JACO | RESEARCH EDITION

User guide

kinova

V1.0.0

ABOUT THIS DOCUMENT

 Read all instructions before using this product.

 Keep these instructions for future reference.

 Heed all warnings on the product and in this guide.

 Follow all instructions.

This document contains information regarding the setup and the operation of Kinova's JACO arm. It is intended for:

- Field service, customer support and sales employees of authorized distributor of JACO
- End user

Symbols, definitions and acronyms

 Important information regarding the safety of Kinova's products and their operator[1].

 Tip on the maintenance, operation and manipulation of Kinova's products.

 Refer to accompanied documents

 Direct current

 Alternating current

 Operating temperature range

 Compliance with WEEE[2] directive

[1] In order to ease the use of this document, a list of the most important warnings is presented in Appendix 4.

[2] Waste electrical and electronic equipment

 Compliance with ROHS[3] directive

 Class II electrical device rating

 Type BF Applied Part device

Warranty

For more information regarding the warranty included with your product, please refer to the sheet included in the JACO arm case.

[3] Restriction of hazardous substances

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TABLE OF CONTENTS

GENERAL INFORMATION

No modification of this equipment is allowed.

Do not modify this equipment without authorization of the manufacturer.

If this equipment is modified, appropriate inspection and testing must be conducted to ensure continued safe use of equipment.

The JACO robotic arm is a revolutionary device designed for multiple research applications. It is a leading product in a new generation of lightweight portable robotic manipulator that enables users to interact with their environment with complete safety, freedom, and effectiveness.

The JACO arm has a weight of 5.6 kg, can reach approximately 90 cm in all directions and can lift objects of up to 1.5kg[4]. It can be mounted on a mobile platform or a fix station (see following figure[5]).

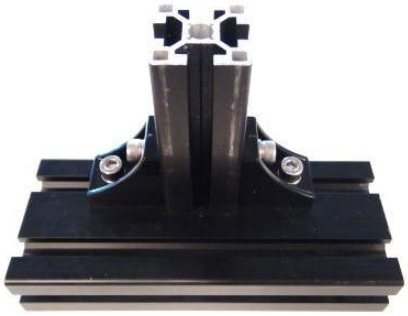


Figure 1 - JACO fix station

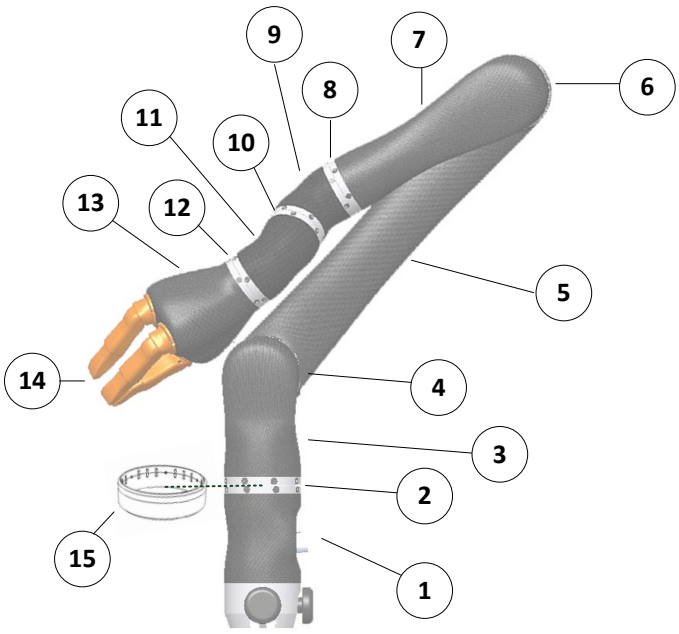
The Normal Use Definition contains some fundamental information to the proper operation of the JACO arm.

It is not recommended to let the JACO arm under heavy rain or snow.

[4] See the Normal Use Definition for more details on the JACO arm prescribed usage.

[5] You may access a short review of the installation procedure by following this link: www.youtube.com/watch?v=RsTLQx5NaIU

Part Identification



PART ID	NAME
1	Fixed Base
2	Actuator #1
3	Base
4	Actuator #2
5	Arm
6	Actuator #3
7	Forearm
8	Actuator #4
9	Wrist #1
10	Actuator #5
11	Wrist #2
12	Actuator #6
13	Hand
14	Fingers
15	Plastic Ring

Figure 2 - JACO part ID

External Connection

The following figure shows the external connectors located on the JACO arm fixed base[6].

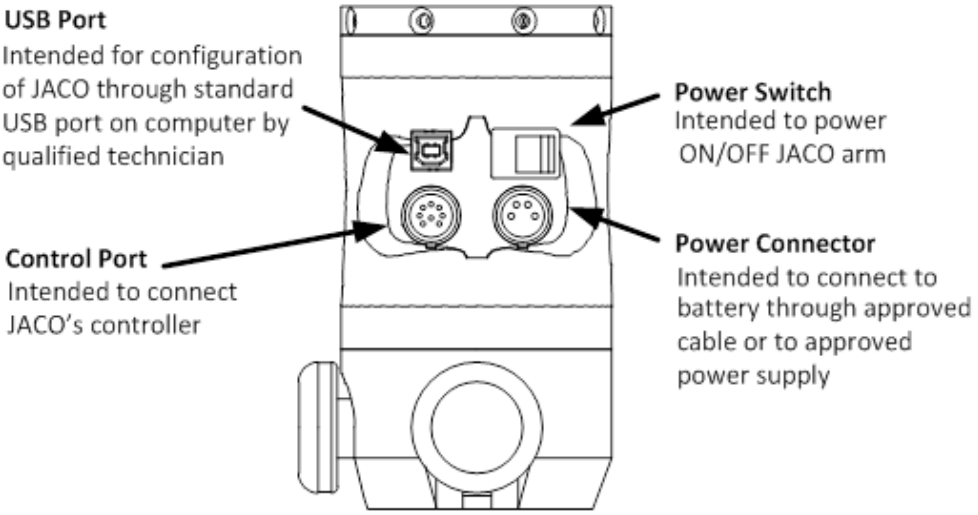


Figure 3 – JACO fixed base external connectors

[6] If you need more specific information about the use of any optional accessories and/or system, please contact your local distributor or Kinova Support (see Contacting Support).

Control Port and Power Connector are intended to be connected only with Kinova approved device. Connecting other devices may result in bad performance or even make your JACO inoperable and void your warranty.

Do not defeat the safety purpose of the polarized or grounding type plug. If the provided cable does not fit in your outlet, consult an electrician for replacement of obsolete outlet. (For table mounted unit only)

To prevent risk of fire or electric shock, avoid overloading wall outlets and extension. (For table mounted unit only)

Protect the cords from being walked on or pinched.

Programmable Systems Identification

The following figure details the software versions of the programmable systems installed in your JACO when it was shipped from the factory.

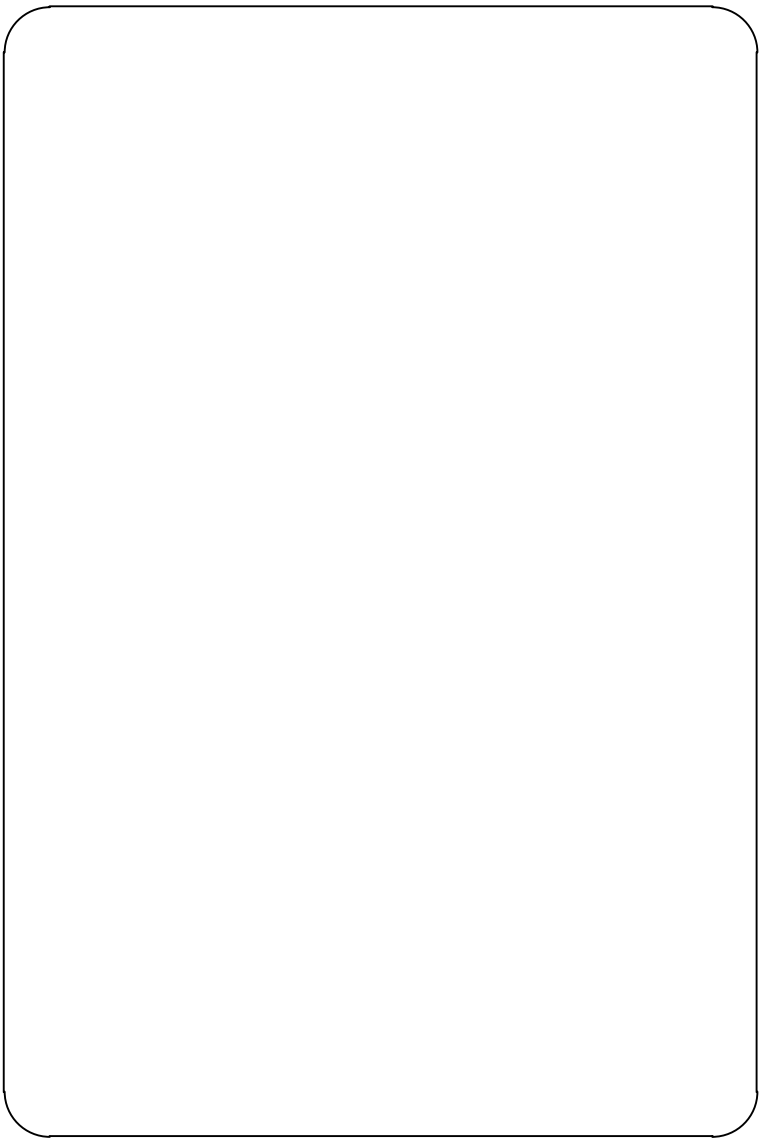


Figure 4 - Programmable systems identification

Specifications

ENVIRONMENT

General

- Ambient temperature from 0°C to 30°C
- Can be used under light rainfall for limited period (IPX2 rating)
- Can be used under normal atmospheric pressure conditions

Storage

- Ambient temperature from 0°C to 50°C
- Relative Humidity : 55% max

ELECTRICAL

Input Power

- Voltage: 18V to 29V d.c.
- Current : 2A in normal use, 10A max
- Powered by the external power supply

Output Power (controller port)

- Voltage: 24V +/- 20% d.c.
- Current : 1.5A continuous, 3A max

Power Supply

- Input power: 100V to 240V a.c., 50Hz to 60Hz, 2.0A
- Output power: 24V d.c., 5.0A
- Model: CENT1120A2451F01
- Mark: SL POWER ELECTRONICS CORP.
- Type: I.T.E POWER SUPPLY

MECHANICAL

General

- Total weight: 5.6Kg +/- 5%
- Maximum Load : 1.5kg at mid-range (45cm)
- Maximum Load : 1.0kg at end-range (90cm)
- Reach : 90cm
- Maximum linear arm speed : 15cm/sec

MECHANICAL	**Hand and fingers** ▪ 3 fingers or 2 fingers simultaneous utilisation ▪ Independent control available for each finger ▪ Finger force limited to 7N (1.54 lb_f) ▪ Flexible fingers for durability
FIRMWARE	▪ Each axis controlled independently ▪ Redundant security on each axis / fingers ▪ Redundant error check in joints and in control system ▪ Position and error calculation every 0.01 second ▪ Automatic recovery on system fault.

Please assure to follow the specified storing conditions when putting JACO away in its case.

User Profile and Learning Period

The user of the JACO arm must satisfy the following criteria:

- Be able to program functions with the API OR

  Be able to use the Kinova's joystick;
- Have necessary visuomotor ability to operate JACO at minimum speed.
- User knows how to safely operate JACO ;
- User understands well the basic movements of JACO;
- User has demonstrated a significant control over the JACO arm.

If JACO is to be used by a young user (age 10 or under), Kinova also strongly suggests that the use of JACO should be progressive and under adult supervision.

Marking and Label

Please note that these labels may slightly differ from the ones accompanying your device depending of your country. The following figure depicts the information about the label affixed on the JACO arm fixed base.

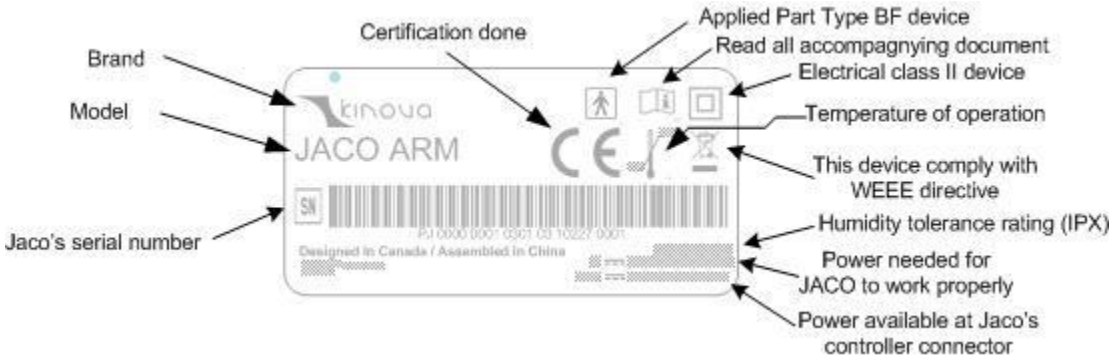


Figure 5 - JACO Label view

The following figure presents more info about the label apposed on the JACO arm box.

Figure 6 - JACO Box Label view

KINOVA'S JOYSTICK

The Kinova's standard controller is a 3 axis joystick mounted on a support which includes 5 independent push buttons and 4 auxiliary inputs (on the back side).

Part Identification

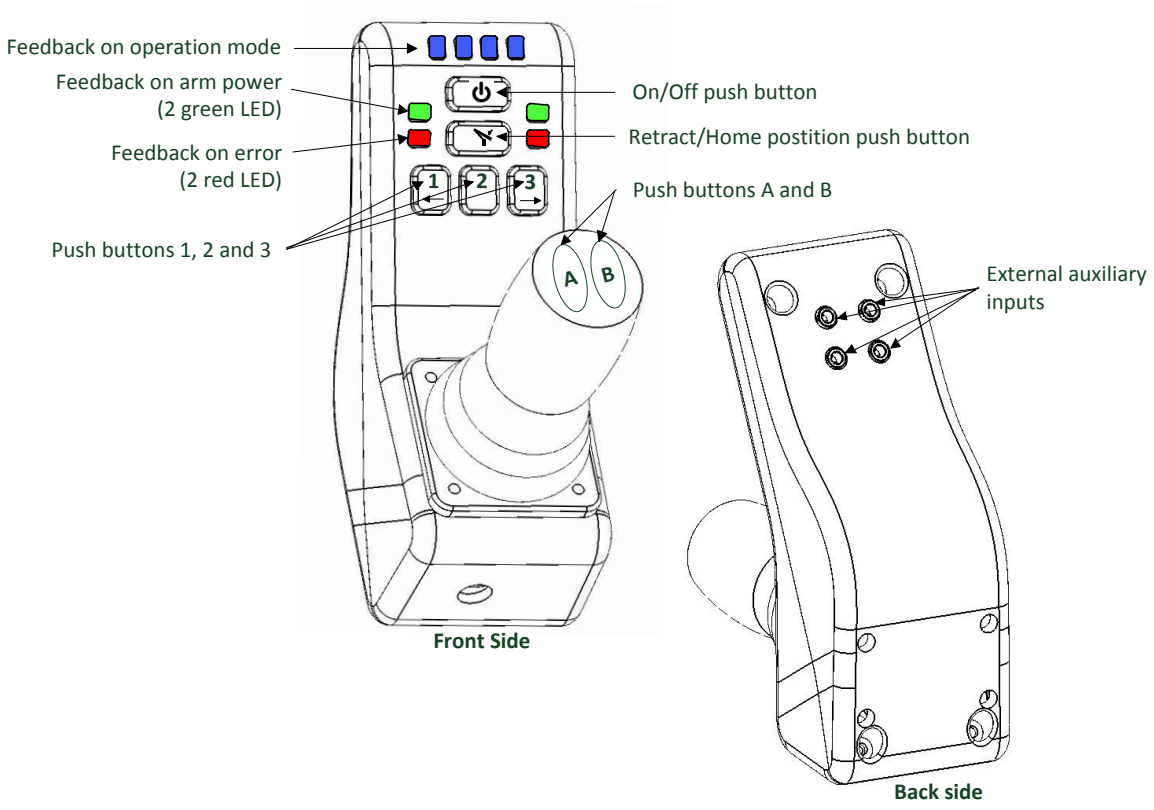


Figure 7 - Kinova's joystick part ID

Kinova's Joystick's Functions

The joystick allows two operation modes, i.e. the joystick may control the JACO arm using either 2 or 3 axis. The "2-axis" operation mode will disable the rotation of the lever[7].

The following table lists the default factory settings for the use of the joystick's buttons for 3-axis and 2-axis control.

[7] See Appendix 1 for joystick movements).

BUTTONS	ONE CLICK	HOLD 2 SEC (*HOLD UNTIL POSITION IS REACHED)
⏻	Deactivate/Activate Joystick	Change joystick operating mode (2-axis Vs 3-axis)
	---	HOME/RETRACT function*
3-AXIS		
1	Deactivate/Activate Drinking mode	---
2	---	Set Position
3	---	Go to pre-set position*
A	Reach Finger mode	Decrease speed
B	Reach Translation & Wrist mode	Increase speed
Ext1	Reach Finger mode	Decrease speed
Ext2	Reach Translation & Wrist mode	Increase speed
Ext3	---	HOME/RETRACT function *
Ext4	Deactivate/Activate Drinking mode	---
2-AXIS		
1	Deactivate/Activate Drinking mode	---
2	Reach Wrist orientation & Finger mode	Decrease speed
3	Reach Translation-X/Y & Translation-Z/Wrist rotation mode	Increase speed
A	---	---
B	---	---
Ext1	Reach Wrist orientation & Finger mode	Decrease speed
Ext2	Reach Translation-X/Y & Translation-Z/Wrist rotation mode	Increase speed
Ext3	---	HOME/RETRACT function *
Ext4	Deactivate/Activate Drinking mode	---

Figure 8 - Joystick Buttons Use

Visual retroaction

Kinova's joystick offers visual retroaction such as:

- Blue lights : Feedback on control mode (see following table)
- Green lights : Feedback on arm power
- Red lights : Feedback on error

BLUE LIGHTS RETROACTION

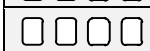
BLUE LIGHTS		CONTROL MODE
3-Axis		Translation (X-Y-Z)
		Wrist
		Finger
		Drinking mode (to use with wrist rotation mode)
		Disabled controller
2-Axis		Translation (X-Y)
		Translation (Z) / Wrist Rotation
		Wrist Orientation
		Fingers
		Drinking mode (to use with wrist rotation mode)
		Disabled controller

Figure 9 – Feedback on control mode

When no blue lights are visible, the controller is disabled. To enable the controller, you must either proceed with the following options:

- The On/Off button must be pushed;
- The JACO arm must be set in its HOME position by holding the HOME/RETRACT function until the JACO arm stops moving.

GREEN LIGHTS RETROACTION

The green lights offer visual feedback on the power status of the JACO arm:

GREEN LIGHTS	POWER STATUS
Flashing	The JACO arm has just been turned on and the internal communication is stabilizing. The JACO arm is not yet ready to use.
Solid	The JACO arm is powered and ready to use.

Figure 10 – Feedback on power status

RED LIGHTS RETROACTION

The red lights offer visual feedback on possible errors that may occur while operating the JACO arm:

RED LIGHTS	CAUSES OF THE ERROR STATUS	ACTIONS TO BE TAKEN IN ORDER TO RESOLVE THE SITUATION
Flashing	The weight that is being lifted is too heavy or too much force is applied on the arm.	Safely put down the object, or release force applied on the arm, and wait until red lights turn off.
	The temperature of a section of the arm is too high.	The usage of the arm is excessive and doesn't respect the normal use definition. Safely put down any object that is in JACO's hand, bring back the arm to its RETRACT position, and wait until red lights turn off.
	The input voltage to the arm (or batteries) is too low.	Safely put down any object that is in JACO's hand, bring back the arm to its RETRACT position. Ensure the power supply is appropriate and connections are secure, or batteries are charged properly before using the arm again.
Solid	The JACO arm is in fault.	Turn off the arm and turn it back on. If the problem remains, contact your distributor or Kinova.

Figure 11 – Feedback on error status

OPERATING PRINCIPLES

The JACO arm operating principles are very simple and intuitive. The JACO arm may be operated through several controllers. The following sections present the general control principles through Kinova's joystick.

Basic movements

The control over the JACO arm is said to be Cartesian as the user only controls movements of and around the hand. The different joints are piloted automatically following the given command. The JACO arm is capable of 16 different movements which may be divided into several modes of control. The following figure summarizes the different movements and modes of control related.

In the "*Translation mode*", the user controls the position of the hand in space. The hand will always keep its parallelism to the JACO fixed base. Translation X refers to left/right movements of the hand. Translation Y refers to front/back movements of the hand. Translation Z refers to up/down movements of the hand.

In the "*Wrist mode*", the user controls the position of the arm around the center point of the hand (reference point) which will not move (or move slightly) when operating this mode. Lateral orientation refers to a thumb/index circular movement of the wrist around the reference point. Vertical orientation refers to a top/bottom circular movement of the wrist around the reference point. Wrist rotation refers to a circular movement of the hand around itself.

The *"Drinking mode"* is to be used with the wrist rotation only. While operating the JACO arm in the *"Drinking mode"*, the reference point (normally set in the middle of the hand), is offset in height and length to produce a rotation that will compensate when user drinks from a glass or bottle without a straw.

In the "*Finger mode"*, the user controls the opening and closing of two or three fingers.

The JACO arm will sometimes respond differently to a given command than described in this section. This may be due to the singularity avoidance algorithms embedded in the kinematics. It is a normal protective behaviour of the JACO arm and is position dependant.

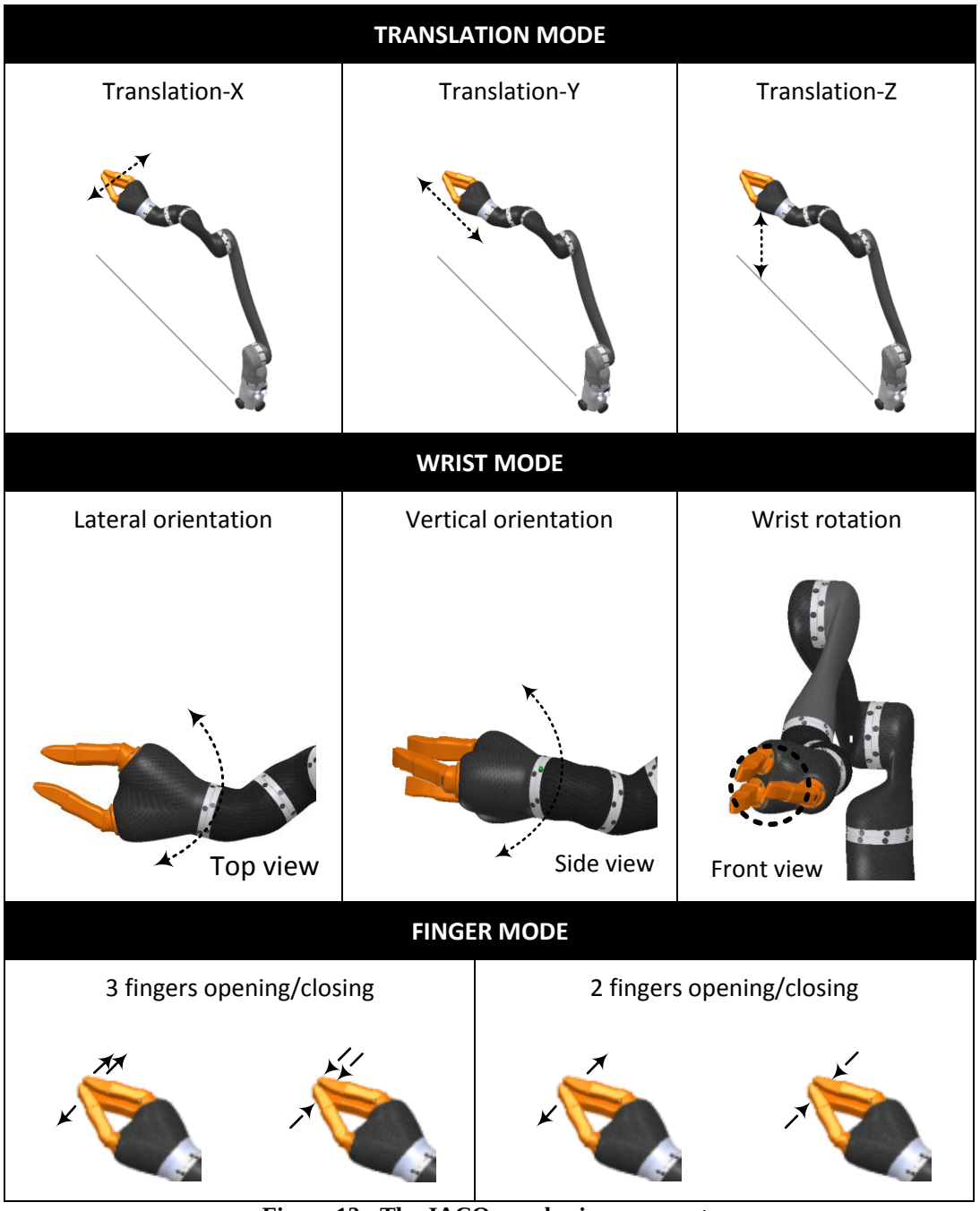


Figure 12 - The JACO arm basic movements

HOME/RETRACT Positions

The JACO arm comes with two factory default pre-set positions that may be configured by a certified technician: the HOME and the RETRACT position.

- The HOME position refers to the position of the arm when it is ready to be used. In the HOME position, JACO is awaiting a command from the joystick.
- The RETRACT position refers to the position of the arm when it is not used. The user should always place the arm in the RETRACT position when it is unused as it diminishes the physical volume occupied by the arm. In the RETRACT position, JACO is in standby mode; the joystick features are disabled and power consumption is much lower.

Never use the HOME/RETRACT function when carrying liquid. The HOME position is pre-set and the wrist may have to rotate and drop the liquid.

Operating the JACO arm

This section explains how to operate the JACO arm with factory configuration[8], contact your reseller for operation instructions with your adapted configuration.

Before operating the JACO arm, please make sure it is properly installed.

Wait for the JACO arm to reach room temperature prior using it.

Do not manipulate cutting, very sharp or any dangerous tools or objects with the JACO arm.

Do not eat directly with the JACO arm's fingers, always use utensil.

This equipment is not designed to act as patient lift.

This equipment is not designed to be used in presence of flammable mixture. (Not AP or APG rated).

Do not install the JACO arm near any heat sources, such as radiators. Do not use it to directly manipulate hot objects.

[8] You may also refer to the reminder presented in appendix 3.

The following instructions will help you start with the device[9]. For a step-by-step formation on the use of the JACO arm, please refer to appendix 2.

1) Turn ON the device by pushing the On/Off switch located on the JACO arm fixed base.
2) Wait until the green lights on the controller stop flashing.
3) Put the JACO arm in its HOME position by holding the HOME/RETRACT function until the JACO arm stops moving. The arm will slowly reach the HOME position.

When starting the JACO arm, you are in 3-Axis operation mode and "*Translation mode*".

One must open the fingers at their maximum opening range when using them after powering up JACO.

To change the operating mode of the Joystick, hold the On/Off button for 2 seconds. At this point, the stick rotation is not effective anymore.

When the power is turned off, the JACO arm will fall on itself and may damage itself, depending on its position at the time of disconnection. Be sure to support its wrist before turning the power off.

[9] Those steps may change upon different configurations.

THREE-AXIS MODE

JOYSTICK MOVEMENT	JACO ARM MOVEMENT
TRANSLATION MODE	
Incline FRONT	Hand moves forward
Incline BACK	Hand moves backward
Incline LEFT	Hand moves left
Incline RIGHT	Hand moves right
Rotate stick CLOCKWISE	Hand moves up
Rotate stick COUNTER-CLOCKWISE	Hand moves down
WRIST MODE	
Incline FRONT	Vertical orientation – Top side
Incline BACK	Vertical orientation – Bottom side
Incline LEFT	Lateral orientation – Thumb side
Incline RIGHT	Lateral orientation – Index side
Rotate stick CLOCKWISE	Wrist rotation clockwise
Rotate stick COUNTER-CLOCKWISE	Wrist rotation counter-clockwise
FINGER MODE	
Incline FRONT	Open Two Fingers
Incline BACK	Close Two Fingers
Incline LEFT	Close Three Fingers
Incline RIGHT	Open Three Fingers

Figure 13 – Reminder for 3-Axis operation mode

TWO-AXIS MODE

JOYSTICK MOVEMENT	JACO ARM MOVEMENT
TRANSLATION-X & TRANSLATION-Y	
Incline FRONT	Hand moves forward
Incline BACK	Hand moves backward
Incline LEFT	Hand moves left
Incline RIGHT	Hand moves right
TRANSLATION-Z & WRIST ROTATION	
Incline FRONT	Hand moves up
Incline BACK	Hand moves down
Incline LEFT	Wrist rotation clockwise
Incline RIGHT	Wrist rotation counter-clockwise
WRIST ORIENTATION	
Incline FRONT	Vertical orientation – Top side
Incline BACK	Vertical orientation – Bottom side
Incline LEFT	Lateral orientation – Thumb side
Incline RIGHT	Lateral orientation – Index side
FINGER MODE	
Incline FRONT	Open Two Fingers
Incline BACK	Close Two Fingers
Incline LEFT	Close Three Fingers
Incline RIGHT	Open Three Fingers

Figure 14 – Reminder for 2-Axis operation mode

Normal Use Definition

The limited warranty offered with the JACO arm is based on a normal use of JACO. The definition of a normal use of the JACO arm includes that you cannot exceed one or more of the values listed in the following tables:

GENERAL INFORMATIONS

CRITERIA	VALUES
Maximum linear speed	0.2m / sec
Maximum linear acceleration	1,6m / sec^2
Maximum weight lift at mid-range	1.5 Kg
Maximum weight lift at maximum range	1.0 Kg

Figure 15 - Normal use definition for JACO (general information)

ACTUATORS AND FINGERS

	MINIMUM POSITION	MAXIMUM POSITION
Axis 1	-1000°	+1000°
Axis 2	+42°	+318°
Axis 3	+17°	+343°
Axis 4	-1000°	+1000°
Axis 5	-1000°	+1000°
Axis 6	-1000°	+1000°
Finger 1	posSwitch	posSwitch + 60,0[10]
Finger 2	posSwitch	posSwitch + 60,0
Finger 3	posSwitch	posSwitch + 60,0

Figure 16 - Normal use definition for actuators and fingers

Please note that the rules of utilization have been established for use in normal environment and shall not represent any limitation.

[10] Those values can't be associated with any known units. They represent a proportion of the opening.

During normal operation, the joints are subject to heating. The joints are normally covered with plastic rings which will protect the user from any danger that may be occurred by the heating of the metal parts.

CONSERVATIVE USE OF THE HAND AND FINGERS

The fingers of the JACO arm are made flexible in order to protect the internal mechanism. When using the fingers to push on objects, the user must take special care not flex the fingers beyond their maximal opening as this could damage the internal mechanism.

Do not force the fingers beyond their maximal opening as this could damage some internal components.

ELECTROMAGNETIC INTERFERENCE FROM RADIO WAVE SOURCE

Even if JACO complies with all relevant standards, your arm may still be susceptible to electromagnetic interference (EMI), which is interfering electromagnetic energy (EM) emitted from sources such as radio stations, TV stations, amateur radio (HAM) transmitters, two way radios, and cellular phones. The interference (from radio wave sources) can cause the JACO stop moving for a period of 10 seconds. In this case, the JACO arm will simply re-init and you will be able to continue to use it. In extremely rare case, it can also permanently damage the JACO arm control system.

The intensity of the interfering EM energy can be measured in volts per meter (V/m). JACO can resist EMI up to certain intensity. This is called "immunity level". The higher the immunity level is, the greater is the protection. At this time, current technology is capable of achieving at least a 20 V/m immunity level, which would provide useful protection from the more common sources of radiated EMI.

There are a number of sources of relatively intense electromagnetic fields in the everyday environment. Some of these sources are obvious and easy to avoid. Others are not apparent and exposure is unavoidable. However, we believe that by following the warnings listed below, your risk to EMI will be minimized.

The sources of radiated EMI can be broadly classified into three types:

1) Hand-held portable transceivers (e.g.: transmitters-receivers with the antenna mounted directly on the transmitting unit, including citizens band (CB) radios, walkie-talkie, security, fire and police transceivers, cellular phones, and other personal communication devices[11]).
2) Medium-range mobile transceivers, such as those used in police cars, fire trucks, ambulances and taxis. These usually have the antenna mounted on the outside of the vehicle.
3) Long-range transmitters and transceivers, such as commercial broadcast transmitters (radio and TV broadcast antenna towers) and amateur (HAM) radios[12].

Because EM energy rapidly becomes more intense as one moves closer to the transmitting antenna (source), the EM fields from hand-held radio wave sources (transceivers) are of special concern. It is possible to unintentionally bring high levels of EM energy very close to the JACO control system while using these devices. Therefore, the warnings listed below are recommended to reduce the effects of possible interference with the control system of JACO.

[11] Some cellular phones and similar devices transmit signals while they are ON, even when not being used.

[12] Other types of hand-held devices, such as cordless phones, laptop computers, AM/FM radios, TV sets, CD players, cassette players, and small appliances, such as electric shavers and hair dryers, so far as we know, are not likely to cause EMI problems to your JACO.

- Do not operate hand-held transceivers (transmitter's receivers), such as citizens band (CB) radios, or turn ON personal communication devices, such as cellular phones, while the JACO is turned ON.
- Be aware of nearby transmitters, such as radio or TV stations, and try to avoid coming close to them.
- Be aware that adding accessories or components, close to JACO's base, may make it more susceptible to EMI.
- Report all incidents of unintended shut down to your local distributor, and note whether there is a source of EMI nearby.

MAINTENANCE AND DISPOSAL

Cleaning Instruction

Only the external surfaces of JACO may be cleaned. Cleaning may be done using a damp cloth and light detergent. The following described the steps for the cleaning JACO:

- Prepare a water/soap preparation using a proportion of about 2ml of dish soap for 100ml of water;
- Immerge a clean cotton cloth in the preparation;
- Take out the cloth and wring out thoroughly;
- Gently rub the external surface to be cleaned.


Do not wash more than three times per day.


Do not immerse any part of the JACO arm under water or snow.


JACO is not intended to be sterile. No sterilization process should be applied to the arm.


Do not rub the external surfaces with abrasive materials.

Preventive Maintenance

The JACO arm requires no maintenance other than cleaning and lubricating the fingers every 6 months.


Refer all services to qualified service personnel. A service is required when the apparatus has been damaged in any way, for example if the power-supply cord or plug is damaged, if the JACO arm does not operate normally or has been dropped.


There is no “home serviceable” part inside JACO, do not open.

Disposal


The JACO arm contains parts that are deemed to be hazardous waste at the end of their life. For further information on handling and recycling contact your local recycling authority or local JACO distributor. In any way, always dispose of product through a recognized agent.

PACKING MATERIAL

The JACO arm packing material can be disposed as recyclable material.

METAL PARTS

The JACO arm metal part can be disposed as recyclable scrap metal.

ELECTRICAL PARTS, CIRCUIT BOARDS AND CARBON FIBER

Please contact your local distributor to have information regarding disposal of such parts. You can also address questions directly to Kinova through our website (see Contacting Support).

CONTACTING SUPPORT

If you need help or have any questions about this product, this guide or the information detailed in it, please contact a Kinova representative at:

- Support@KinovaRobotics.com

To help us assist you more effectively with problem reports, the following information will be required when contacting Kinova or your distributor support

- JACO serial number[13]
- Date/Time of the problem
- Environment where the problem occurred (per example 30° Celsius, raining, ...)
- Actions performed immediately before the problem occurred

355 Peel, #301
Montreal, Quebec (Canada)
H3C 2G9

www.KinovaRobotics.com

[13] This will allow the support agent to have all the information regarding your JACO as the software version running in the device, the part revisions and characteristics, etc.

APPENDIX 1: JOYSTICK MOVEMENTS

As previously stated, the Kinova's joystick is a 3-Axis joystick mounted on a support. The joystick axes refer to the following actions:

- Incline left/right
- Incline front/back
- Rotation of the lever clockwise/counter-clockwise

The following figure shows the joystick's movements.

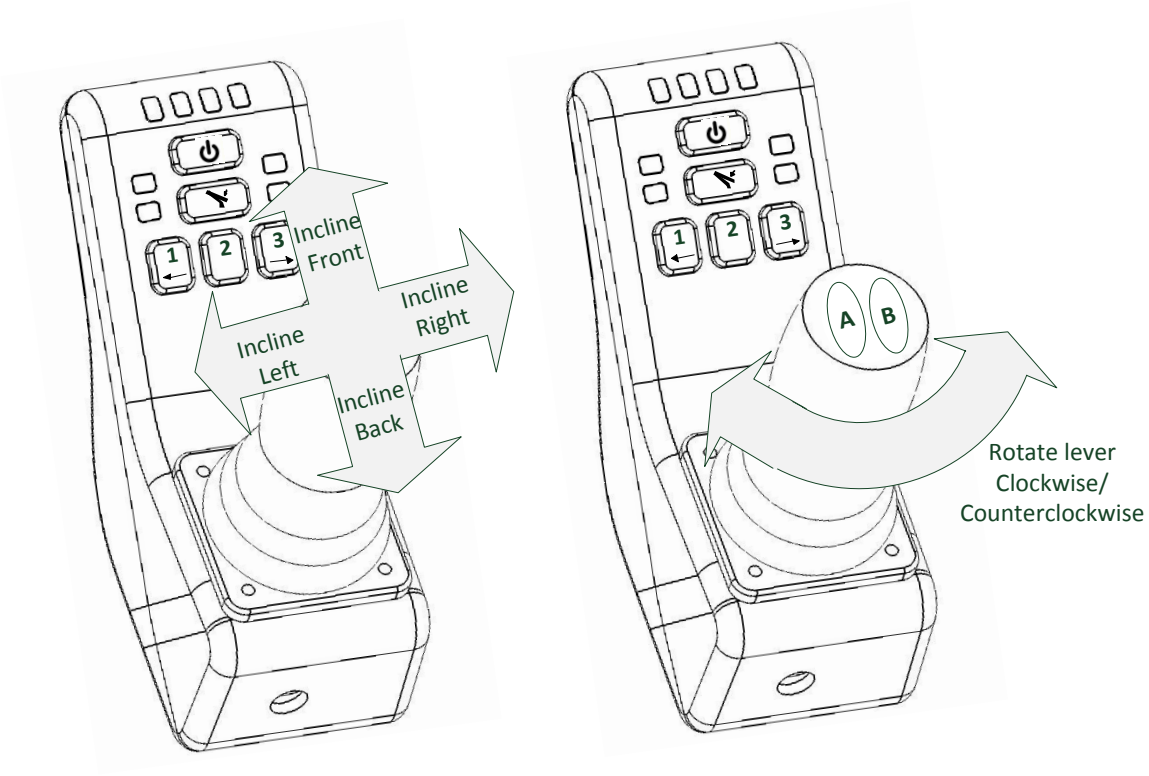


Figure 17 - Kinova's joystick possible commands

APPENDIX 2: STEP-BY-STEP APPROACH TO OPERATE THE JACO ARM

This section explains how to operate the JACO arm with the factory default configuration.

Getting started

4) Turn ON the device by pushing the **ON/OFF switch** located on the JACO arm base.
5) Wait until the green lights on the controller stop flashing.
6) Put the JACO arm in its **HOME** position by holding the **HOME/RETRACT function** () until the JACO arm stops moving. The arm will slowly reach the **HOME** position.

When starting the JACO arm, you are in 3-Axis operation mode, ''Translation control mode", meaning that any movement of the joystick will move the center of the hand parallel to the floor.

To change the operating mode of the Joystick, hold the ON/OFF button for 2 seconds. At this point, the stick rotation is not effective anymore.

7) You may move the 3 axis of the joystick to experience the Translation control mode.

Don't forget the lever rotation.

8) One hit on **Button B** will bring you in Wrist control mode meaning that any movement of the joystick will result in a rotation around the center of the hand.

Another hit on Button B will bring you back in Translation control mode.

9) One hit on **Button 1** will activate the Drinking mode which may be used only in Wrist mode. When rotating the joystick lever, you will see the JACO arm's wrist rotation now compensate for height and distance while turning. This movement is ideal when trying to drink directly from a glass.

Another hit on Button 1 will disable Drinking mode.

10) One hit on **Button A** will bring you in the Finger control mode. The three fingers will move according to a left/right inclination of the joystick while only two fingers will move according to a front/back inclination of the joystick.

At any time, you may use the HOME/RETRACT function () until the arm stops moving to bring it back into its HOME position.

If you hold the HOME/RETRACT function () again, the arm will start to move toward its RETRACT position.

11) Hold the **On/Off Button** (⏻) for 2 seconds to change the operating mode. This will disable the stick rotation. You are now in a 2-Axis Translation control mode.

    As the stick rotation won't have any effect, you may only control the horizontal translation of the arm (Translation-X and Translation-Y)

12) One hit on **Button 3** will bring you to control the vertical translation of the hand (Translation-Z) and Wrist rotation.

Another hit on Button 3 will bring you back in Translation-X and Translation-Z control mode.

13) One hit on **Button 1** will activate the Drinking mode which may be used only in Wrist mode. When rotating the joystick lever, you will see that the JACO arm's wrist rotation now compensate for height and distance while turning. This movement is ideal when drinking directly from a glass.

14) One hit on **Button 2** will bring you to control the wrist orientation (Lateral orientation and Vertical orientation).

15) One hit on **Button 2** will bring you to Finger control mode. The three fingers will move according to a left/right inclination of the joystick while only two fingers will move according to a front/back inclination of the joystick.

Another hit on Button 2 will bring you back in Lateral orientation and Vertical orientation control mode.

APPENDIX 3: REMINDER ON THE JACO ARM OPERATION

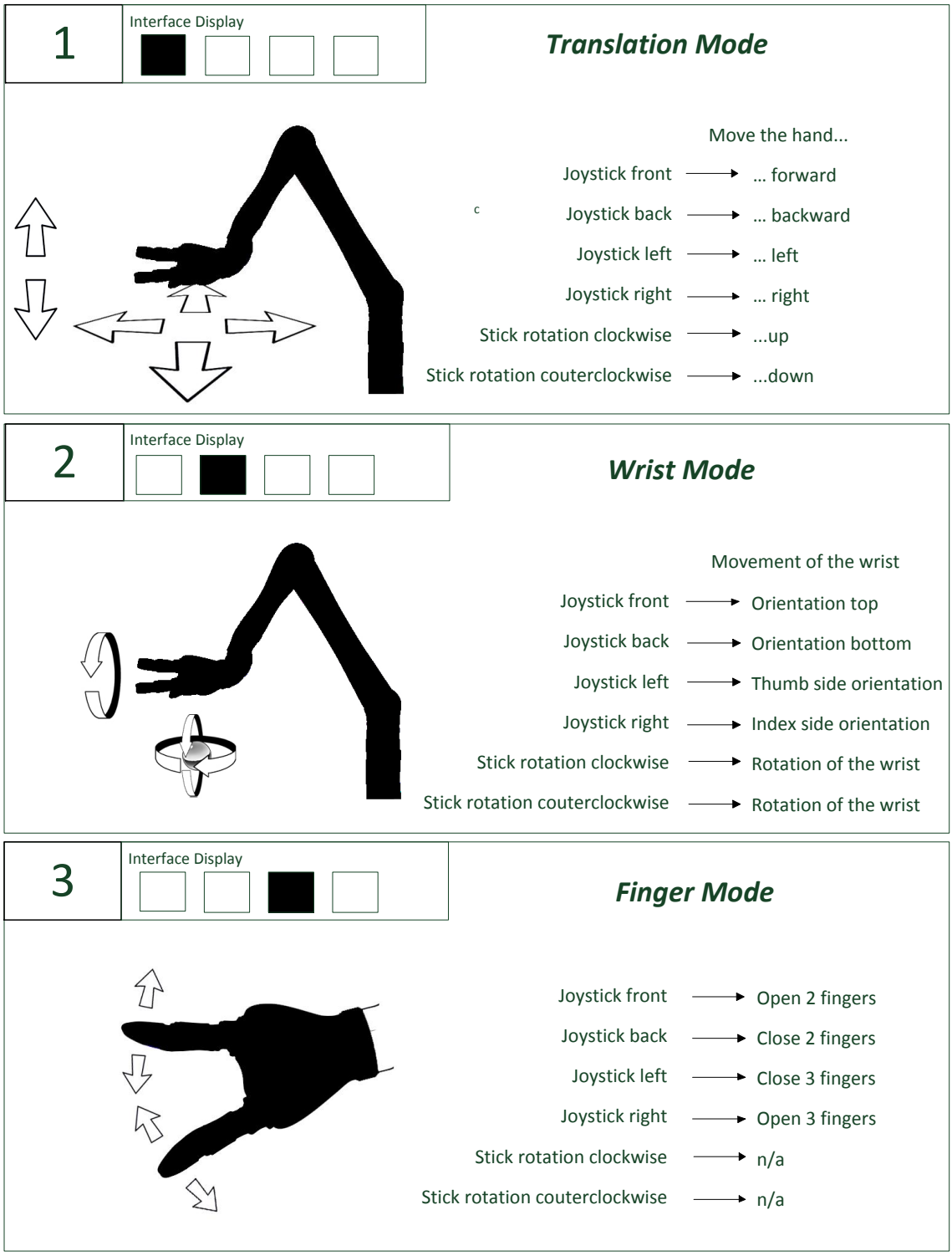


Figure 18 - Visual reminder for 3-Axis operation mode

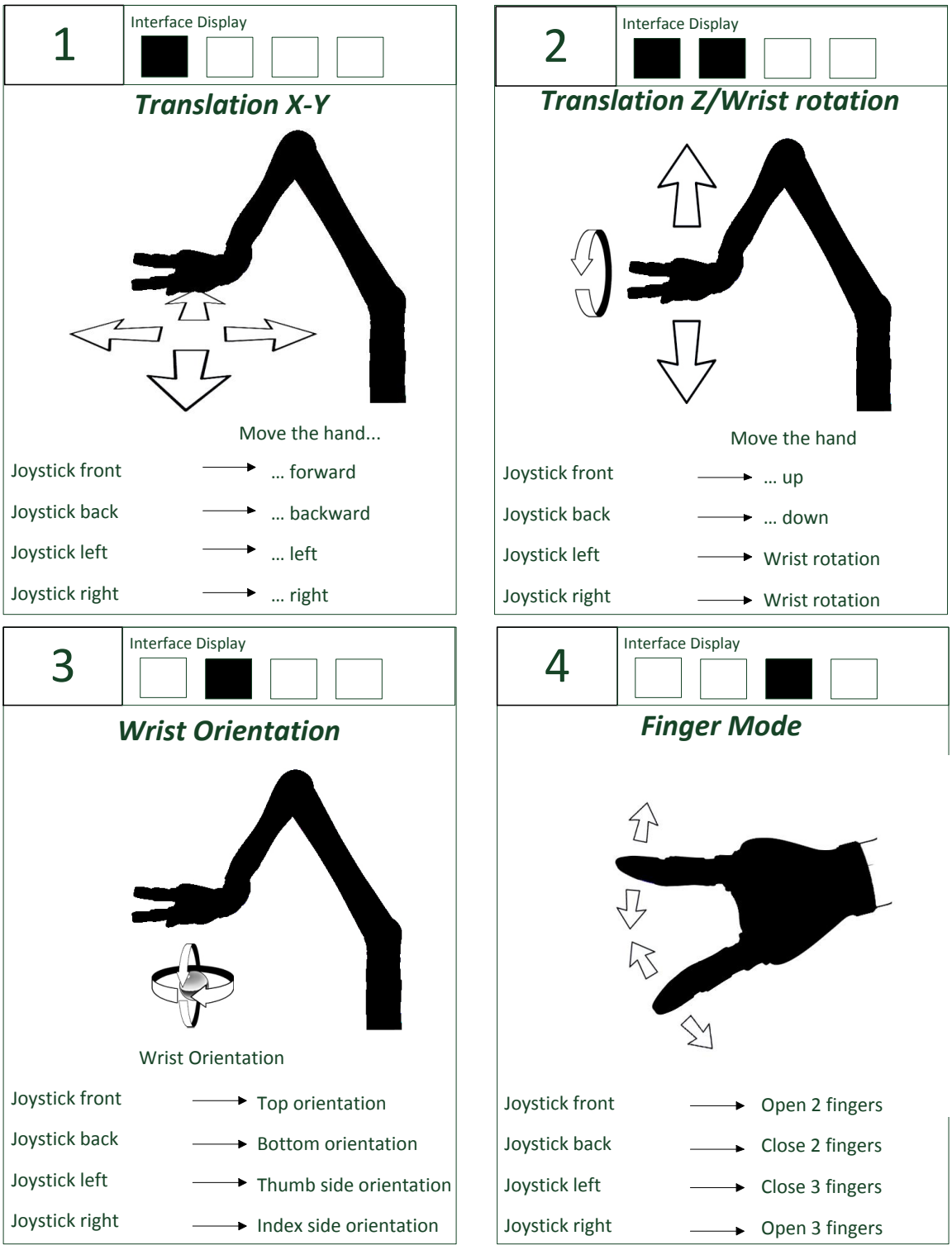


Figure 19 - Visual reminder for 2-Axis operation mode

APPENDIX 4: MAJOR WARNING REMINDER


The Normal Use Definition contains some fundamental information to the proper operation of the JACO arm.


It is not recommended to let the JACO arm under heavy rain or snow.


Please assure to follow the specified storing conditions when putting JACO away in its case.


Wait for the JACO arm to reach room temperature prior using it.


Never use the HOME/RETRACT function when carrying liquid. The HOME position is pre-set and the wrist may have to rotate and drop the liquid.


Do not manipulate cutting, very sharp or any dangerous tools or objects with the JACO arm.


When the power is turned off, the JACO arm will fall on itself and may damage itself, depending on its position at the time of disconnection. Be sure to support its wrist before turning the power off.


Do not force the fingers beyond their maximal opening as this could damage some internal components.


Do not immerse any part of the JACO arm under water or snow.