April Tag vision-based localization for Mobile Manipulation

Level: Exam project, Bachelor thesis, Master thesis, or an internship

Duration: 2 to 6 months

Start: By agreement

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Institution: ETF Robotics

Overview and Technology: This project extends a mobile manipulation pipeline by adding visual feature–based localization using AprilTags. A mobile manipulator (e.g., RB-KAIROS with a Franka Emika Panda and a wrist- or mast-mounted RGB-D camera) will use AprilTag detections as persistent visual landmarks to improve the robot's ability to localize task-relevant frames (tables, bins, fixtures) and to refine the relative pose between the mobile base, arm, and workspace. The student will integrate an AprilTag detection node into a ROS-based system, maintain consistent TF trees, and expose tag poses as "visual anchors" that can be used by MoveIt and navigation stacks to plan repeatable, precise whole-body motions for pick-and-place or interaction tasks, following the structure of existing ROS+MoveIt Panda projects.

Platforms / hardware	Software & tools
• RB-KAIROS mobile base with Franka Emika Panda 7-DoF cobot • Intel RealSense RGB-D camera (flange- or mast-mounted) • PC workstation	• Linux + ROS (ROS1/ROS2) • Python, C++ • MoveIt for motion planning • AprilTag / apriltag_ros package • OpenCV (optional for additional image processing) • Navigation stack (move_base)

Project options (projects can be modified based on student interests**)**

• AprilTag-based workspace calibration: automatically registering work surfaces, bins, and tool frames into the robot TF tree
• Visual tag–based task pose localization for mobile manipulation (e.g., fruit crates, shelves, tool stations)
• Evaluation of repeatability and robustness: compare tag-based localization versus pure odometry / SLAM for a simple pick-and-place task

Expected outcomes	Recommended background
• Working ROS package (or set of nodes) for AprilTag detection and TF integration with a mobile manipulator • Demonstration scenario: mobile manipulator navigates to a tag-defined workspace and executes a manipulation task using MoveIt • Short IEEE–style report detailing methods and experimental evaluation	• Basics of robot kinematics and coordinate frames (TF) • ROS basics (nodes, topics, TF, launch files) • Basic computer vision (camera models, extrinsic calibration)

Literature
• MoveIT tutorials
• ROS Basics
• April Tag tutorials