-based approach to plan power grasps. Central to our method is a reformulation of grasp planning as an infinite program under complementary constraints (IPCC), which allows contacts to happen between arbitrary pairs of points on the object and the robot gripper. We show that IPCC can be reduced to a conventional finite-dimensional nonlinear program (NLP) using a kernel-integral relaxation. Moreover, the values and Jacobian matrices of the kernel-integral can be evaluated efficiently using a modified

Fast Multipole Method (FMM). We further guarantee that the planned grasps are collision-free using primal barrier penalties. We demonstrate the effectiveness, robustness, and efficiency of our grasp planner on a row of challenging 3D objects and high-DOF grippers, such as Barrett Hand and Shadow Hand, where our method achieves superior grasp qualities over competitors.

- **Human-like Trajectories Generation for Robot Arms Given Certain Properties**
  I designed a model using VAE + LSGAN which can generate human-like trajectories for some scenarios involving human robot interactions with certain given properties like smoothness and length etc. The main purpose of this project is to make the robot behavior more understandable and legible for human partners.

Sriram Sankararaman's lab, Computer Sciense Department, UCLA *2019/07-2019/09*
Research Assistant, Cross-disciplinary Scholars in Science and Technology Program *LA, CA, USA*

- **Identification of Cell-type-specific Genetic Regulation of Gene Expression for Transcriptome-wide Association Studies**
  We developed a new approach leveraging Tensor Component Analysis (TCA) to estimate cell-specific expression levels from bulk tissue measurements using single nucleotide polymorphisms (SNPs) as predictors. We show that this model performs well in simulations and applied it to a cohort of around 1,500 individuals with expression measured in blood, identifying SNPs that predict a significant proportion of variation in expression levels in four major white blood cells. These SNPs and their estimated effects can be used for cell-specific TWAS in large cohorts with genetic data such as the UK Biobank, which includes over 500,000 samples. I also built and published an R package named TWAS for our project. Here is our project's Poster. (Our Poster Link)

PUBLICATION

[1] **Duo Zhang**, Xifeng Gao, Kui Wu, Zherong Pan. Provably Robust Semi-Infinite Program Under Collision Constraints via Subdivision. *preprint on arXiv*

[2] Zherong Pan, **Duo Zhang**, Changhe Tu, Xifeng Gao. Planning of Power Grasps Using Infinite Program Under Complementary Constraints. *IEEE RA-L Letters 2022.*

PRESENTATION

Identification of cell-type-specific genetic regulation of gene expression for transcriptome-wide association studies
Poster presentation at UCLA CSST program

HONORS AND REWARDS

National Scholarship
Sponsored by Ministry of Education of the People's Republic of China
Excellent Cadre Scholarship
Sponsored by Shandong University
Excellent Student Scholarship
Sponsored by Shandong University
Provincial Third Prize of China Undergraduate Mathematical Contest in Modeling
Sponsored by China Society for Industrial and Applied Mathematics
Provincial Third Prize of The Chinese Mathematics Competitions
Sponsored by China Mathematics Society
Honorable Mention of Mathematical Contest in Modelling (MCM)
Sponsored by Mathematical Association of America
Provincial Third Prize of Internet+ Innovation and Entrepreneurship Competition
Sponsored by Ministry of Education of the People's Republic of China

Shandong University Basketball Game Advanced Individual
Sponsored by ANTA sports

SKILLS

Programming Languages
C++, Python, Java, Matlab
Other Skills
Metal Material Processing (including turning, milling, planing, forging, casting, molding, 3D printing and some CNC technologies)