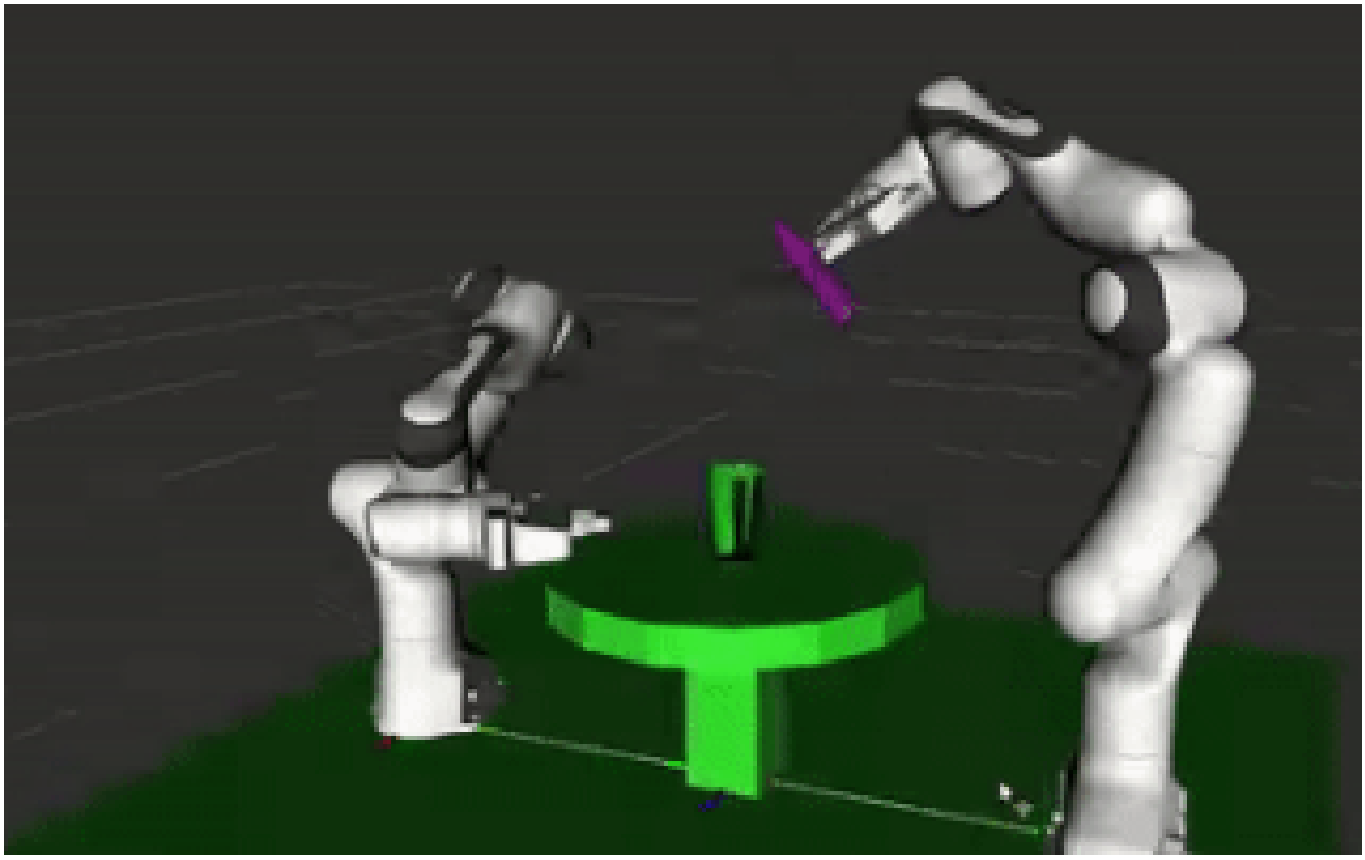
Task-Level motion planning for Multi-manipulator systems



Team: US-Cobots

Team Members

1. Muskaan Maheshwari

Present: MS(Owning), Robotics and Autonomous Systems(AI), Arizona State University, Tempe, Arizona, United States.
Past: BTech, Electrical Engineering, IIT Palakkad, India
Strength: Leadership, AI Algorithms, Deep Learning, Control System etc.

Contacts:
Email: muskaanmaheshwari13@gmail.com
LinkedIn: https://www.linkedin.com/in/muskaan-maheshwari-0103/

2. Rajendra Singh

Present: Sr. Software Developer @ R&D, US Technology
Past: BTech, Computer Science and Engineering, IIT Palakkad, India
Strength: ROS[1] , Perception[2], Robot-Manipulation[3], Open-source[4] etc.

Contacts:
Email: singh.raj1997@gmail.com
LinkedIn: https://www.linkedin.com/in/iamrajee/
Website: https://iamrajee.github.io/projects/
Youtube: https://www.youtube.com/channel/UCzNSEsxHfpq_84-EkU9CRnQ

3. Shravani Ventrapragada

Present: MS(Owning), Robotics and Autonomous Systems(AI), Arizona State University, Tempe, Arizona, United States.
Past: BTech, Electronics and Telecommunication Engineering, Symbiosis Institute of Technology
Strength: OpenCV, Control System, Deep Learning, AI Algorithms etc.

Contacts:
Email: vsshravani99@gmail.com
LinkedIn: https://www.linkedin.com/in/shravani-ventrapragada/

Description

We want to solve the problem of multi-arm manipulation. There are various complex manipulation tasks[5] with can't be done using a single[6] robotic arm and require two or more arms[7]. However, as the number of arms increases, the manipulation task becomes more complex as they have a shared space. Additionally, to get the optimal performance, all the arms have to work with each other to accomplish more complex tasks which can't be done using a single arm otherwise.

Our solution is to use task-level[8] motion planning to break down the complex task into more simple sub-tasks and then use multi-arm planning avoiding all obstacles and self-collision on the way using pointcloud[9] from the OAK-D-Lite camera.

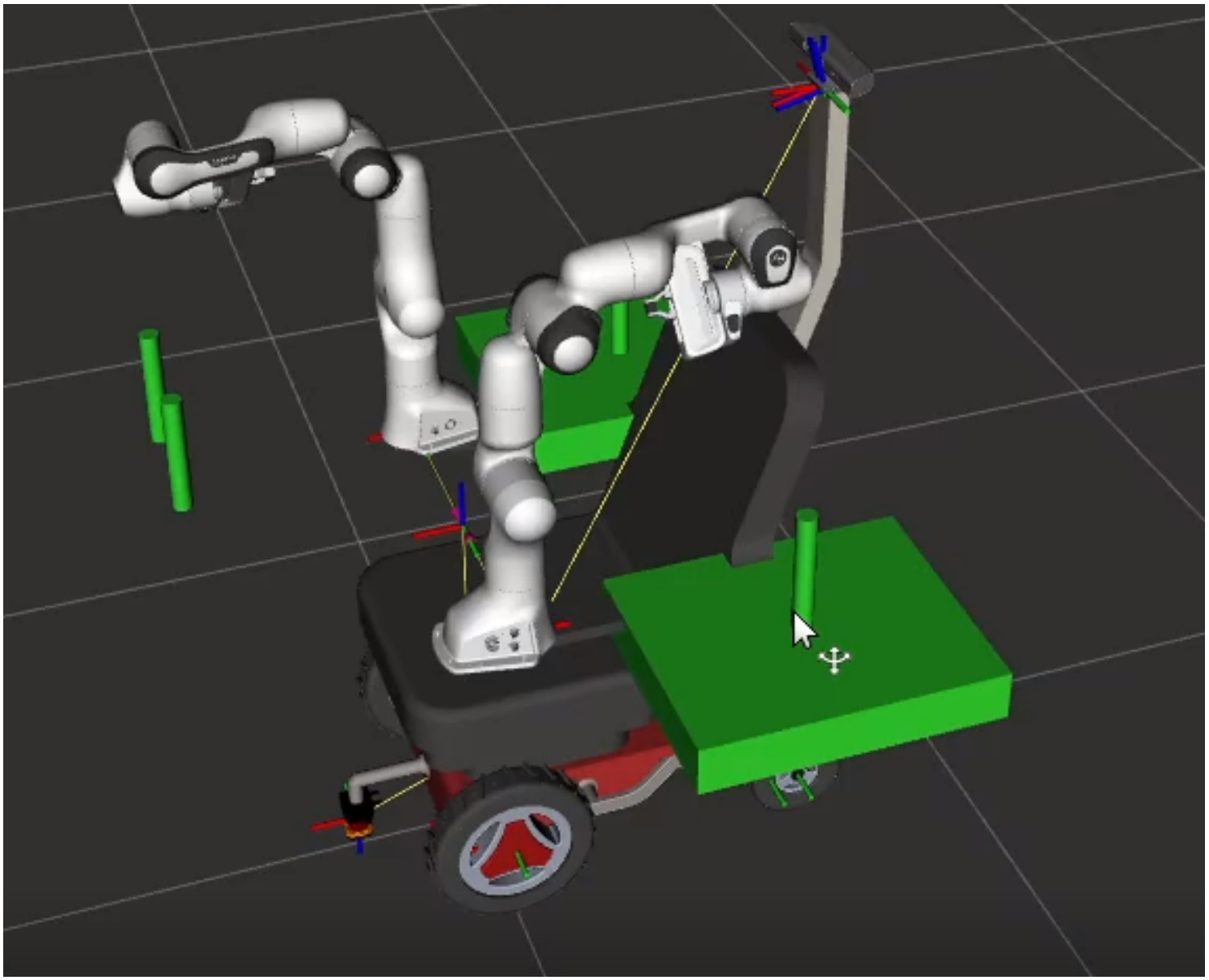
We see great potential in our solution primarily because our long term goal is to implement a dual-robotics arm on a mind[10] controlled wheelchair[11]. We see this could bring great independence to war-amputees or those specially-abled people who have limited mobility. Our vision is total independence to those in need, i.e cooking, cloth changing, housework etc.

We will be using three OAK-D-Lite cameras to generate a 3D point cloud of the environment. Two OAK-D-Lite(*Auto Focus*) would be attached to the end-effect of each arm to give a closer look at the various objects in the environment. One more OAK-D-Lite(*Fixed Focus*) would be used to watch the entire scene for avoiding obstacles and self-collisions. Stereo images from OAK-D-Lite will be passed to the point cloud library(PCL)[12] and 3D-Object detection model[13] to create a 3D point cloud and then detect 3D objects in the scene to be able to manipulate with them.

Any 6-DOF arm can be used for manipulation tasks however for the initial prototype during 3 months, we are planning to use Lego Mindstorm kit to build two 6-DOF custom arms[14].

During 3 months we wish to at least accomplish a simple multi-arm manipulation task[15] autonomously with Lego arms and OAK-D-Lite stereo cameras.

Mockups



Link: https://youtu.be/-4GLB-gUQ7E

Prior Work/References

[1]. ROS Related Repositories: https://github.com/iamrajee/roskinectic_src, Few More...

[2]. Perception: https://github.com/iamrajee/perception_ws

[3]. Manipulated Code: https://github.com/iamrajee/ws_moveit

[4]. Open-source contributions: https://github.com/iamrajee

[5]. Multi-Arm Manipulation: https://youtu.be/tS2U0AX3r_M

[6]. Writing using Uarm: https://youtu.be/9NbwE4PMeyQ

[7]. Team RoboSimian Darpa Robotics Challenge - https://youtu.be/OesfwU1rsyg

[8]. Task-Level Motion Planning for Multi-Manipulator System: Report, Presentation

[9]. Manipulation in 3D: https://youtu.be/gf0l-3L9S58, https://youtu.be/WAmr9yiQ7aw

[10]. Team CEREBROS OpenCV AI Competition 2021: https://youtu.be/yrghhSulJKs

[11]. Aachen Armchair Engineers: https://youtu.be/Ezp-A3RLB5o

[12]. PCL-Based Shape(Cylinder) Detection: https://www.youtube.com/watch?v=Hbbucm-V4uo

[13]. 3D-Object(drones) detections using with stereo camera: https://youtu.be/Q3dO8PBsrjI

[14]. Lego 6-DOF ARM: https://youtu.be/7zobzqcsjIQ, https://youtu.be/LEbUUOfdNLM

[15]. Multi-Arm Construction: https://youtu.be/K7N7RMx9Q88