Assistive Robotic Arm Control using Niryo NED2 for Daily Living Tasks

Project Description:

This project focuses on the hardware implementation of a 6-DOF robotic arm (Niryo NED2) to assist individuals with disabilities in performing everyday tasks. The robot was programmed to perform activities such as:

Task 1: Pouring water into a cup

Task 2: Placing a lid on the cup

Task 3: Feeding food using a spoon

Task 4: Fastening a zipper on clothing

The robotic arm was controlled using Python and the pyniryo API. Each task was executed using predefined joint movements, with tuned grip strengths and wrist rotations. Additionally, preliminary attempts were made to simulate the setup in ROS2 Humble and Gazebo, validating basic motion planning in a virtual environment.

Project Objectives:

- Build a motion control pipeline for assistive robotic tasks using the Niryo NED2 arm
- Execute object manipulation tasks with safe and repeatable trajectories
- Adapt gripper configurations (rotation, force, opening width) for different objects
- Test motions in simulation using ROS2 Humble and Gazebo before hardware execution
- Evaluate robot accuracy, stability, and ergonomic alignment in human-centric tasks

Methods and Materials:

1. System Design

The Niryo NED2 robotic arm was mounted on a stable surface and calibrated using Niryo Studio. The control logic was implemented in Python using pyniryo, with pose-based and joint-space movements.

2. Algorithm/Model Development

The motion logic was defined manually using:

- Pre-calculated joint angles for pickup and placement
- Wrist pitch/rotation adjustments to maintain object orientation
- Grip strength tuning for objects like cups and spoons

3. Implementation Steps

- Defined each task's approach, pickup, action, and return poses
- Tuned wrist and elbow movements for realistic actions (e.g., simulating pouring)
- Configured strong grip values for zipper and lid handling
- Validated the poses in learning mode before scripting
- Wrote modular task-specific Python functions

4. Hardware Components (if applicable)

- Niryo NED2 Robotic Arm
- Niryo Standard Gripper
- Tabletop workspace with predefined zones
- Real-world items: cup, bottle, lid, spoon, zipper-enabled bag

5. Software Tools

- Niryo Studio (for calibration and testing)
- Python with pyniryo package
- ROS2 Humble (for simulation attempts)
- Gazebo (basic URDF integration and trajectory visualization)

Project Outcome:

1. Output results

- Successfully executed 4 assistive tasks using hardware
- Robust pose transitions and safe grip configurations
- Natural-looking feeding motion with 90° wrist control
- Straight-line zipper pull using Cartesian pose planning

2. Simulation video link (drive link)

Task 1: Pouring water into a cup

https://drive.google.com/file/d/1IDhjUwj-Z8eW_73UX-6APG37hO5RHOvC/view?usp=sharing

Task 2: Placing a lid on the cup

https://drive.google.com/file/d/1TF2nVHDAB8a3SMI96zPqmq61A5oFl-Ct/view?usp=sharing

Task 3: Feeding food using a spoon

https://drive.google.com/file/d/1gIGrWTJ1oroYud6jgcTNg93eaVRYRcCR/view?usp=sharing

Task 4: Fastening a zipper on clothing

https://drive.google.com/file/d/1E0Ppxaj9VkQeJaKNluUmUHOTofTkCCkf/view?usp=sharing

3. GitHub link (Source code)

   https://github.com/Soumyals/Assistive-Robotic-Arm-Control-

   using-Niryo-NED2-for-Daily-Living-Tasks.git

References:

- Niryo Official Documentation – https://niryo.com/docs/
- ROS2 Humble Tutorials – https://docs.ros.org/en/humble/index.html
- Gazebo Tutorials – https://gazebosim.org/tutorials
- https://github.com/NiryoRobotics/niryo_robot_ros2_humble
- Personal experimentation with pyniryo API and Niryo Studio