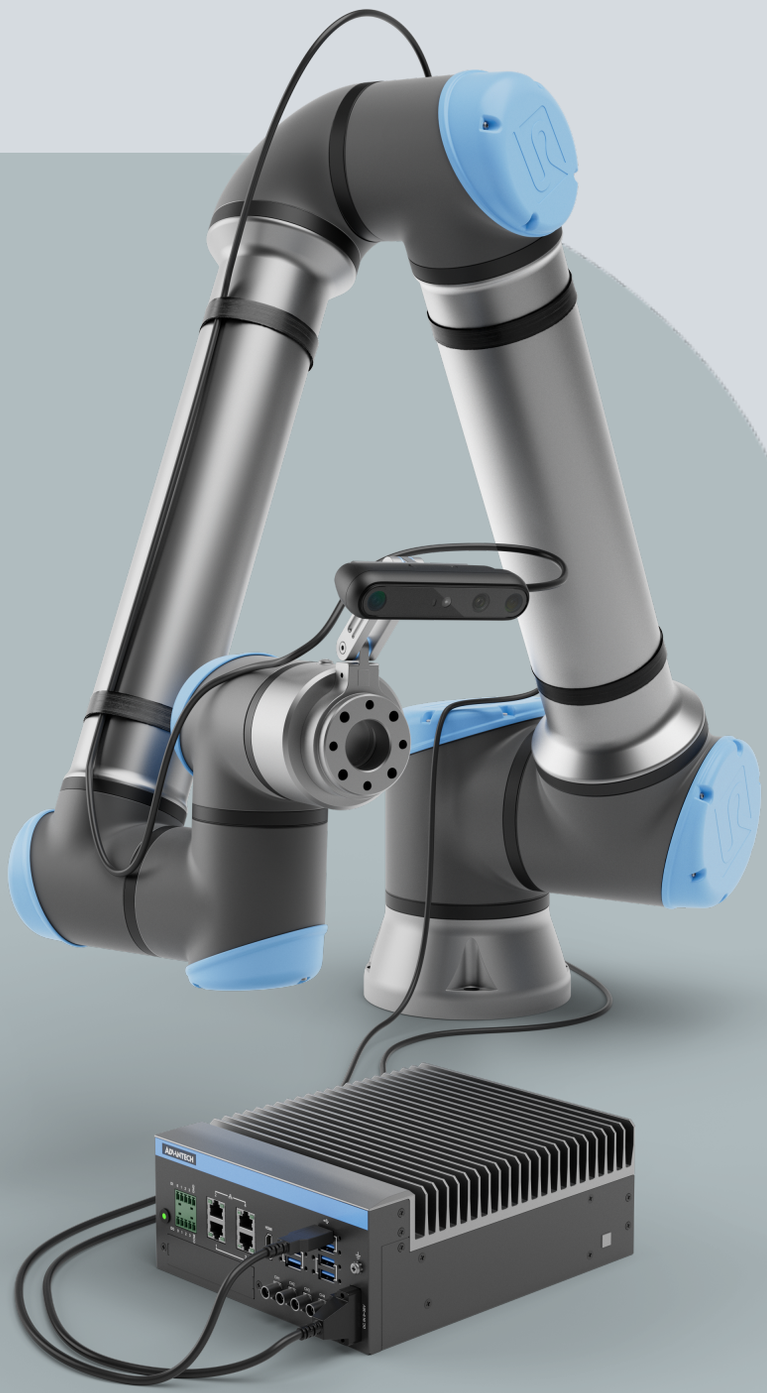
UNIVERSAL ROBOTS

# User Manual

## AI Accelerator



Original instructions (en)

PolyScope X

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# 1. Introduction

## 1.1. About This Guide

**Description**

This guide provides the essential information to start using the AI Accelerator.

**Terminology**

This document uses terminology from industrial robotics and AI research.

- Tool refers to the end effector, such as a gripper.
- Part refers to the workpiece.
- Experiments are the trial exercises in this guide.

Assembling the AI Accelerator can require supervision by technically trained personnel.

**In the box**

AI Accelerator ships in a single box with the following parts:

- Compute module from Advantech, based on NVIDIA Jetson Orin
- Camera
- Camera mount
- Camera cable
- Cable straps for camera cable (4 pcs)
- Tool flange bolts (4 pcs, 40 mm)
- Calibration board
- This document

The following parts are required to complete the demo setup described in 10 Software on page 34:

- Universal Robots e-Series or UR-series robot (purchased separately)

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# 1.2. Product Description

**Description**

AI Accelerator enables PolyScope X integration with Perception and AI.

The AI Accelerator extends Universal Robots capabilities with:

- Hardware and software for camera-based AI applications
- Computational power optimized for AI applications
- A URCap framework for distributing and using AI applications

Scripts and example applications are available from `https://docs.universal-robots.com/`.

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# 2. Safety

**Description**

This chapter contains important safety information that you must read and understand **before** first use of the AI Accelerator.

Read the general safety information and the instructions and guidance pertaining to the risk assessment and intended use provided. Pay particular attention to text accompanied by warning symbols. Read and understand the specific engineering data relevant to mounting and installation to understand the integration of UR robots before the robot is powered on for the first time.

The integration and application of AI Accelerator require risk assessment and risk reduction, even if the application remains undeployed.

- Always conduct a thorough risk assessment specific to your experiment and subsequent application.
- Reduce risks in accordance with the results of the risk assessment.

**NOTICE**

Universal Robots disclaims any and all liability if any part of the AI Accelerator is damaged, changed, or modified in any way. Universal Robots cannot be held responsible for any damages caused to any equipment due to programming errors or malfunctioning of the components.

**READ MANUAL**

Read the manual for the robot **before** first use. Follow all safety precautions stated in the robot manual.

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# 2.1. Safety Message Types

**Description**

Safety messages are used to emphasize important information. Read all the messages to help ensure safety and to prevent injury to personnel and product damage.

**WARNING**

Indicates a hazardous situation that, if not avoided, can result in death or serious injury.

**WARNING: ELECTRICITY**

Indicates a hazardous electrical situation that, if not avoided, can result in death or serious injury.

**WARNING: HOT SURFACE**

Indicates a hazardous hot surface where injury can result from contact and non-contact proximity.

**CAUTION**

Indicates a hazardous situation that, if not avoided, can result in injury.

**GROUND**

Indicates grounding.

**PROTECTIVE GROUND**

Indicates protective grounding.

**NOTICE**

Indicates the risk of damage to equipment and/or information to be noted.

**READ MANUAL**

Indicates more detailed information that should be consulted in the manual.

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## 2.2. Validity and Responsibility

**Description**

The information in this manual does not cover designing, installing, integrating, or operating a robot application, nor does it cover all peripheral equipment that can influence the safety of the robot application.

The robot application must be designed and installed in accordance with the safety requirements set forth in the relevant standards and regulations of the country where the robot is installed.

The person/s integrating the AI Accelerator are responsible for ensuring the applicable regulations in the country concerned are observed and that any risks in the robot application are adequately reduced. This includes, but is not limited to:

- Performing a risk assessment for the complete robot system
- Interfacing other machines and additional safeguarding if required by the risk assessment
- Setting the correct safety settings in the software
- Ensuring safety measures are not modified
- Validating that the robot application is designed, installed, and integrated
- Specifying instructions for use
- Marking the robot installation with relevant signs and contact information of the integrator
- Retaining all documentation, including the application risk assessment, this manual, the robot manual, and additional relevant documentation.

## 2.3. Limitation of Liability

**Description**

Any information provided in this manual must not be construed as a warranty, by UR, that the industrial robot will not cause injury or damage, even if the industrial robot complies with all safety instructions and information for use.

## 2.4. General Warnings and Cautions

**Description**

The following warning messages can be repeated, explained, or detailed in subsequent sections.

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**WARNING**

Failure to adhere to the general safety practices listed below can result in injury or death.

- Verify the robot arm, camera mount, and tool/end effector are properly and securely bolted in place.
- Verify the robot application has ample space to operate freely.
- Verify personnel are protected during the lifetime of the robot application including transport, installation, commissioning, programming/ teaching, operation and use, dismantling and disposing.
- Verify robot safety configuration parameters are set to protect personnel, including those who may be within reach of the robot application.
- Avoid using AI Accelerator if any of its parts are damaged.
- Avoid wearing loose clothing or jewelry when working with the robot. Tie back long hair.
- Avoid placing any fingers behind the internal cover of the Control Box.
- Inform users of any hazardous situations and the protection that is provided, explain any limitations of the protection and the residual risks.
- Inform users of the location of the emergency stop button(s) and how to activate the emergency stop in case of an emergency or an abnormal situation.
- Warn people to keep outside the reach of the robot, including when the robot application is temporarily inactive (waiting).
- Be aware of robot orientation to understand the direction of movement when using the Teach Pendant.
- Adhere to the requirements and guidance in ISO 10218-2.

**WARNING**

Handling tools/end effectors with sharp edges and/or pinch points can result in injury.

- Make sure tools/end effectors have no sharp edges or pinch points.
- Protective gloves and/or safety glasses can be required.

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**WARNING: HOT SURFACE**

Prolonged contact with heat generated by the robot arm, Compute module, or the Control Box during operation can cause injury.

- Do not handle or touch the robot while in operation or immediately after operation.
- Check the temperature on the log screen before handling or touching the robot.
- Allow the robot to cool down by powering it off and waiting one hour.

**CAUTION**

Failure to perform a risk assessment prior to integration and operation can increase the risk of injury.

- Perform a risk assessment and reduce risks prior to operation.
- If determined by the risk assessment, do not enter the range of the robot movement or touch the robot application during operation. Install safeguarding.
- Read the risk assessment information.

**CAUTION**

Using the robot with untested external machinery or in an untested application can increase the risk of injury to personnel.

- Test all functions and the robot program separately.
- Read the commissioning information.

**NOTICE**

Very strong magnetic fields can damage the robot.

- Do not expose the robot to permanent magnetic fields.

**READ MANUAL**

Verify all mechanical and electrical equipment is installed according to the specifications and warnings found in the **Mechanical Interface** and in the **Electrical Interface** sections of the robot User Manual.

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# 2.5. AI AcceleratorSafety

**AI Accelerator** The AI Accelerator enables AI to work with vision and sensor feedback to make logical decisions about the robot arm's behavior.

**WARNING**

AI decision-making can introduce additional risks, including unintended motion, safety hazards, and system failures.

- Be aware of sudden, unexpected motions resulting from AI decisions.
- Be aware of the risk of unpredictable motion patterns.
- Restrict personnel traffic within and around the robot application's reach when the application runs an AI experiment or demo.

**WARNING**

Prolonged robot inactivity can be misinterpreted as a stop, which can result in equipment damage or personnel injury due to unexpected movement or a sudden start.

- The application developer is responsible for installing and programming AI Accelerator to reduce unexpected movement situations.
- Check the program state to determine if the robot is completely stopped or temporarily inactive (waiting). If the program is running but the robot is not moving, the robot can move again unexpectedly.

**WARNING**

Failure to turn off, secure, and lock out all sources of hazardous energy to the robot application when servicing or repairing any part of the AI Accelerator setup can result in death or serious injury due to unexpected movement.

- Turn off, secure, and lock out sources of hazardous energy before conducting all service and repair procedures.

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# 3. Intended Use

**Description**

The AI Accelerator is intended to create robot applications using Pereception, AI and PolyScope X integraton solution.

Possible applications of AI Accelerator are limited by combination of the technical specifications of it's components. Consult technical specification of individual components to determine their suitability for a purpose.

For details about the conditions under which the robot should operate, see Declarations and Certificates and the technical specifications in the robot **User Manual**.

All UR robots are equipped with safety functions, which are purposely designed to enable collaborative applications, where the robot application operates together with a human. The safety function settings must be set to the appropriate values as determined by the robot application risk assessment.

Collaborative applications, without guards or protective devices, are only intended for non-hazardous applications, where the complete application, including tool/end effector, work piece, obstacles and other machines, is low risk according to the risk assessment of the specific application.

**WARNING**

The AI Accelerator shall not be used with CB3 robots or PolyScope versions prior to 10.11.1.

- Only use AI Accelerator with UR e-Series robots running PolyScope X 10.11.1 or later.

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**WARNING**

Using UR robots or UR products outside of the intended uses can result in injuries, death and/or property damage. Do not use the UR robot or products for any of the below unintended uses and applications:

- Medical use, i.e. uses relating to disease, injury or disability in humans including the following purposes:
  - Rehabilitation
  - Assessment
  - Compensation or alleviation
  - Diagnostic
  - Treatment
  - Surgical
  - Healthcare
  - Prosthetics and other aids for the physically impaired
  - Any use in proximity to patient/s
- Handling, lifting, or transporting people
- Any application requiring compliance with specific hygienic and/or sanitation standards, such as proximity or direct contact with food, beverage, pharmaceutical, and /or cosmetic products.
  - UR joint grease can be released into the air (vapor), or drip.
- Any use, or any application, deviating from the intended use, specifications, and certifications of UR robots or UR products.
- Misuse is prohibited as the result could be death, personal injury, and /or property damage

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**WARNING**

- The AI Accelerator is designed for use in standard industrial environments and is sold “AS-IS”. Universal Robots makes no declaration of conformity, claim of functionality, or fitness for particular purpose to the extent the AI Accelerator is used beyond the prescribed intended use.
- The user shall ensure that the AI Accelerator is at all times used in full compliance with all applicable regulatory and legal requirements. If the user utilizes the AI Accelerator for applications outside the intended use, the user shall bear sole and exclusive liability.

**READ MANUAL**

Failure to use the AI Accelerator in accordance with the intended use can result in unsafe situations.

- Read and follow the recommendations for intended use provided in this manual.

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# 4. Operating Environment

**Description**

Special precautions should be taken when using components of the AI Accelerator in industrial environment.

Consider summary of the factors, such as ingress prevention rating for each of the components, the airflow requirements and ambient temperature range. See 6 Technical Specifications on page 21 and **Technical Specifications** section in Robot User Manual.

**WARNING: ELECTRICITY**

Failure to follow any of the below can result in serious injury or death due to electrical hazards.

- Make sure all equipment not rated for water exposure remain dry. If water is allowed to enter the product, lockout-tagout all power and then contact your local Universal Robots service provider for assistance.

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# 5. Declarations and Certificates (original EN)

UNIVERSAL ROBOTS

**EU Declaration of Incorporation (DOI)** *(in accordance with 2006/42/EC Annex II B)* *original EN*

| **Manufacturer:** | **Person Authorized to Compile the Technical File:** |
|---|---|
| **Universal Robots A/S**<br>Energivej 1<br>DK-5260 Odense S Denmark | **David Brandt**<br>Technology Officer, R&D<br>Universal Robots A/S, Energivej 51, DK-5260 Odense S |

**Description and Identification of the product:**

| | |
|---|---|
| **Product and Function:** | **AI Accelerator** consists of software, camera, camera mount, camera mounting accessories, bolts to attach the mount to a UR robot tool flange and a camera calibration. The UR AI Accelerator is only intended for use with the Universal Robots e-Series robots, which has its own DOI.<br>*The box includes a computational module Advantech NVIDIA Jetson Orin covered by their DOI: https://buy.advantech.eu/Compact-Tower-Systems/AI-Jetson-Platforms-Edge-AI-Computer-Systems/model-MIC-733-AO6A1.htm*<br>See the above link for the Advantech NVIDIA declaration. |
| **Model:** | **AI Accelerator** |
| **Serial Number:** | **Starting 24XX 200550 01 0001 and higher**<br>*year* — *month* — *Revision number, starting 01* — *Sequential numbering, restarting at 0 each year* |
| **Incorporation:** | **The UR AI Accelerator shall only be put into service upon being integrated into a final complete machine (robot application or robot cell), which conforms with the provisions of the Machinery Directive and other applicable Directives**. |

**It is declared that the above products fulfil, for what is supplied, the following directives as detailed below:**
When this component is integrated into and becomes part of a complete machine, the integrator is responsible for the completed machine fulfilling all applicable Directives, applying the CE mark and providing the Declaration of Conformity (DOC).

| | |
|---|---|
| **I. Machinery Directive 2006/42/EC** | **The following essential requirements have been fulfilled:**<br>1.1.2, 1.1.3, 1.2.6,1.3.4, 1.5.1, 1.7.2, 1.7.4, Annex VI.<br>It is declared that the relevant technical documentation has been compiled in accordance with Part B of Annex VII of the Machinery Directive. |
| **II. Low-voltage Directive 2014/35/EU** | Reference the Directive and the harmonized standards used below. |

**Reference to the harmonized standards used, as referred to in Article 7(2) of the MD & LV Directives and Article 6 of the EMC Directive:**

| | | |
|---|---|---|
| **(I)** EN ISO 10218-1:2011 *as applicable* | **(I)** EN ISO 13850:2015 *as applicable* | **(I) (II)** EN 60204-1:2018 *as applicable* |
| **(I)** EN ISO 13849-1:2015 *as applicable* | **(I)** EN ISO 14118:2017 *as applicable* | |

The manufacturer, or his authorised representative, shall transmit relevant information about the partly completed machinery in response to a reasoned request by the national authorities.

Approval of full quality assurance system for Universal Robots by the notified body Bureau Veritas: ISO 9001 certificate #DK015892 and ISO 45001 certificate #DK015891.

Odense Denmark, 22 November 2024

*Roberta Nelson Shea, Global Technical Compliance Officer*

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# 6. Technical Specifications

| | |
|---|---|
| Package dimensions | 350 x 300 x 260 mm |
| Package weight | 5 kg |
| **Compute module** | NVIDIA Jetson Orin<br>Advantech MIC-733-AO 64Gb, 1Tb SSD |
| Compute module IP classification | IP40 |
| Compute module operating temperature | -10 ~ +60 °C with 0.7 m/s airflow (MaxN mode) |
| Compute module operating humidity | 95% @ 40 °C (non-condensing) |
| **Camera** | Orbbec Gemini 335Lg |
| Camera IP classification | IP67 |
| **Camera mount** | Tool flange extender and camera bracket |
| Camera mount weight | 300 gr |
| Camera mount material | Aluminium |
| **Camera cable** | Amphenol RF 5 m. |
| Cable guides material | Velcro® polypropylene and velour PA |
| **Calibration board** | 8x7 nodes, 15 mm checker size |
| | |

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# 7. Assembling the AI Accelerator

**Description**

Complete assembly of AI Accelerator requires the following steps:

1. Mounting the robot
2. Attaching camera mount and optionally an end effector (See Attaching the Camera Mount )
3. Affixing camera cable (See Camera cable)
4. Connecting Ethernet cables
5. Connecting power cables

**Mounting the robot**

For mechanical and electrical installation instructions of the robot arm and the Control Box, refer to the robot **User Manual.**

## 7.1. Camera

**Description**

The main options for camera mounting in the robot machine vision application are: robot-mounted or fixed-mounted. The camera mount included in AI Accelerator allows camera to be mounted on Universal Robots robot arms.

**Camera mount**

The AI Accelerator camera mount is designed to be inserted between the robot tool output flange and the end effector.
Before mounting the camera, familiarize yourself with the **Securing Tool** section of the **Mechanical Interface** chapter in the robot User Manual and mounting instructions that came with the selected end effector.

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**Assembly**

The camera mount is supplied pre-assembled. To attach camera to the mount:

1. Remove camera from the packaging.
2. Point the connector on the camera towards the tool flange adapter.
3. Use two M4 screws to attach camera to the holder.
4. Align camera cable along the grooves on the camera holder and attach it with wire ties.

**Camera Cable**

Chapter Camera cable explains how to arrange the cable connecting the camera to compute module, externally along the robot arm.

## 7.2. Attaching the Camera Mount

**Securing the Robot Arm**

Read the **Mechanical Interface** section in robot User Manual.

Before attaching the camera you should mount the robot arm according to the requirements specific to your robot model as described in **Securing the Robot Arm** chapter in robot User Manual. You can test the robot movement without any attachments.

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**End of Arm**

Read the **Securing Tool** chapter in robot User Manual.

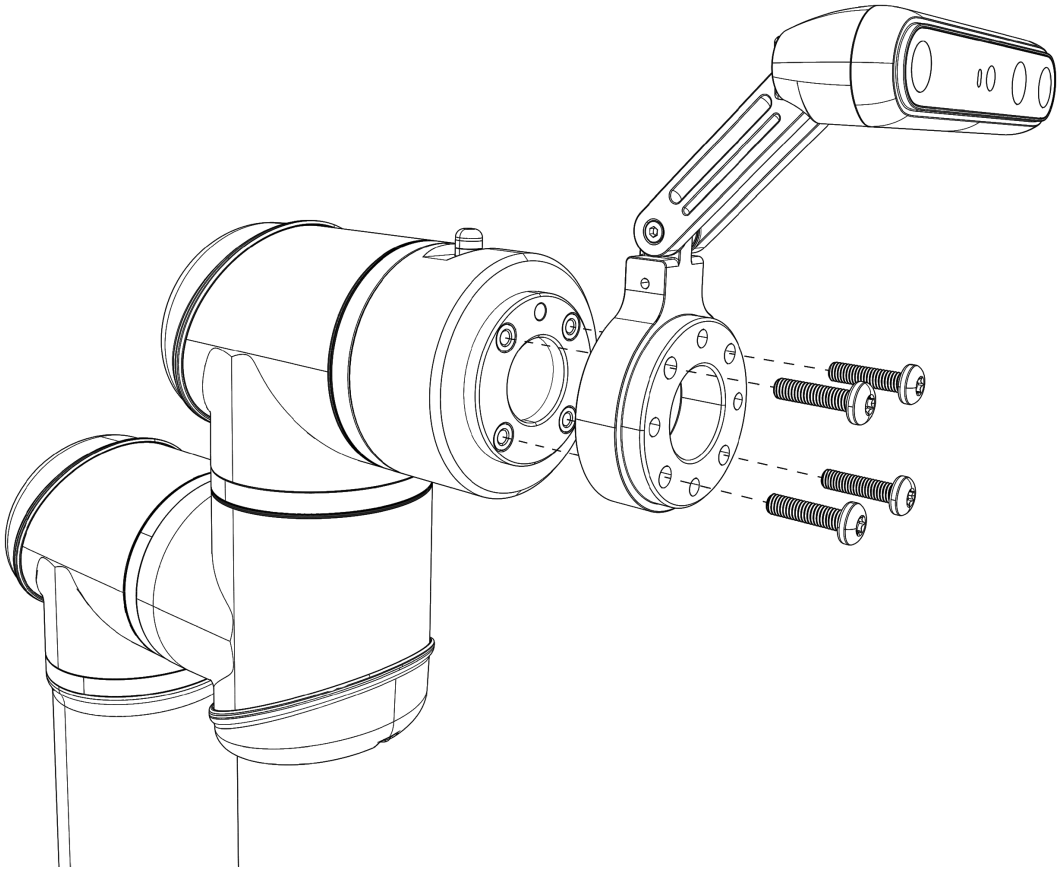
Supplied with the kit you will find four M6 bolts. Bolts in the kit are suitable for attaching the camera mount without an end effector.

Camera mount could be inserted between the robot tool flange connector and an end effector using longer bolts.

**CAUTION**

Very long M6 bolts can press against the bottom of the tool flange and short circuit the robot.

- Do not use bolts that extend beyond 10 mm to mount the tool.



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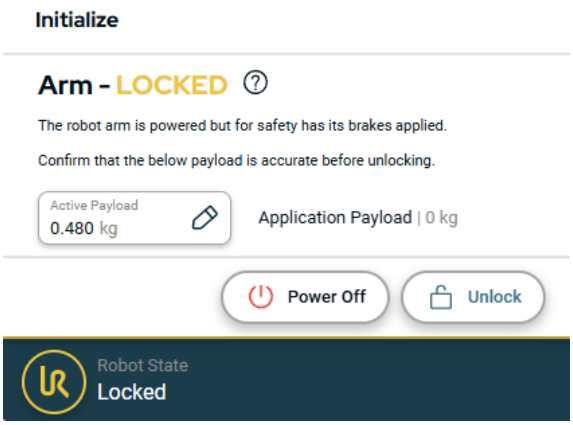
### Correct payload

**CAUTION**

Incorrect payload can result in unexpected robot movement when entering Freedrive.

- Remember to set the correct payload on the robot and adjust the Center of Gravity (CoG).

As a guidance, assembled camera mount, camera and mounting bolts weight approximately 480 gr.

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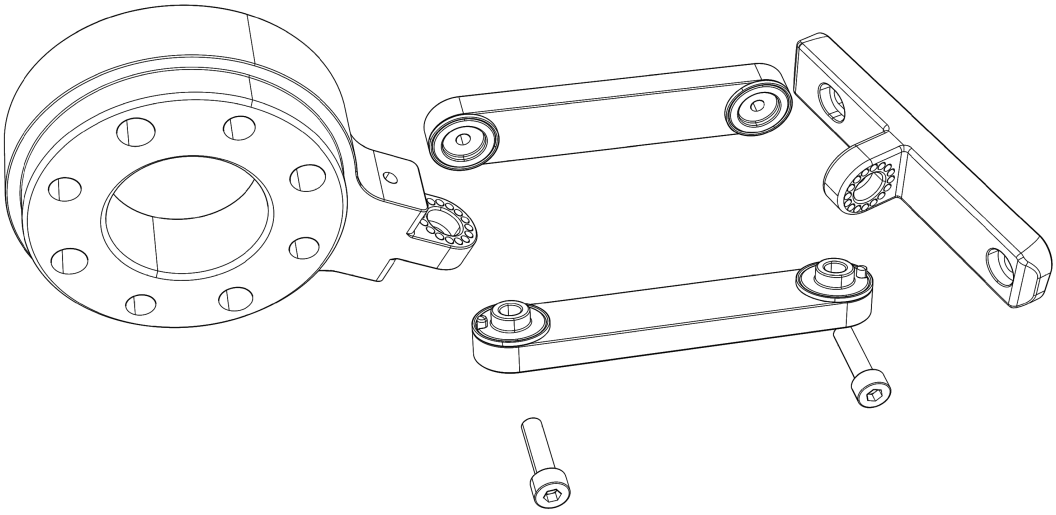
**Adjusting the camera mount**

Robot vision applications require consistent camera positioning, either fixed to the robot arm or static relative to the robot base.

To ensure the necessary rigidity, camera mount parts are secured with locking pins, which prevent accidental changes to the camera position. Adjusting the camera position requires disassembling the camera mount, realigning the parts, and reassembling them.



**CAUTION**

- Do not attempt to adjust camera position by forcing camera mount parts.
- Camera mount screws should be tightened to 5 Nm.
  Do not overtighten these screws.

**CAUTION**

Repeat camera calibration after adjusting camera position.
See 10.3 Camera calibration on page 38.

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# 7.3. Camera cable

**Description**

**CAUTION**

Your robot should be mounted and powered off before attaching the external cable and end effector.
External cables can create risks of entanglement for the operator or interfere with robot operation.
Cables can be damaged by the robot motion and create additional hazards.
Care must be taken when affixing external cables that these risks are mitigated.

- Restrict range of possible joint movement to prevent damage to the camera cable.

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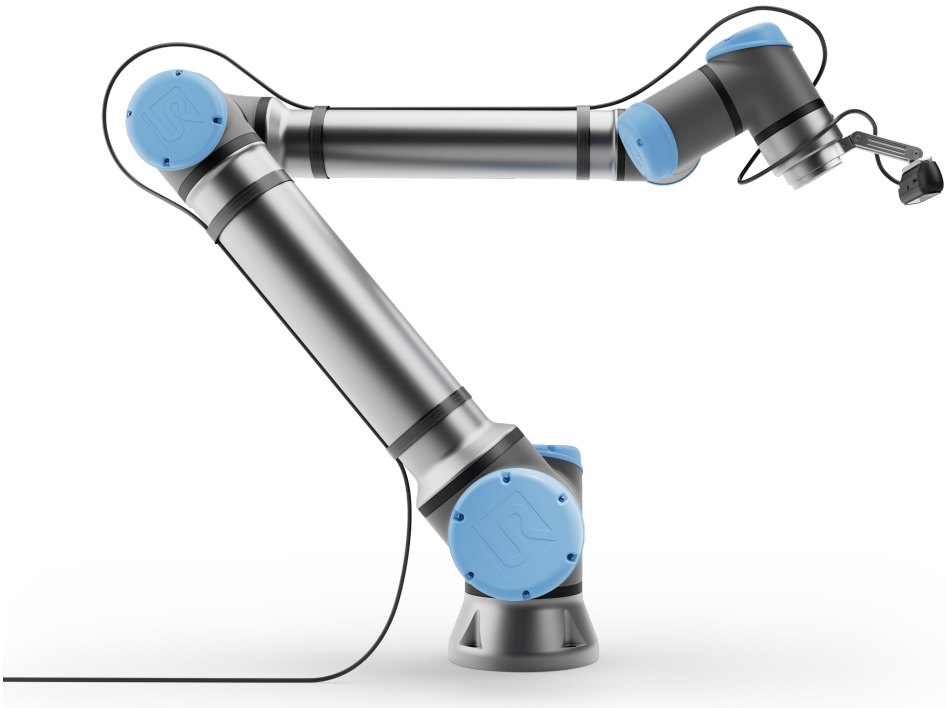
**To affix the camera cable**

While robot joints can rotate plus and minus 360 degrees from the zero position, this movement will damage the camera cable and in practice is not required in most applications.

The safety functions of the robot can be used to limit the motions range of the joint. Refer to the robot **User Manual** for descriptions of how to use the safety functions.

1. Before affixing the cable, pose the robot to the median position of all movements necessary for your application.
2. Attach the camera cable to the camera.
3. Make loose coil around wrist joints of the robot arm. Run the remainder of the cable along the arm.
4. Use cable straps to fix cable to the upper part of the arm. Make sure that the cable is not under the buckles of the cable straps.
5. Leave some loose cable between the two tubes of the robot arm and fix the cable to the bottom part of the arm.
6. Connect the camera cable to compute module.



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**Restricting joint movement**

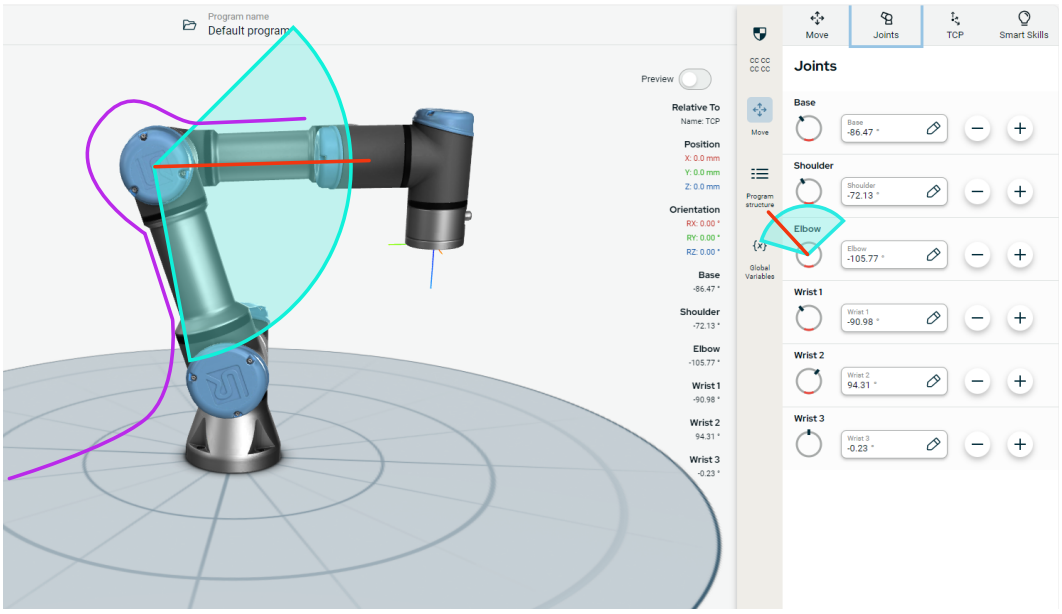
When the camera cable is attached to the robot, you can restrict joint movement. Before continuing you should familiarize yourself with robot **Freedrive**, refer to the robot User Manual.

To restrict joints movement:

1. In PolyScope open 3D View and **Joints** tab.
2. Start the robot arm, unlock the brakes and start Freedrive.

   You may want to move the Freedrive restrictions panel to make joint angles visible.
3. While in Freedrive, slowly move robot arm from side to side, imitating robot movement in your application.
4. Observe the camera cable and give cable more slack or reposition cable coils if necessary.
5. Move robot to most extreme positions of your application and take note of the joint angles for each joint.
6. Enter these values as **Joint Positions** in **Joint Limits** of the **Safety** settings of your robot.

Read robot User Manual, **Safety** section on how to enter joint restrictions in PolyScope X.




**Testing joint limits**

Try to move robot using the **Move** tab and verify that camera cable is not overtightened or clamped by possible robot movements.

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# 7.4. Compute Module

**Description**

AI Accelerator includes Compute module based on NVIDIA Jetson Orin.

> **READ MANUAL**
> Read the NVIDIA Jetson Orin manual and follow all safety instructions.

**Compute Module position**

When positioning the Compute Module, ensure the following:

- The Compute Module is placed in a clean and dry space with sufficient airflow.
- The cable from the 3D camera can reach the Compute Module.

**Connecting Compute Module**

The Compute Module network connections are pre-configured with Lan1 designated for connecting to the robot's Control Box and Lan2 available for optional Internet connection.

Connect the port marked Lan1 on the Compute Module directly to the robot's Control Box with an Ethernet cable. Do not use router or switch.

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# 7.5. Tool Selection

**Description**

The AI Accelerator does not provide a tool or end effector. You need to choose the correct end effector for your set up/work cell. Tool choice can depend on different requirements including:

- Purpose
- Weight
- Connections

**Purpose**

A gripper type end effector, like a vacuum or finger gripper, is the most common tool for moving objects around. Verify this gripper works with Universal Robots software PolyScope X.

**Weight**

The total weight of the camera module, gripper and work part shall not exceed the maximum payload of your robot.

**Connections**

The selected end effector should use tool flange output for communicating with the robot. Running an additional external cable or pneumatic pipe for a vacuum gripper can complicate your application.

Make sure your selected end effector does not obscure camera vision.
You can rotate camera around tool flange adapter if necessary.

**CAUTION**

Remember to adjust payload and TCP settings after change of tooling.

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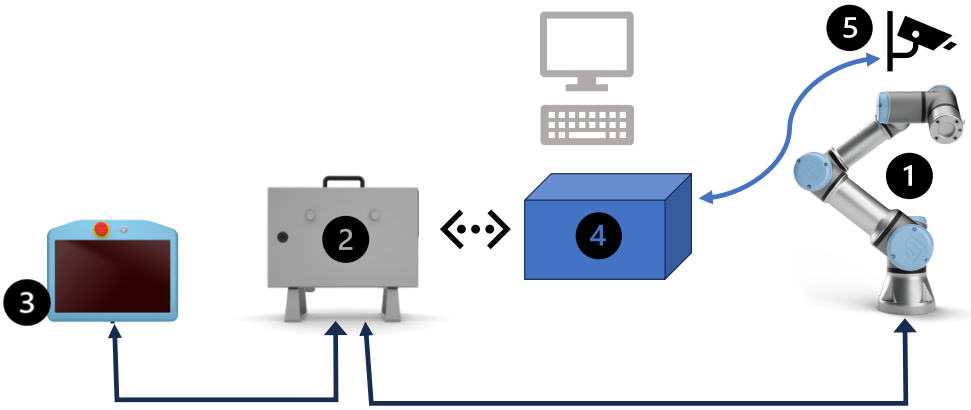
# 8. Connectivity

**Description** This section describes the connection of the components of the AI Accelerator

> **WARNING: ELECTRICITY**
> Do not use any cables if they are damaged or show signs of wear.




1. **Robot Arm**
   Connected to Control Box with proprietary cable.
2. **Control Box**
   Connected to the mains power (not shown).
3. **Teach Pendant**
   Connected to the Control Box with proprietary cable.
4. **Compute module**
   Directly connected from Lan1 on the compute module to Control Box via Ethernet cable.
5. **Camera**
   Connected to Compute module with supplied camera cable (USB or GMSL).

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# 9. Cybersecurity Threat Assessment

## 9.1. General Cybersecurity

**Description**

Connecting components of AI Accelerator to a network can introduce cybersecurity risks. These risks can be mitigated by using qualified personnel and implementing specific measures for protecting the robot's cybersecurity.
Implementing cybersecurity measures requires conducting a cybersecurity threat assessment.
The purpose is to:

- Identify threats
- Define trust zones and conduits
- Specify the requirements of each component in the application

**WARNING**

Failure to conduct a cybersecurity risk assessment can place the robot at risk.

- The integrator or competent, qualified personnel shall conduct a cybersecurity risk assessment.

**NOTICE**

Only competent, qualified personnel shall be responsible for determining the need for specific cybersecurity measures and for providing the required cybersecurity measures.

**READ MANUAL**

Read the robot User Manual sections **Cybersecurity Requirements** and **Cybersecurity Hardening Guidelines**.

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# 10. Software

**Description**

AI Accelerator uses ROS messaging for two-way communication between the Docker software run by the Compute module and the URCap running in robot's controller.

Before running the software installation and configuration scripts, make sure all hardware is correctly connected.

1. Robot's control box and Compute module must be directly connected.
2. Camera cable is plugged in to Compute module.
3. Robot's control box is powered on and PolyScope X started.

The brakes in the robot arm can remain engaged until you proceed to calibration or other activities requiring robot movement.

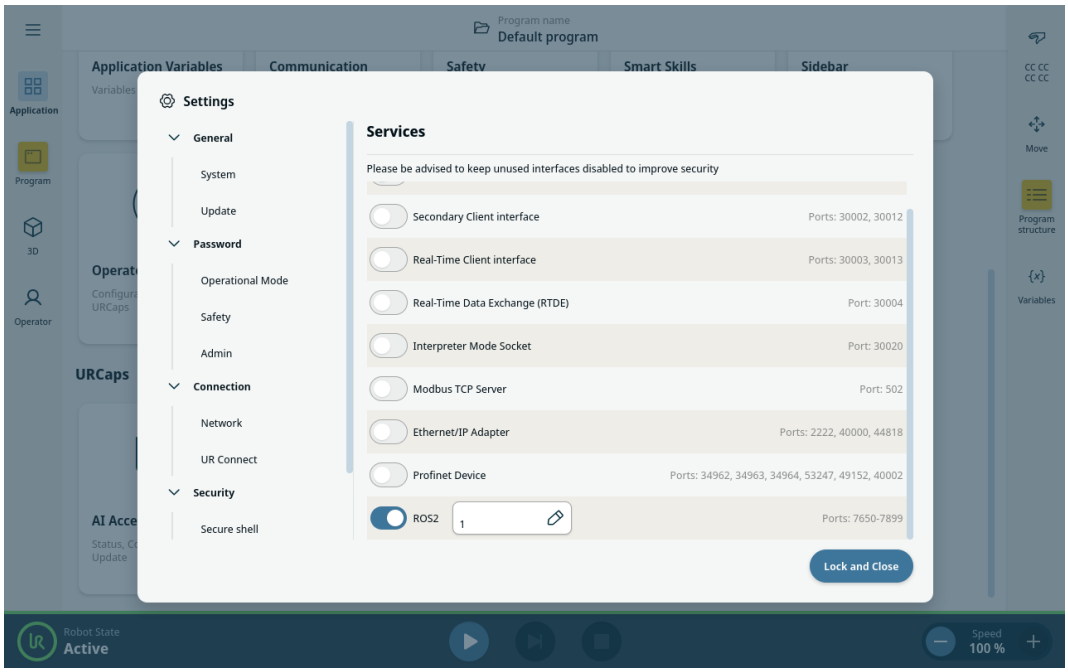
**Correct time settings**

Time synchronization and time stamp is extensively used by components of AI Accelerator. Therefore it is important to set correct time in robot's controller and compute module.

**Correct network settings**

The AI Accelerator must be on the same network as the robot's Control Box.

1. Open the hamburger menu in the top left corner and select **Settings**
2. Navigate to the network menu and unlock if necessary
3. Change to static IP, IP `192.168.0.10`, Subnet mask 255.255.255.0
4. Tap **Apply Configuration**
5. Navigate to the **Services** menu and unlock if necessary
6. Enable ROS2 and set the `ROS_DOMAIN_ID` to `1`
7. Tap **Lock and Close**

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# 10.1. Installing the software

**Description**

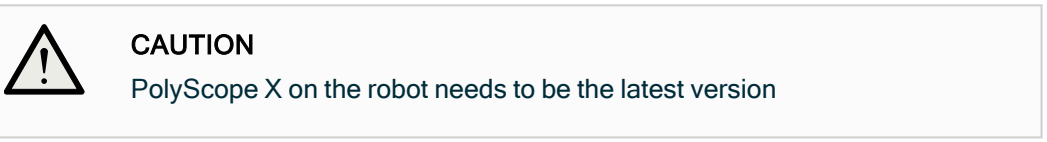
The compute module of the AI Accelerator comes with pre-installed OS. The remaining software is installed on the robot via URCaps.

**Installing the URCaps**

Installation and configuration of the software components of AI Accelerator should be performed in the following order:

1. Download URCaps from Centercode and save them on a USB drive
2. Start the Compute module and the robot
3. Install the URCaps

Each step is described in more detail below.




**Download URCaps**

1. Open `https://www.universal-robots.com/products/ur-developer-suite/ai-accelerator/` . Universal Robots continuously work on improving AI Accelerator software. There might additional software functionality posted to our web site.
2. Locate the AI Accelerator and follow instructions on the page.
3. Download `aia-core-<version>.urcapx` and `orbbec-gemini-v335Lg-<version>.urcapx` from centercode.
4. Save both files on a USB drive.

**Start system**

1. Turn on the compute module. It will auto start when power is connected.
2. Turn on the robot by pressing the power button on the Teach Pendant.

**Install URCaps**

1. Insert USB drive in the Teach Pendant or Control Box (recommended)
2. Tap the folder icon at the top of the screen to enter System Manager
3. Navigate to the URCap section and unlock it if necessary
4. Tap the +URCap button and follow the instructions to install the URCaps

# 10.2. Using the AI Accelerator software

**Description**

The AI Accelerator comes with a software to setup and monitor the system. The software is installed as a URCap (aia-core) and can be found in PolyScope X **Application** settings.

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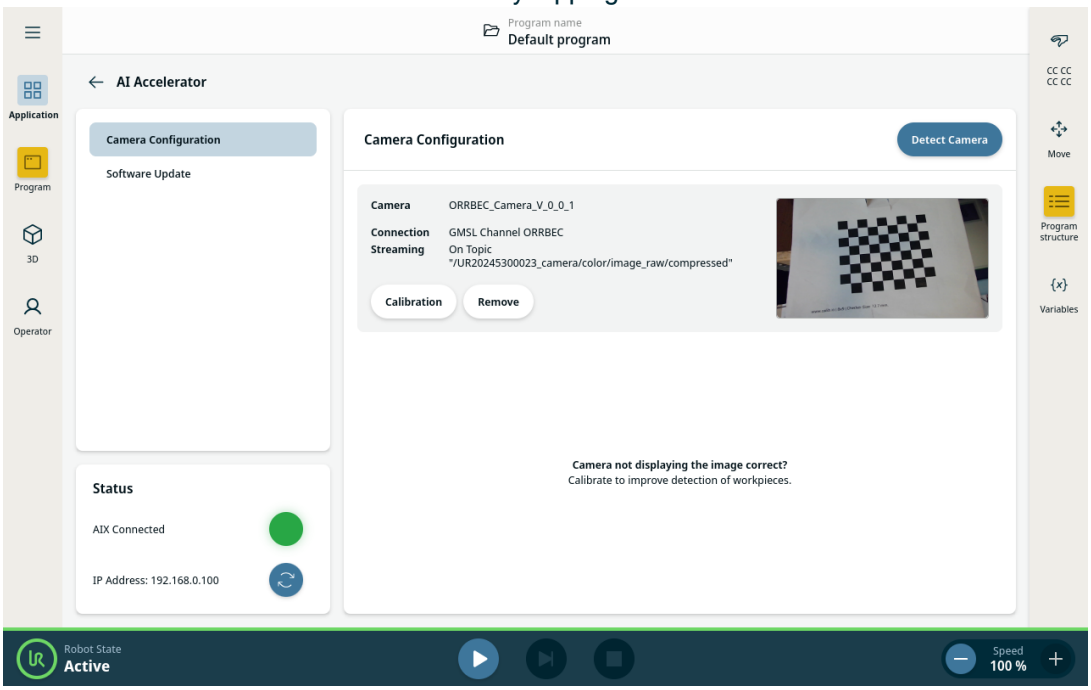
### Adding a camera

Installation and configuration of the software components of AI Accelerator on the robot should be performed in the following order:

1. Open AI Accelerator URCap and navigate to the **Camera Configuration** section. This shows a list of currently available cameras.
2. Tap the **Add camera** button to add a camera.
3. Select the camera type from the list. More camera types can be added via URCaps. Universal Robots provides URCap for the Orbbec camera.
4. The camera is now added and you should see the live feed from the camera.

You can remove the camera or calibrate it by tapping the buttons under the camera name.




In the bottom left corner you can see the status and IP address of the compute module.

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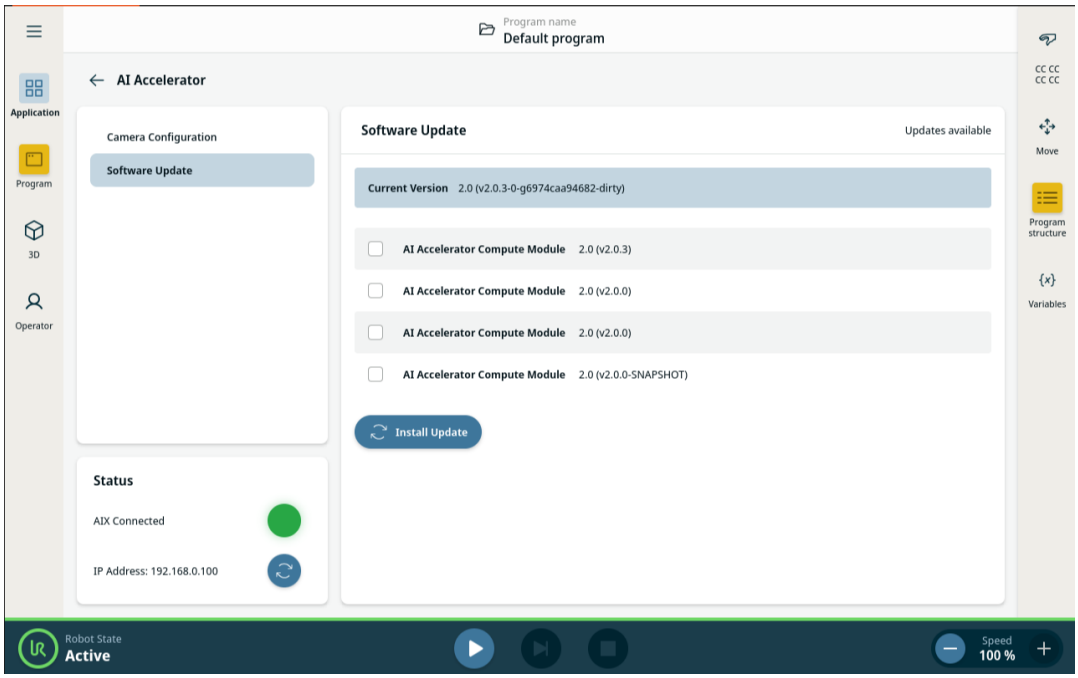
### Updating software

1. Navigate to the **Software Update** section. This shows the current versions of URCaps.
2. Insert a USB drive with the new version of AI Acceleratorsoftware. For best performance you should use USB port inside the Control Box, not the USB port on the Teach Pendant.

   You can find the latest update on Centercode
3. Tap the **Check for updates** button and choose the .aiup file
4. Wait for the update to complete. This may take a while and AI Accelerator may need to restart more than once.
5. Navigate to the **Software Update** section to verify that the update was successful.




**WARNING**

All data on the compute module will be lost after the update. Make sure everything is backed up before updating.

### Trouble shooting

I can't see the live camera feed:

- Check that the IP address on the robot is set correctly
- Check that the cables are correctly connected
- Check that ROS2 is enabled and domain id set to 1
- Check that correct camera URCap is installed
- Check that the physical selector switch on the camera is set to the cable type you are using
- Restart PolyScope X

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# 10.3. Camera calibration

**Description**

The end effector and the camera must be calibrated for precise robot operation, allowing the system to accurately translate visual data into coordinated movements.

Calibration is performed by recording camera images and matching them with the robot poses. A special calibration board, with fixed positions, is used to recognize camera orientation.

**Adjusting robot payload**

**CAUTION**

Ensure that you are using the correct Payload and Center of Gravity (CoG). Incorrect payload may result in Robot arm movement when pressing the Freedrive button.

You can use the Payload Estimation Wizard in PolyScope to assess the Payload and CoG.

**Preparing for calibration**

A calibration board is required to calibrate the camera and is provided with the AI Accelerator. It is also possible to use a custom calibration board.

- Position the calibration board inside the robot reach area, where you can move the robot arm maintaining the distance of 20 to 80 cm between the camera and the board.
- Do not make any adjustments to the position of the calibration board during the calibration.
- The calibration board must be evenly lit. Avoid shadows, for example from robot arm or operators body.

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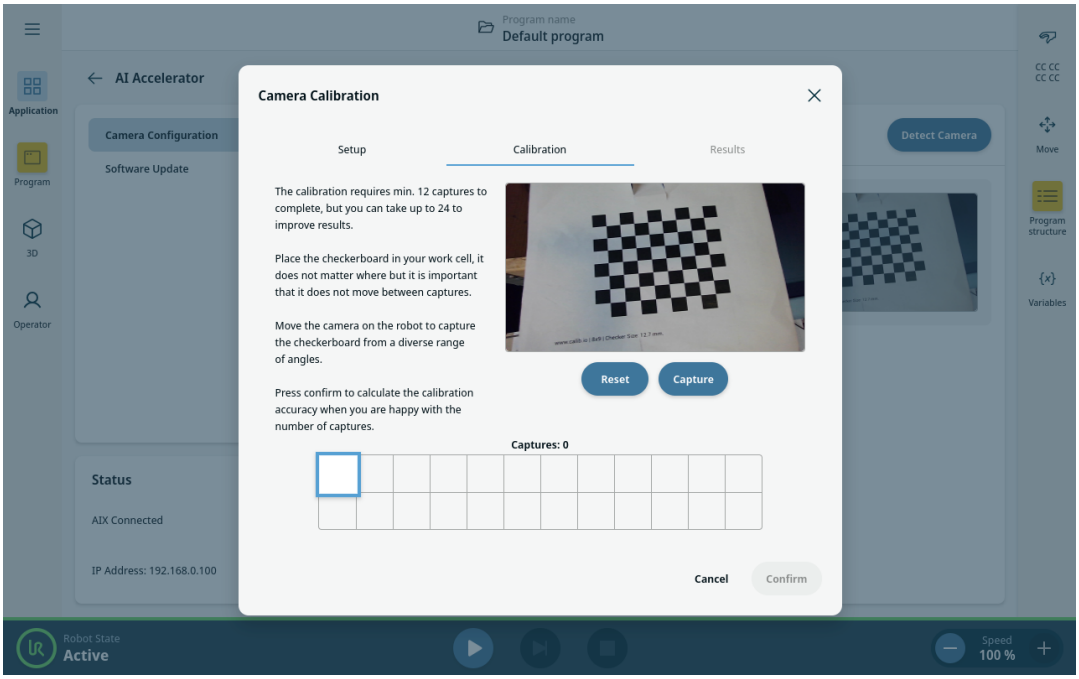
**To calibrate the camera**

In the AI Accelerator UPCap select **Camera Configuration**.

1. Select the camera and tap **Calibrate**.
2. If you are using the provided calibration board check the **Default**, otherwise enter dimensions of your custom board.
3. From the Calibration tab follow the instructions on the screen to capture minimum 12 images of the calibration board from different angles.

   For best results try to move all the joints of the robot arm between the captures.
4. Tap **Confirm** and wait for the calibration to complete.




**Repeating the calibration**

It is necessary to perform the calibration again after making any changes that affect the position of the camera on the robot. These might be any adjustments to the camera mount, replacement of the gripper or tightening of the bolts that hold the camera on the tool flange. You can repeat the calibration by tapping **Replay**. The robot automatically moves through all manually recorded poses and re-takes images of the calibration board.

**WARNING**

Stand outside the robot reach, robot will move automatically.

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