EECE 5554 Quaternions Proposal and Team Contract
(remixed from https://web.mit.edu/6.005/www/fa15/projects/abcplayer/team-contract/)

Scope and description of work

- **Project Title:** *Semantic Mobile Manipulation with TurtleBot 4*

- **Problem / Topic:**
  We will command a TurtleBot 4 to move autonomously using its built-in sensors and functions, incorporating both the Nav2 stack and a set of custom algorithms for higher-level decision making. The goal is to enable the robot to recognize, approach, and interact with physical objects in its environment using visual and spatial perception.

- **Data Collection:**
  All data will be collected using the TurtleBot 4's onboard sensors, including the OAK-D depth camera, LiDAR, and built-in odometry sensors. These will be used for localization, mapping, and environmental awareness.

- **Analysis and Algorithms:**
  We plan to use ROS 2 (either the Humble or Jazzy distribution) as our core framework for robot control and communication. Navigation will likely rely on built-in SLAM and path-planning capabilities, supplemented by Python scripts for control and coordination. Libraries such as OpenCV, and YOLO will be utilized for various image processing functions.

- **Team Members:**
  - David Ross
  - Rongxuan Zhang
  - Zesong Guo
  - Junrui Xu

- Task assignments will be finalized once the architecture and hardware setup are stable. Work will generally be divided by modules, with each member responsible for specific components and expected outputs.

- **Project Levels:**

- **Level 1 — "No Sweat" Goal:**
  Set up all required environments (ROS 2 Humble/Jazzy, Docker, and necessary drivers).
  - **Functionality:** Establish communication with the TurtleBot 4, and verify access to core sensor feeds (LiDAR, camera, odometry).
  - **Utilities:** Utilize its OAK-D camera and a pre-trained object detection model (such as YOLO) to identify objects within its line of sight. Use SLAM toolbox to generate maps and have generic path finding capabilities.

- **Level 2 — "Target" Goal:**
  At this level, the project expands to include basic manipulation capabilities. There are two possible approaches depending on hardware feasibility:
  - **Mounted Arm Approach (preferred):** A lightweight robotic arm will be mounted on the TurtleBot. The robot will identify a selected object, navigate to it, align appropriately, and use the arm to pick it up. It will then deliver the item to a designated drop-off location.
  - **Station Rendezvous Approach (alternative):** The TurtleBot will navigate to a fixed robotic-arm workstation. Using fiducial markers for precise positioning, the arm will place an object onto the TurtleBot, which will then transport it to another location.
  - **Expected outcome:** Successful integration of perception, navigation, and manipulation modules, with the TurtleBot reliably approaching objects or docking at a workstation and completing an object-transfer cycle.

- **Level 3 — "Stretch" Goal:**
  In the final stage, the system will evolve into a task-oriented mobile manipulation platform capable of executing a sequence of delivery operations.
  - The robot will autonomously determine routes between objects and destinations based on user-defined or sensor-inferred goals.
  - It will be able to receive simple task commands such as "pick up item A and deliver to location B," execute them using its existing perception and navigation subsystems, and return for the next assignment.
  - Optional stretch objectives include multi-item delivery scheduling, dynamic re-planning if obstacles appear, and simple voice or gesture-based task initiation.
  - **Expected outcome:** Demonstration of a fully integrated perception-navigation-manipulation system performing multi-step delivery tasks with minimal human intervention.

Meeting Norms

- **Meeting Location:** Primarily on campus after EECE 5554 class sessions (Tuesdays and Fridays at 3:30 PM).
- **Virtual Meetings:** Conducted via Microsoft Teams as needed.
- **Frequency:** At least twice weekly after class, with additional virtual sessions as required.
- **Attendance:** All members are expected to attend in-person meetings. Online meetings may be held between sub-teams collaborating on specific modules.
- **Follow-up:** Meeting notes and decisions will be posted in the Teams chat for anyone who must miss a session. Members who miss meetings are expected to review these notes and follow up promptly.

Communication Norms

- **Primary Platforms:** Microsoft Teams for group communication and updates; text and email for quick coordination.
- **Document Tools:** Google Docs or Microsoft Word for collaborative documentation and reporting.
- **Availability:** No known recurring conflicts beyond normal holidays. Members will communicate any special scheduling conflicts in advance.

Work Norms

- **Task Division:** Work will be distributed evenly based on project modules. Each member will have defined inputs, outputs, and deliverables for their assigned tasks.
- **Accountability:** If a team member cannot meet their commitment, an immediate team discussion will be held to reassign work and determine corrective actions.

- **Tracking Responsibilities:** Assignments and deadlines will be recorded in our shared Teams workspace.

- **Quality Control:** Work will be reviewed collaboratively during weekly meetings to ensure consistency.

- **Conflict Resolution:** If differing opinions arise on quality or implementation, the team will discuss options and vote (see below).

Decision Making

- Decisions will be made by team vote.
- At least two affirmative votes are required to approve a decision if full consensus cannot be reached.
- Team members are expected to remain open to feedback and avoid fixating on personal ideas without consensus.

Evaluations

- The project will be graded as a **team deliverable** rather than individual contributions.
- However, if a member consistently fails to complete assigned work or violates group norms, the issue will be documented and may be reviewed separately with the instructor.

Please write all your names here to indicate that you have read and agree to these work norms

Group: Quaternions

Members:

- David Ross
- Rongxuan Zhang
- Zesong Guo
- Junrui Xu