# Robot Embodiment: TIAGo

**SPECS**

| | |
|---|---|
| **Height** | 110–145 cm |
| **Footprint** | ø 54 cm |
| **Arm Payload** | 3 Kg (without end-effector) |
| **Battery autonomy** | 4–5h (1 battery)/8–10h (2 batteries) |
| **Mounting points** | On head, laptop tray and mobile base |
| **OS** | Ubuntu LTS, Real Time OS |

Sensors:

- Force-torque sensor on wrist.
- Customizable laser and sonar sensors
- inertial measurement unit (IMU)
- RGB-D camera
- two microphone arrays.

# Prior Work: Robot Teleoperation

## Understanding Whole-body Robot Teleoperation Strategies Under Diverse Task Objectives and Constraints


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# Simulation Environment Development for TIAGo Robot For Human-Robot Collaboration

- **What Students Will Do:** Create the simulation environment (*simulated world and robot's presence in the environment*) to enable humans to tele-operate the robot inside the created environment. TIAGo is a dual-arm humanoid robot.
- **Deliverables:**
  - 3D Simulated Environment (choice of Unity, Issac Sim, etc.)
  - Account for human presence in the simulation through VR
  - Functional Robot Teleoperation in Simulated Environment
  - Demo (video or live) showcasing the combined creation
- **Size group:** 3
- **Skills:**
  - Required: 3D modeling, ROS, simulation, programming (python)

- **Mentors:** Kaitlynn Pineda (kpineda3@jhu.edu), Han Zhang (hzhan206@jhu.edu)

# Improving Real-Time Robustness for Human-Robot Communication In-The-Wild

Motivation:

- Deploying robots in the real world introduces a dynamic environment; systems will encounter varying lighting conditions, background noise, groups of humans, etc.
- To best support robot systems for human-robot interaction in the real world, it is crucial for the robot's understand of the human's communication attempts to be robust
- Ongoing research problems include knowing when someone is done speaking, performing speaker diarisation, and handling noisy environments, etc.
- What multi-modal approaches can be used to more strongly enhance the TIAGo's ability to understand humans in its environment in real-time for close-proximity interactions?
  - Available sensors on the TIAGo robot include:
    - RGB-D camera
    - two microphone arrays.

# Improving Real-Time Robustness for Human-Robot Communication In-The-Wild

**What Students Will Do:**

- Students will implement and test 3-5 different multi-modal approaches to explore solutions for noisy and complex environments. Options include vision-based, audio-signal processing, depth-sensing, etc.
- **Deliverables:**
  - Literature review with a short report on existing methods and their positives/negatives
  - Selection of 3-5 approaches with a test-plan for each, including defined metrics
  - Implement each approach for the TIAGo robotic system
  - Test each approach in real-time on the TIAGo system and report findings
- **Size group:** 1-3 (3 preferred)
- **Skills:** ROS, programming(Python), deep learning, signal analysis. Most appropriate for CS, EE or Robotics majors (current or past)
- **Mentors:** Kaitlynn Pineda (kpineda3@jhu.edu)

# Humanoid Robot Behavior Adaptations For Canine Encounters

Motivation:

- As humanoid robots become more prevalent, it is crucial to think about how their deployment can impact people in their daily lives
- Service dogs are legally permitted to accompany their handlers anywhere the public is allowed
- While task-trained service animals undergo extensive training, service dogs are not robots and can make mistakes, reacting to unknown stimuli. Thus, it is possible they could be overwhelmed if encountering foreign stimuli from humanoid robot behavior
- Dogs have sensitive hearing and are very attuned to movement; it is possible humanoid robot behaviors may interfere or distract them from their ability to carry out their task
- As designers and engineers, how can build robotic systems that can minimize interference and adapt for people who rely on service animal support due to their disability?

Additional Reference: Designing_For_Canine_User_Framework

# Humanoid Robot Behavior Adaptations For Canine Encounters

This project will encompass both engineering and a design research approach (UX/HCI research methods). Students will need to conduct proper user investigations (e.g. interviews) before finalizing and building their engineering solution.

- **Deliverables:**
  - [Research A] Conduct literature review on existing work
  - [Research B] Consult human-expert interviews; each person performs least 3 unique (e.g. service dog handlers, dog trainers, animal behavioralist or cognition researchers)
  - [Research C] Analyze results from interviews to identify 5 (minimum) potential humanoid (TIAGo) behavior adaptations
  - [Prototype] Implement the behavior adaptions on the TIAGo robot (first in simulation, then test on robot)
  - Receive feedback from human-experts on initial prototype
  - Produce a final prototype based on human-expert feedback
  - [Test] (*subject to recruitment availability*) Test solution with trained service animals or local canines and their handlers
- **Size group:** 1-3 (3 preferred)
- **Skills:** Human-centered research methods; ROS, Python
- **Mentors:** Kaitlynn Pineda (kpineda3@jhu.edu)