# Dobot X-Trainer Operation Guide and FAQ

## 1. Safety Operation Guide

### Safety operation principles

- Before operating, make sure you have read and understood all safety information in the user guide.
- Ensure all operators are professionally trained and familiar with the equipment's operation procedures and safety regulations.

### Security risks and prevention

- During operation, avoid interference between the slave hands to prevent collisions that could damage the robot and camera.
- Operators should always pay attention to the movement of the slave hands to prevent accidental collisions or falls.

### Emergency handling

- In case of an emergency, immediately press the emergency stop button to halt all operations (pressing any button will achieve a global emergency stop).
- Do not restart the equipment until the issue is fully resolved. Contact FAE promptly.

### Maintenance

- Check all parts of the equipment regularly to ensure there is no wear or damage.
- Keep the equipment clean to prevent dust and debris from entering the mechanical structure.

# 2. Operating Instructions and Precautions

## Preparation before operation

- Make sure the Dobot X-Trainer is placed on a stable workbench, with no obstructions around and sufficient operating space.
- Check that all cables are secure and undamaged.

## Startup process

- Power on the equipment in sequence according to the instructions in the User Guide, ensuring all devices (including master hand, slave hand, camera, etc.) are powered on properly.

## How to use master hand

- **Unlock and lock the handle**
  - **Unlock:** Hold the handle at the end of the master hand with both hands, short-press the unlock button (yellow button on the left), and the master hand will be unlocked, allowing you to freely move it to the desired position.
  - **Lock:** Move the master hand to the desired position, short-press the unlock button again, and the master hand will be locked in the current posture.
  - **NOTICE:**
    - Before unlocking the master hand, make sure you are holding the handle firmly with both hands to prevent accidental drops.
    - After locking the master hand, avoid collisions or strong vibrations to prevent damage to the servo.
    - During operation, maintain a safe distance between the master and slave hands to avoid interference.
- **Synchronize master and slave hand postures**
  - Long-press the unlock button (yellow button on the left) for more than 2 seconds to synchronize the master hand with the slave hand. After synchronization, the slave hand will mimic the master hand's movements for teleoperation control.
  - **NOTICE: The left and right master hands can be synchronized individually using their respective buttons.**
- **Gripper control**
  - Use the trigger on the handle to control the slave-hand gripper. Pressing the trigger closes the gripper, and releasing it opens the gripper. The depth of the trigger press controls the gripper's opening degree (stroke).

## Data collection

- Ensure all settings (including camera ID, master-slave hand synchronized posture, etc.) are configured as per the User Guide before starting data collection.

- Short-press the record button (green button on the right) to start recording, and short-press it again to stop recording and save the data.
- **NOTICE:**
    - **Effective conditions:** The recording function is only effective after the master and slave hands are successfully synchronized.
    - **Unified control:** Any master hand (left or right) can control the start and stop of recording for all master-slave hands and cameras, i.e., it is not possible to record data for just the left or right hand alone.

# 3. Safety Mechanism

### Master-slave safety synchronization mechanism

- **Auto-disconnect synchronization:** In the event of power failure or alarm, the system will automatically disconnect the synchronization between the master and slave robot arms to prevent collision damage.
- **Low-speed synchronization mechanism:** Synchronization between the master and slave hands is done at low speed to reduce collision risks from fast synchronization.

### Master hand drop detection function

- Dobot X-Trainer is equipped with a master hand drop detection mechanism. When the system detects a drop or rapid abnormal movement of the master hand, it will automatically disconnect the synchronization between the master and slave robot arms and trigger an alarm to prevent collisions or damage to the slave hand.
- **NOTICE:** Avoid fast or rough operations during teleoperation to prevent triggering the drop detection mechanism.

### Slave hand collision detection function

- **5-level collision detection:** Nova2 comes with a 5-level collision detection function that immediately stops the robot arm's movements in the event of an accidental collision.
- **ISO15066 safety certification:** Certified to ISO15066 safety standards to ensure the safety of human-robot collaboration.

### Speed and safety position limits

- **Speed limit:** During teleoperation, the maximum speed in the downward Z-axis direction is limited to prevent collision accidents due to fast movements.
- **Position limit:** The robot's operating range is confined to a safe area, including posture limits for the J3/J4 axes and a cubic space defined around the center point of the gripper's end (approximately equivalent to the space above the EVA foam), to prevent entering potential danger zones.

- When safety limits are triggered, the teleoperation will automatically stop, and the indicator light will turn red.
- If you need to modify these limits, refer to the “Configuring and collecting data” section of the User Guide. Before modification, ensure that you have thoroughly assessed the risks and conducted adequate testing to verify that the modifications will not compromise the safety of teleoperation.

### Dual global emergency stop buttons

- **Global emergency stop:** Equipped with dual emergency stop buttons, pressing any one of them will achieve a global emergency stop to quickly prevent accidents.

### Safety protection foam

- A large area of flexible EVA foam is placed in the operating space to effectively cushion accidental drops of the slave hand, reducing damage risks.

## 4. Common Issues and Solutions

### Issue 1: Too much delay in teleoperation

- **Cause:** The computer configuration may be insufficient.
- **Solution:** Make sure the computer meets the required specifications and try reducing the frequency of teleoperation.

### Issue 2: Failure to synchronize the master and slave hands

- **Cause:** The USB connection may be unstable, or the synchronization posture settings may be incorrect.
- **Solution:** Reconnect the USB cable and check if the synchronization posture settings are appropriate. If the posture difference is too large, synchronization will fail.

### Issue 3: Blurry or no camera image

- **Cause:** The camera may not be powered correctly or the camera lens may be dirty.
- **Solution:** Check the camera's power connection and clean the camera lens for clear images.

### Issue 4: Insensitive gripper control

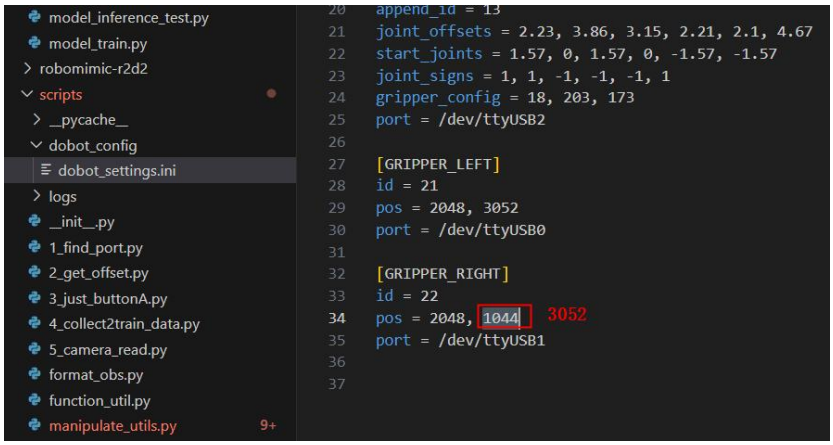
- **Cause:** The gripper control trigger may be damaged, or there may be a problem with the gripper itself.
- **Solution:** Check the function of the gripper control trigger and replace damaged parts if necessary.

## Issue 5: Unresponsive or crashing software script interface

- **Cause:** There may be a software conflict or insufficient memory.
- **Solution:** Close unnecessary background programs, ensure there is enough memory space, and restart the software.

## Issue 6: One gripper does not automatically open/close after powering on

- **Cause:** There may be a bug in the old version of the code.
- **Solution:** Open `dobot_setting.ini` and change the pose parameter for the gripper that doesn't open/close from 1044 to 3052. For example:




## Issue 7: Camera reports an error "couldn't resolve request" occurs after running the run_control project


- **Cause:** The camera may be connected to a USB 2.0 port.
- **Solution:** The camera and master hand should be connected to different USB hubs, and the camera's USB hub should be connected to the computer's USB 3.0 port.

## Issue 8: The slave hand cannot be remotely operated after switching to remote control mode during teleoperation using the QT interface

- **Cause:** After starting teleoperation using the QT interface, if you use the host computer to connect to the slave hand and switch to remote control mode, and then switch back to TCP mode, remote control will not be possible due to TCP status errors.

- **Solution:** Do not switch to remote control mode by connecting to the slave hand after starting teleoperation using the QT interface. If this issue occurs, close and reopen the slave hand in the QT interface (reset status), then start teleoperation again.

### Issue 9: Error "CondaError: Run 'conda init' before 'conda activate'" occurs when running conda activate

- **Cause:** Incorrect environment variable configuration.
- **Solution:** Refer to the User Guide to correctly configure Anaconda's environment variables. Follow the instructions to run `conda init` before running `conda activate`.

# 5. Environment Configuration FAQ

### 1. How to install Ubuntu operating system, graphics driver, and CUDA?

Refer to:
https://ubuntu.com/tutorials/install-ubuntu-desktop#1-overview
https://www.centennialsoftwaresolutions.com/post/installing-nvidia-driver-cuda-11-x-and-cudann-8-x-on-ubuntu-20-04

### 2. How to install Anaconda?

Refer to:
https://docs.anaconda.com/free/anaconda/install/linux/

### 3. Error "ERROR: Could not build wheels for egl_probe" occurs when running `pip install -e ModelTrain/detr`, which is required to install pyproject.toml-based projects

Refer to:
https://stackoverflow.com/questions/75003495/error-could-not-build-wheels-for-prophet-which-is-required-to-install-pyprojec