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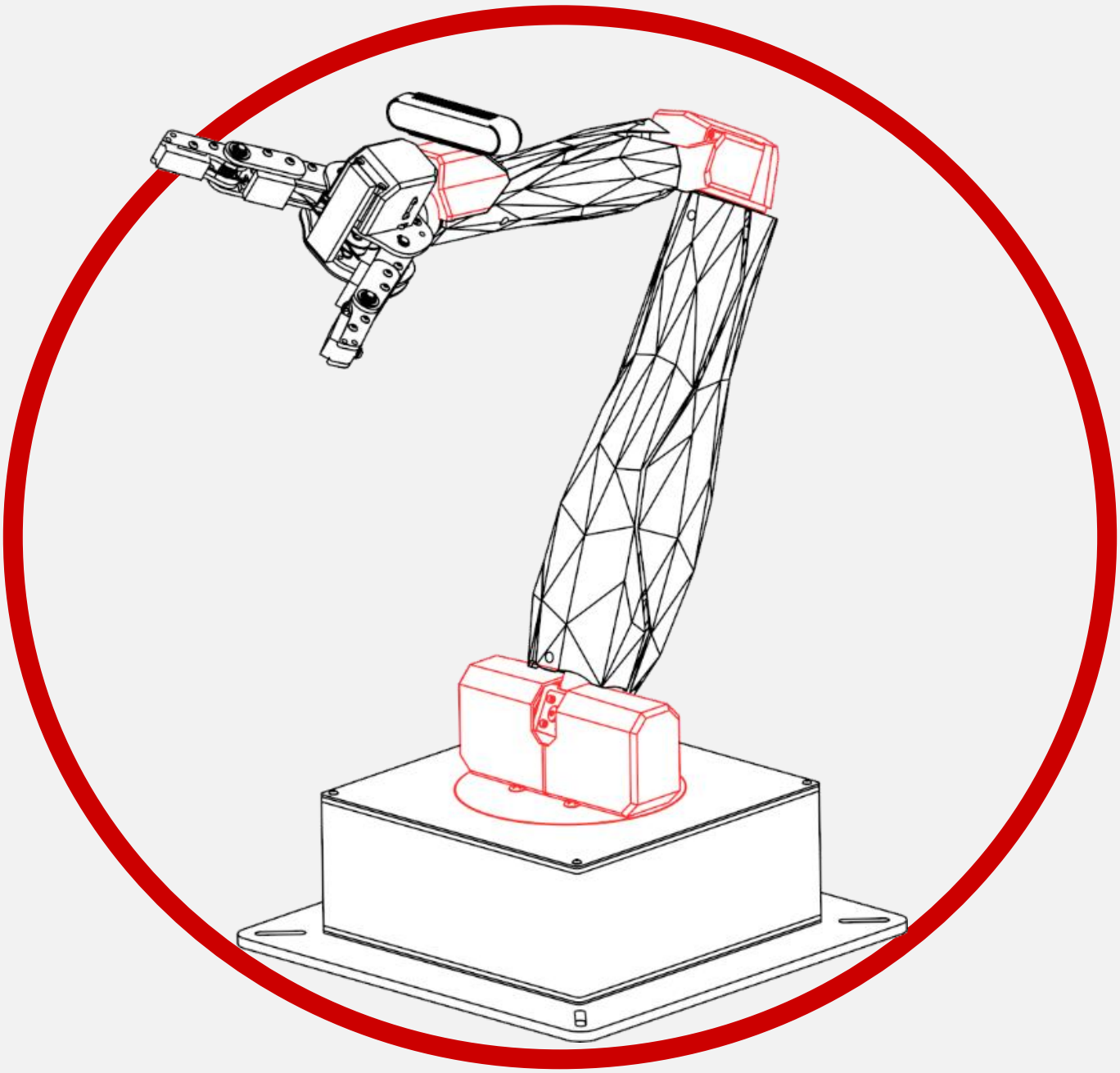

QArm

Basic IO

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Caution

This equipment is designed to be used for educational and research purposes and is not intended for use by the public. The user is responsible for ensuring that the equipment will be used by technically qualified personnel only. Users are responsible for certifying any modifications or additions they make to the default configuration.

QArm – Application Guide
Play

Why explore Basic IO?

Prior to operating any complex robotic system, it is imperative to familiarize yourself with the various components of the system. Part of the process involves functional testing of the system's individual hardware components, including its sensors and actuators, as well as validating the overall operation of the system. It also involves becoming familiar with the software environment which facilitates interaction with the system, as well as how to safely operate the system. The Quanser QArm is a 4 degree-of-freedom (DOF) serial robotic manipulator with an integrated RGB camera as well as an optional 2-finger gripper. You will use the MATLAB/Simulink environment with the QUARC real-time control software to design, develop, and validate a variety of robotic applications. In this lab you will explore various aspects of the QArm including how to interact with the system using MATLAB/Simulink and QUARC, the manipulator's input-output (IO), modes of operation, and safe operating procedures.

Background

The QArm content contains 1 labs that focuses on Basic IO. This lab focuses on understanding the differences between sending position commands to a QArm and sending PWM position commands.

Getting started

Ensure you have completed the following labs

Before you begin this lab, ensure that the following criteria are met.

- The QArm has been setup and tested. See the QArm Quick Start Guide for details on this step.
- You are familiar with the basics of Simulink. See the Simulink Onramp for more help with getting started with Simulink.

QArm Overview

The Quanser QArm, pictured in Figure 1, is a 4-DOF serial manipulator with a tendon-based two-stage gripper. You can independently control the base, shoulder, elbow, and wrist joints by commanding either angular position in radians or by providing a pulse-width-modulated (PWM) command. A user-programmable LED strip is located at the base of the unit.

Figure 1: Quanser QArm

Core specifications of the manipulator, including user input commands as well as feedback signals are summarized in Table 1.

Control Modes

The joints of the Quanser QArm can be operated using two different modes: position mode or PWM (voltage) mode.

In *position mode*, the built-in PID controller for each joint can be commanded an absolute angular position in radians as indicated in Table 1. If an angular position beyond the allowable range is commanded, the command will be coerced to the nearest minimum or maximum angle by the manipulator's built-in controller.

In *PWM mode*, the manipulator's built-in PID position controllers are bypassed, allowing each joint to be individually commanded using a PWM signal with a duty cycle ranging between -1 and 1. The joint controllers output a voltage ranging between 0 and 12 V, proportional to the commanded duty cycle. For example, a PWM command of 0.4 (40% duty cycle) will output 4.8 V to the desired joint, whereas a PWM command of -0.6 (- 60% duty cycle) will output -7.2 V to the desired joint.

While it is recommended to use operate the arm in position mode, PWM mode allows you to create your own custom controllers for a desired performance.

Gripper

The tendon-based two-stage gripper can be commanded a value ranging between 0 and 1. Proportional to the commanded value, the signal will adjust the angular position of the gripper fingers between 0˚ and 175˚. For example, a command of 0 will fully open the gripper, while a command of 1 will fully close it. The gripper motor also provides current feedback, which can be used to control the gripping force.

Joint degrees-of-freedom	4
Joint and gripper ranges	Base: -2.9671 rad (-170˚) to +2.9671 rad (170˚) Shoulder: -1.4835 rad (-85˚) to +1.4835 rad (+85˚) Elbow: -1.6581 rad (-95˚) to +1.3090 rad (+75˚) Wrist: -2.7925 rad (-160˚) to +2.7925 rad (+160˚) Gripper: 0 (0%) to 1 (100%)
Manipulator reach	754 mm (horizontal) and 894 mm (vertical)
Payload	750 g for 15 minutes 500 g for 25 minutes 250 g otherwise
Control rate	500 Hz

Base RGB LED	Input: R (0-1), G (0-1), B (0-1)
Position mode commands	Absolute position in rad; as per above ranges
PWM mode commands	Input a signed percentage: -1 to 1 Applying an output: -12 to 12 V
Feedback	Joint Position (rad) Joint Current (A) Joint Temperature (°C) Joint Velocity (rad/s) Joint PWM duty cycle (%) Gripper Position (%) Gripper Current (A) Gripper Velocity (%/s) Gripper PWM duty cycle (%)
User accessible IO:	Encoders I2C SPI UART PWM Regulated power
Vision	Intel RealSense D415 (RGB & depth)
Computer interface	QFLEX 2 USB

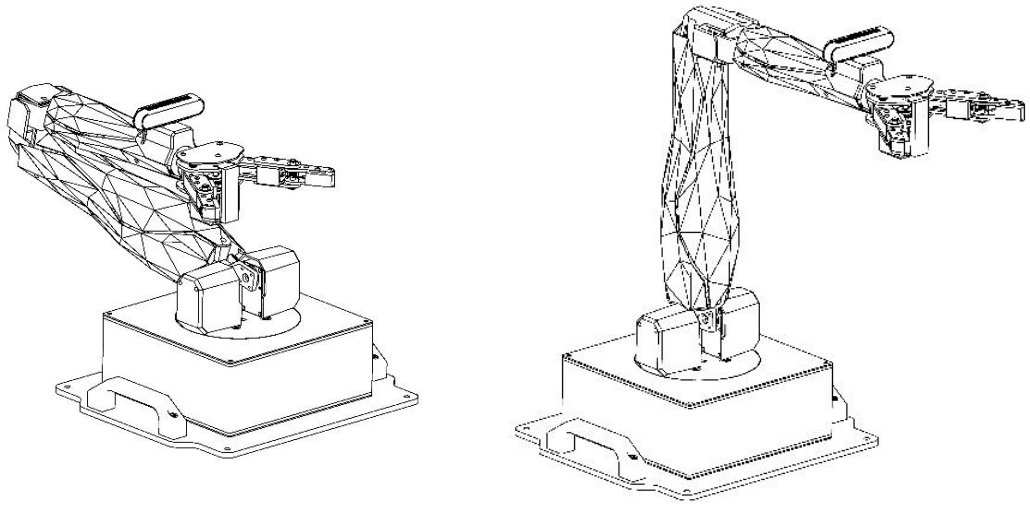
Table 1: QArm core specifications

Base LED

A user programmable RGB LED is located at the base of the manipulator. The color of the LED can be controlled by providing red, green, and blue values as a percentage between 0 and 1. For example, to set the color of the LED to red, a value of [1, 0, 0] must be commanded. Similarly, to set the LED to yellow, a value of [1, 1, 0] must be commanded.

Home Position

Figure 2 illustrates the rest position (a) and the home (or zero) position (b) of the QArm manipulator. When instructed to hold the manipulator in the home or zero position, carefully place the arm in the shown position and hold it firmly prior to powering on the system. To power down the manipulator after experimentation is complete, firmly hold the manipulator. Turn off the power using the power switch and move the manipulator to the rest position.



a. Rest Configuration Home Configuration

Figure 2. Rest and Home Configurations of the QArm (note the handlebars on the base)