

Individual Component Analysis – Dual Axis Actuator

Project Description

This project's objective is to design and manufacture a robotic arm with seven degrees of freedom. The goal is to give consumers a more affordable yet quality robot arm that can be utilized to collect data for machine learning and artificial intelligence.

Analyzed Component: DYNAMIXEL 2XL430-W250-T



Figure 1: DYNAMIXEL 2XL430-W250-T

The component that will be analyzed in this write-up is the DYNAMIXEL 2XL430-W250-T, a dual axis actuator sold by Robotis. This component is critical to the design because it serves as the connection between the robot's arm linkage and end effector. It also provides an additional two axes giving the end effector a wider range of mobility and flexibility.

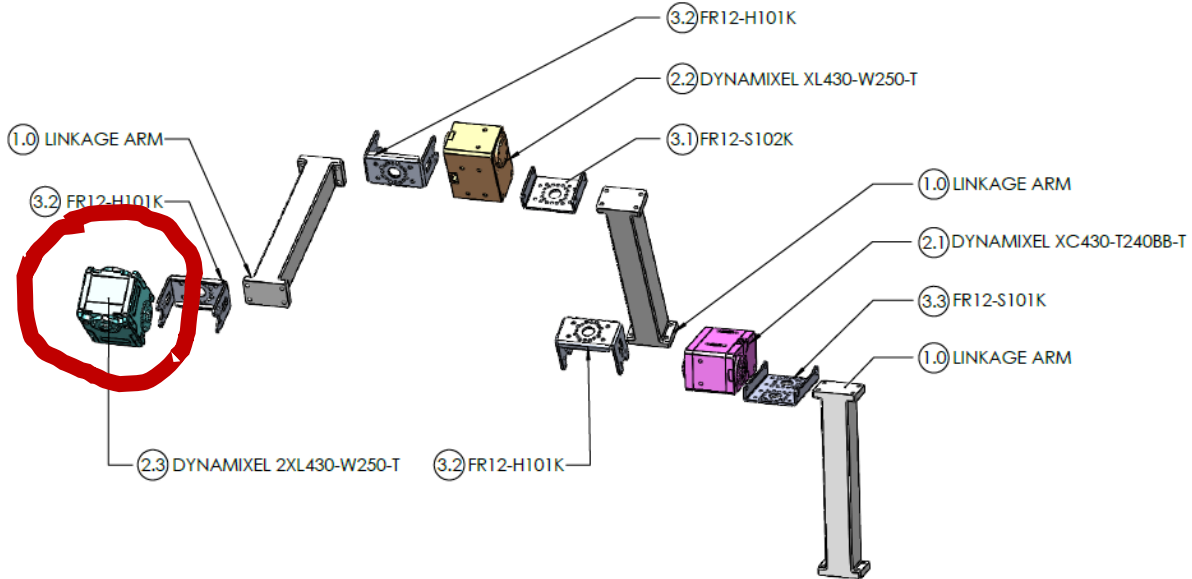


Figure 2: The DYNAMIXEL 2XL430-W250-T is the final component on the arm linkage and is what is used to join it and the end effector

Functional Requirements

Requirement Code	Requirement
FR-001	The actuator shall be capable of supporting the end effector
FR-002	The actuator shall be capable of lifting a load of 500 grams when grabbed by the end effector
FR-003	The actuator shall be dual axis or utilize two actuators for two degrees of freedom

Component Options

The project's sponsor set a requirement that all actuators were to be Robotis brand. This meant options were limited to their catalogue. The following is a short description of three alternate options to the DYNAMIXEL 2XL430-W250-T.

DYNAMIXEL 2XC430-W250-T:



The 2XC430-W250-T is a dual axis actuator with a 1.8nm stall torque.

DYNAMIXEL XL430-W250-T:



The XL430-W250-T is a single axis actuator with a 1.4nm stall torque. Two in junction are required to achieve an equivalent number of degrees of freedom.

DYNAMIXEL XL330-M288-T:



The XL330-M288-T is a single axis actuator with a 0.52nm stall torque. Two in junction are required to achieve an equivalent number of degrees of freedom

Summary Table

Component Name	Cost	Pros	Cons
2XL430-W250-T.	\$129.90	<ul style="list-style-type: none">• Dual Axis• Inexpensive• Good torque• Metal Gears	<ul style="list-style-type: none">• Large
2XC430-W250-T	\$259.90	<ul style="list-style-type: none">• Dual Axis• High torque• Metal gears	<ul style="list-style-type: none">• Large• Expensive
XL430-W250-T	\$49.90	<ul style="list-style-type: none">• Inexpensive• Good torque	<ul style="list-style-type: none">• Single Axis• Plastic gears
XL330-M288-T	\$23.90	<ul style="list-style-type: none">• Inexpensive• Small and light	<ul style="list-style-type: none">• Single Axis• Low torque• 5V input

Component Justification

The reason for selecting the 2XL430-W250-T is primarily for its dual axis operation, cost and for having a good stall torque.

Dual axis capabilities play a big role for the actuator selection. It is desirable to have two axes for the end effector because it gives it additional movement and rotation for it to pick up objects. Besides the 2XL430-W250-T, the 2XC430-W250-T is the only other dual axis actuator that Robotis sells. It has a stronger motor with a stall torque of 1.8nm over the 1.4nm of the 2XL. The major drawback to it, however, is that it is double the cost. Additionally, the XC series of actuators are praised for their more durable metal gears, however, the 2XL is also equipped with metal gears. The twice as large price tag is unjustifiable because its only standout attribute over the 2XL is its higher stall torque. Because this actuator is placed right before the end effector, the moment on the motors is not as large, especially compared to those closer to the base, so the additional torque isn't weighted as strongly. For the alternate single axis options, to achieve the same mobility as the dual axis, two actuators connected are required. This adds additional complexity and cost for required hardware. In addition, the total weight and size of two actuators generates a larger moment for the actuators at the base.

As stated before, the cost of the 2XC is unjustifiable for the little benefits it provides. The XL430 and XL330 are both cheaper options but requiring two doubles their cost. Using two motors, the XL330 still shows to be an affordable option. Looking deeper at its low stall torque of 0.52nm, it is roughly a third of the stall torque the 2XL, making it a less competitive option. Doing rough calculations, the motor needs at least 1nm of torque to fulfill the lifting capacity of 500grams for the project. The 2XC capable of 1.5nm of torque surpasses this target making it the clear choice of actuator.

Specifications

Weight: 98.2g

No-load RPM: 57 RPM

Dimensions: 36x46.5x36mm

Resolution: 4096 steps

Voltage Input: 11.1V

Stall Current

Stall Torque

Gear Ratio: 257.4:1

References

Sutyasadi, Petrus. *Control Improvement of Low-Cost Cast Aluminium Robotic ...*, repository.usd.ac.id/45285/1/9057_11+Control+Improvement+of+Low-Cost+Cast+Aluminium+Robotic+Arm+Using+Arduino+Based+Computed+Torque+Control.pdf. Accessed 8 Dec. 2022.

2XL430-W250 ..., <https://emmanual.robotis.com/docs/en/dxl/x/2xl430-w250/>

2XC430-W250 ..., <https://emmanual.robotis.com/docs/en/dxc/x/2xc430-w250/>

XL430-W250 ..., <https://emmanual.robotis.com/docs/en/dxl/x/xl430-w250/>

XL330-M288-T ..., <https://emmanual.robotis.com/docs/en/dxl/x/xl330-m288/>