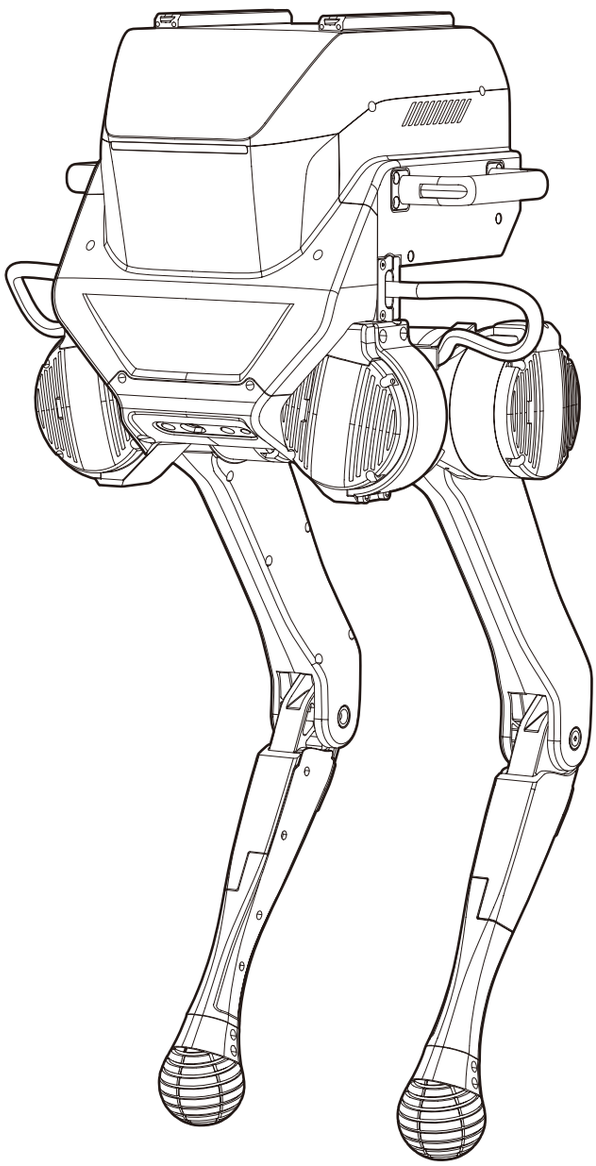
LIMX DYNAMICS

TRON 1

Quick Start Guide

October 2024 V1.0



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Robot Overview

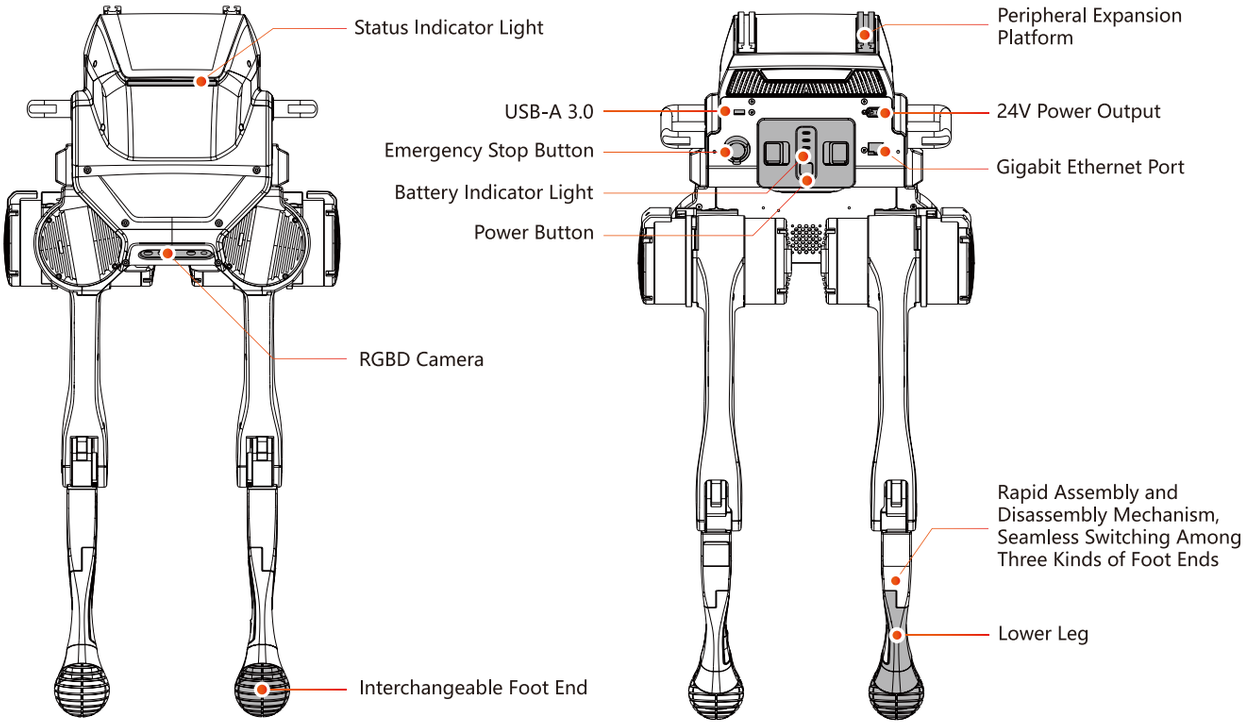
Brief Introduction

TRON 1 is a versatile biped robot designed for researchers. It features a novel configuration, ease of use, stability, durability, and strong extensibility, meeting the demands and needs of:

- Researchers engaged in motion control algorithm research for biped robots.
- Researchers utilizing model-based and reinforcement learning methods for robotic studies.
- Using biped robot as Autonomous Mobile Robot.
- Technology innovation exhibition.

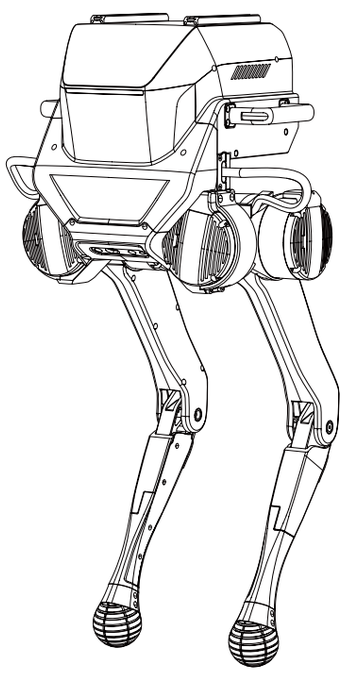
Body Components and Interfaces

Front and Back Diagram



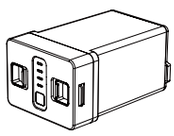
Item	Function Description
Status Indicator Light	Displays the robot's status (control status, abnormal status, low battery, etc.).
RGBD Camera (optional)	Binocular perception sensor
Interchangeable Foot End	Allows users to exchange rubber foot ends.
USB-A 3.0	Can be used for detecting and connecting perception peripherals, such as an additional RGBD camera.
Emergency Stop Button	In an emergency, press this button to enter torque-free mode.
Battery Indicator Light	Displays the current battery level of the device.
Power Button	Power on/ Power off Button
Peripheral Expansion Platform	Allows users to attach and Þx external devices.
24V Voltage Output Por	Capable of providing a stable direct current (DC) voltage of 24 volts, with a peak power rating of 100 W.
Gigabit Ethernet Port	Can be used to connect external computers, routers, or other communication modules, etc.
Lower Leg	Rapid assembly and disassembly mechanism, Seamless switching among three kinds of foot ends.

List of Items

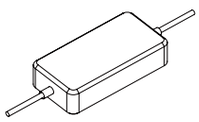


Robot Body × 1

Remote Controller × 1

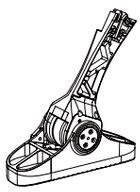


Battery × 1

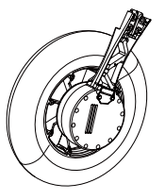


Power Adapter × 1

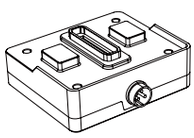
Accessories: Point-Foot x 2



Accessories: Sole × 2 (Optional)



Accessory: Wheeled ×2 (Optional)



Battery Charging Dock

User Guide

Certificate of Conformity

Product Specifications

Category	Details	STD Ed.	EDU Ed.
Mechanical Parameters	Dimensions	≤ 392mm x 420mm x 845mm	≤ 392mm x 420mm x 845mm
	Material	Aluminum Alloy + Industrial Plastic	Aluminum Alloy + Industrial Plastic
	Net Weight	≤ 20kg	≤ 20kg
Battery Parameters	Battery Supply Voltage	48V	48V
	Maximum Battery Power	1000W	1000W
	Battery Swapping	✓	✓
	Battery Type	Ternary Lithium	Ternary Lithium
	Battery Capacity	240Wh (48v/5Ah)	240Wh (48v/5Ah)
	Battery Range	≥ 2h (At Rated Operational Conditions)	≥ 2h (At Rated Operational Conditions)
	Charging Methods	Battery Charging Quick Battery Swap	Battery Charging Quick Battery Swap
	Charger	Battery Charging Dock	Battery Charging Dock
	Charging Time	<1h (20%-80%) 1.5h (100%)	<1h (20%-80%) 1.5h (100%)
Performance Parameters	Load Capacity	10kg (Maximum 15kg)	10kg (Maximum 15kg)
	Movement Speed	• Point-Foot: < 1m/s • Sole: < 1m/s • Wheeled: ≥ 5m/s	• Point-Foot: < 1m/s • Sole: < 1m/s • Wheeled: ≥ 5m/s
	Maximum Climbing Angle	≥ 15°	≥ 15°
	Maximum Obstacle Height Limitation	15cm	15cm
	Computer Specification	12th Gen i3 / 16GB RAM /512GB (CPU/Memory/Storage)	12th Gen i3 / 16GB RAM /512GB (CPU/Memory/Storage)
	Operating Environment	-5℃ to 40℃ Operates in favorable weather conditions	-5℃ to 40℃ Operates in favorable weather conditions
Actuator Parameters	Rated Voltage (V)	48V	48V
	Rated Torque (Nm)	30Nm	30Nm
	Peak Torque (Nm)	80Nm	80Nm
	Peak Motor Speed (rad/s)	15rad/s	15rad/s
Sensor Configuration	RGBD Camera	/	✓ (Optional)
	IMU	✓	✓ (IMU Data Access for Developers)

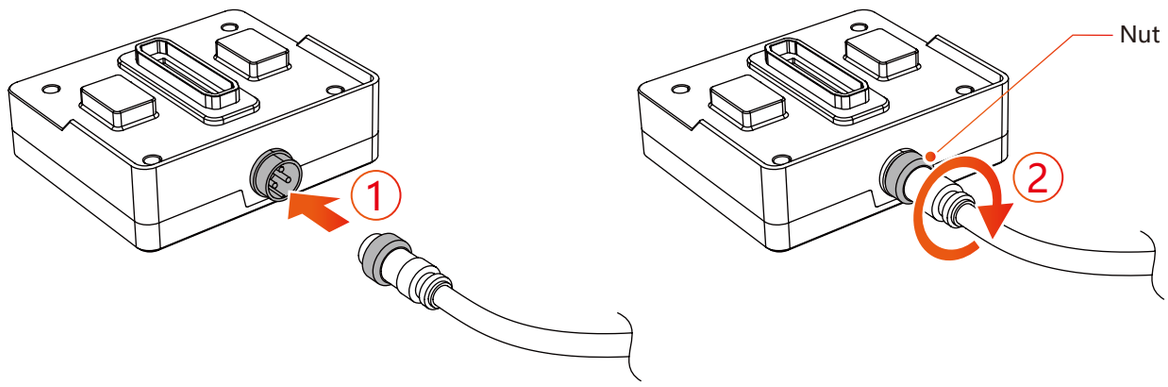
Category	Details	STD Ed.	EDU Ed.
Extensibility	Peripheral Expansion Ports	/	• 1*USB3.0 • 1*GbE
	Peripheral Power Supply Port	/	24V, Output Power: 100W (Peak 200W)
	Peripheral Mounting Point	✓	✓
	Handheld Remote Controller	1 Pcs	1 Pcs
	Remote Controller Communication Range	50m	50m
	Software Upgrade	Supported	Supported
	Remote E-Stop	✓	✓
	E-Stop Button	✓	✓
	Secondary Development	/	Supported
Developer Tools	SDK	/	✓
	Data Visualization Tools	/	✓
	Data Recording and Playback	/	✓
	Joint Control Algorithm	/	✓
	Simulation Platforms	/	✓
Foot End Extension	• Point-Foot	Four-directional Movement, Turning, In-place Stepping, Squatting Up and Down In-place	Four-directional Movement, Turning, In-place Stepping, Squatting Up and Down In-place
	• Sole	Four-directional Movement, Turning, In-place Stepping, Static Standing, Squatting Up and Down In-place	Four-directional Movement, Turning, In-place Stepping, Static Standing, Squatting Up and Down In-place
	• Wheeled	Four-directional Movement, Movement, Differential Steering, Turning, In-place Stepping, Static Standing, Squatting Up and Down In-place	Four-directional Movement, Movement, Differential Steering, Turning, In-place Stepping, Static Standing, Squatting Up and Down In-place
Others	Spare Battery	1 (Optional)	1 (Optional)
	RGBD Camera	/	1 (Optional)
	Roll Cage	1 (Optional)	1 (Optional)
	Accessories: Point-Foot	1 Pair (Optional)	1 Pair (Optional)
	Accessories: Wheeled	1 Pair (Optional)	1 Pair (Optional)
	Accessories: Sole	1 Pair (Optional)	1 Pair (Optional)

Status Indicator Light

Event/Status	Light Color	Light Indication of the Robot' s Conditions	Frequency (Seconds/ Time)	Notes
Booting	Slow Flashing White	During booting process	1	In the Booting-up and Self-check Process
Abnormality Warning	Static Red	An abnormality has occurred with the robot	/	Maintenance Required
Low Battery Warning	Flashing Red	Battery is low (below 20%)	2	Battery Swap ASAP
Extremely Low Battery Warning	Quick Flashing Red	Battery is extremely low (below 5%)	0.5	Robot will squat automatically
Emergency Stop	Flashing Yellow	The Emergency Stop button has been pressed	2	You cannot manipulate the robot under this state
Developer Mode	Static Green	System determines color based on mode setting	/	Once powered on, the robot's system decides the color according to your setting
Remote Control Mode	Static Blue	System determines color based on mode setting	/	Once powered on, the robot's system decides the color according to your setting
Idle Status	Static (Green/Blue)	Robot is in the torque-free mode.	/	It shows static green if the robot is in Developer Mode, static blue if in Remote Control Mode
Standing Status	Static (Green/Blue)	Robot is in the stance mode.	/	It shows static green if the robot is in Developer Mode, static blue if in Remote Control Mode
Walking Status	Dynamic (Green/ Blue)	Robot is in the stepping mode.	2	It shows dynamic green if the robot is in Developer Mode, dynamic blue if in Remote Control Mode

How to Charge the Battery

1. Connect the "Battery Charging Dock" to the "Power Adapter". After aligning the aviation plug with the limit stop, insert it fully and tighten the nut clockwise.
2. Plug the Power Adapter into the electrical outlet.
3. Insert the battery into the dock in the direction indicated by the limit stop, and press down firmly to ensure it is securely inserted.
4. When the battery indicator light is flashing and the red light on the power adapter remains constantly lit, it indicates that the battery is successfully charging. When the battery indicator light remains constantly lit and the green light on the adapter is constantly on, it indicates that the battery is fully charged.
5. It takes approximately one hour to charge the battery from 20% to 80%.



Charging-related Light Signals

	Not charged	Charging in progress	Charging complete
Battery Indicator Light	No light is on	Green light is flashing	Green light is always on
Power Adapter Light	Green light is always on	Red light is always on	Green light is always on

- When the device is not used for a long time, it is recommended to charge the battery every three months to avoid battery damage
- Overnight charging is not recommended.

Startup and Shutdown Process

1. Startup Process

a. Insert the battery into the battery compartment and press firmly until the latch clicks into place.
b. Ensure that the emergency stop button is released.
c. Press and hold the power button for 3 seconds, then release. The battery indicator light and the robot's status light will illuminate.
d. Wait for approximately 20 seconds as the entire robot's system automatically completes the startup program.
e. Upon successful startup, the status indicator light on the robot's body will change from white to a Static Blue or green.

2. Shutdown Process

a. After the robot has completed its tasks, initiate a squatting motion to ensure a smooth landing.
b. Once the robot has stopped moving, press and hold the power button for 3 seconds, then release.
c. The robot's system will automatically proceed through the power-down sequence, turning off the battery indicator light and the status light.
d. Shutdown is now delete .w

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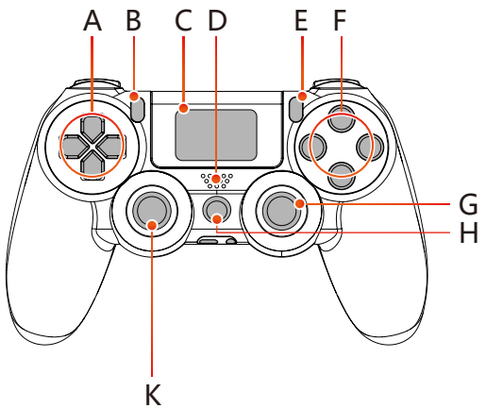
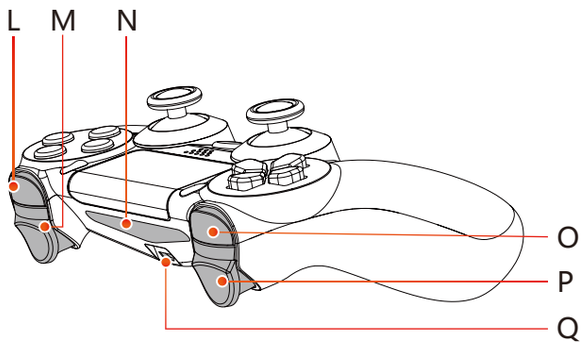
- If you have pressed the power button but are unable to control the robot or access the system normally, please check the battery level Þrst before attempting to restart it.
- If the robot, upon power-up, fails to remote control commands, please verify if the emergency stop button has been pressed.

Remote Controller Buttons Instruction



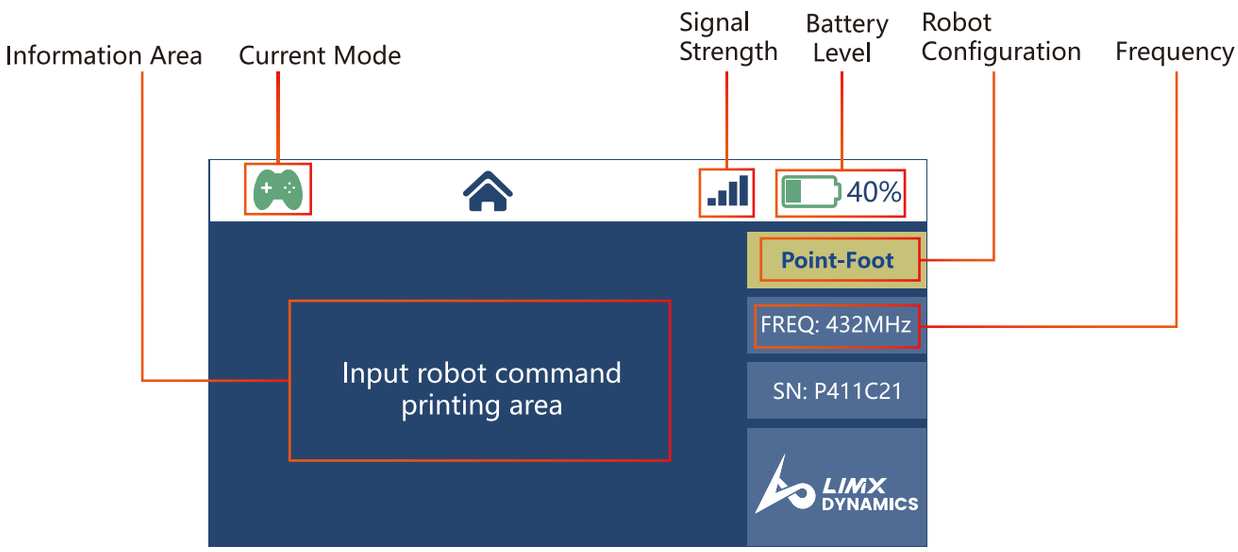


A	Directional buttons, for correcting the robot's positional offset
B	Share Button
C	Screen
D	Speaker Hole
E	Options Button
F	△ Button、○ Button、X Button、□ Button
G	Right Joystick, for controlling the robot's rotation direction
H	Power Button, for turning the remote controller on/off
K	Left Joystick, for controlling the robot's movement in all directions (forward, backward, left, right)
L	R1 Button
M	R2 Button
N	Light Bar
O	L1 Button
P	L2 Button
Q	Micro-USB Port: Charging Port

Turning the Remote Controller On/Off

- **To turn on the remote controller:** Press and hold the power button for at least 3 seconds. Upon hearing a single "beep," this signifies that the remote controller has been successfully powered on and has entered its default interface.
- **To turn off the remote controller:** Press and hold the power button for at least 2 seconds. When you hear three consecutive beeps ("beep, beep, beep"), this indicates that the remote controller has been powered off and the screen display has been turned off.

Remote Controller Screen Information Description



Information Area : Displays key information, machine error messages, and other pertinent data.

Current Mode : Developer Mode / Remote Control Mode

Signal Strength : When disconnected from the robot, the remote controller does not display a signal icon. Upon connection, a white signal bar appears, and a greater number of lit bars signifies a stronger signal.

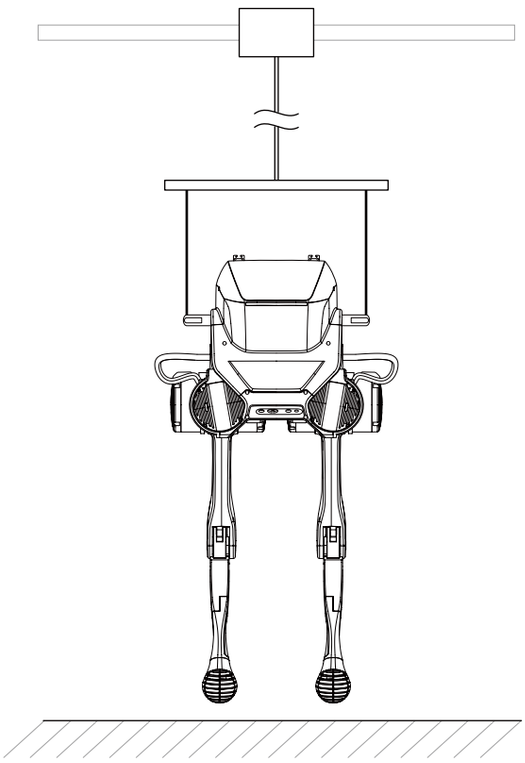
Battery Level : Indicates the battery level of the remote controller.

Frequency : Displays the ongoing communication frequency between the remote controller and the robot.

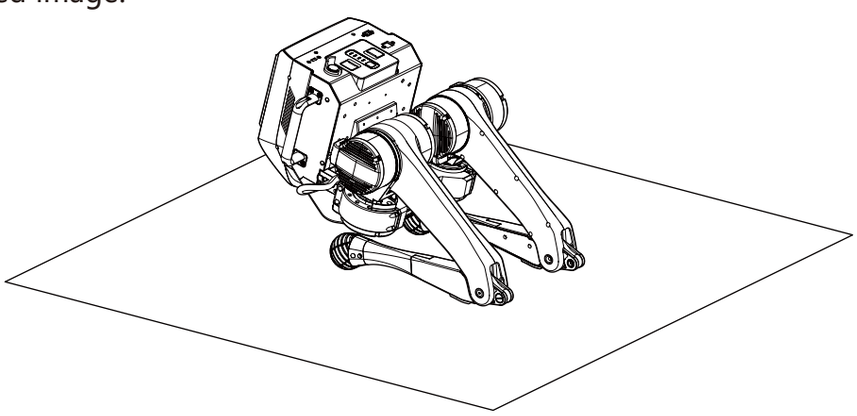
Robot Configuration : Indicates the current robot configuration, including Point-Foot, Wheel-Foot and Sole-Foot.

Power-On Zero Calibration

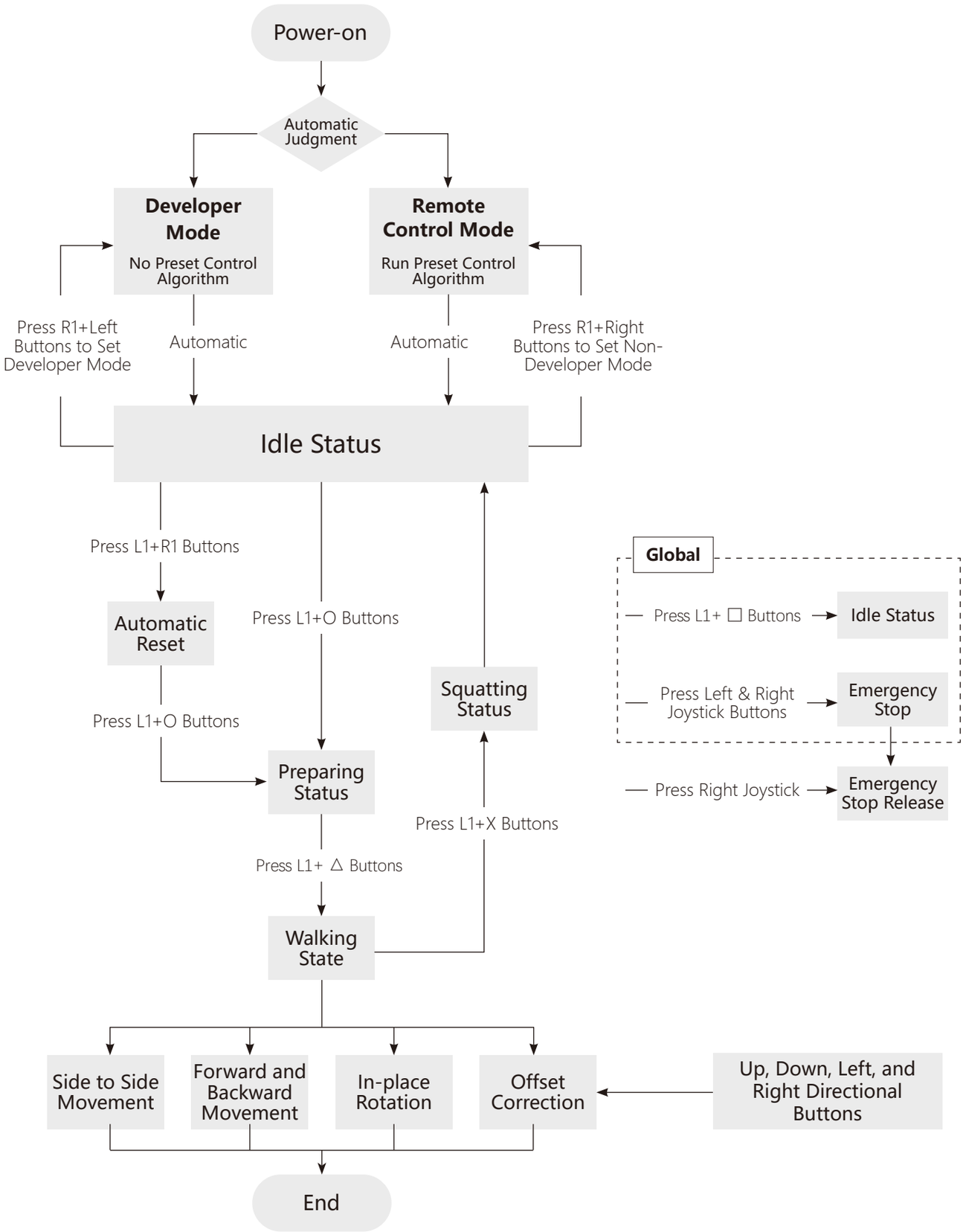
1. Upon powering on the robot, you will notice the status indicator light change from white to blue or green.
2. Ensure the robot is hoisted or lifted, maintaining a height of at least 30 centimeters above the ground, as illustrated in the flowing image.



1. To initiate the automatic zero calibration process, press the L1 and R1 buttons simultaneously on the remote controller. It is crucial to ensure that the robot's joints remain unobstructed during this calibration.
2. 4.Once the zero calibration is successfully completed, gently descend the robot's lower legs to the ground in preparation for a smooth stand-up, as depicted in the provided image.



Usage Process



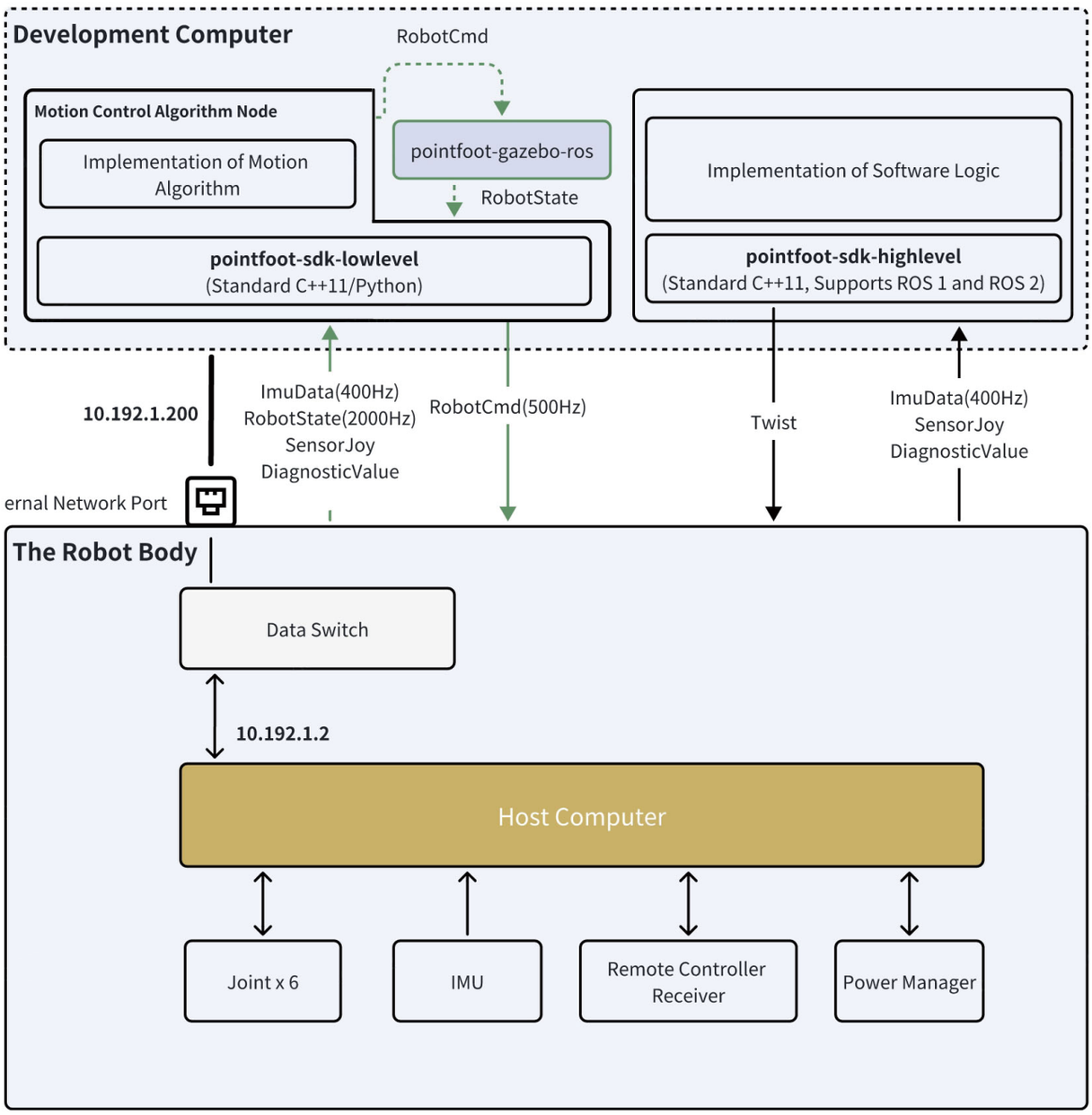
Remote Controller Buttons Instructions

Concept	Status Description	Precondition	Buttons	Notes
Automatic Reset	All joints initialization	Idle Status	L1+R1	
Idle Status	All joint motors are in damping mode, causing them to slowly descend. The robot will enter this mode upon startup.	Global (excluding emergency stop status)	L1+ □	
Preparing Status	Legs will be automatically powered on and execute movements of touching the ground and lifting the upper body.	Idle Status	L1+ ○	Requires external assistance, with lower legs extended and both feet touching the ground.
Walking Status	Robot stands automatically to enter stepping status. Can be remotely controlled.	Standing Status	L1+ △	
Four-directional Movement	Robot follows remote commands, moves forward, backward, left and right.	Walking Status	Left Joystick	
Rotation in Place	The robot rotates clockwise and counterclockwise according to remote commands.	Walking Status	Right Joystick	Invalid when pushed forward or backward.
Forward Tilt Correction	Real-time correction of the robot's tendency to move forward during in-place marching	In-Place Stepping Status	Down Button	
Backward Tilt Correction	Real-time correction of the robot's tendency to move backward during in-place stepping	In-Place Stepping Status	Up Button	
Left Tilt Correction	Real-time correction of the robot's tendency to move forward-left during in-place stepping	In-Place Stepping Status	Right Button	
Right Tilt Correction	Real-time correction of the robot's tendency to move forward-right during in-place stepping	In-Place Stepping Status	Left Button	

Concept	Status Description	Precondition	Buttons	Notes
Squatting Status	The robot squats autonomously.	Walking Status	L1+ X	Hand support is needed, otherwise the robot is prone to falling down.
Developer Mode	Users can perform secondary development, deploy programs, and exercise control.	Idle Status	R1+Left	
Remote Control Mode	Used for remotely controlling robot movement in the context of an RL (Reinforcement Learning) model.	Idle Status	R1+Right	Remains valid until manually switched to another mode (the developer mode).
Emergency Stop Button	All motor drivers power off immediately, but battery power supply and light signals remain on, and the whole machine will drop.	Global Position	Left joystick + Right joystick	Press both buttons simultaneously to trigger an emergency stop, which will immediately cut off power supply to all motors regardless of the current mode or state.
Emergency Stop Release	Motor Power on	Emergency Stop Status	Right joystick	Single-click the right joystick to release the emergency stop. Clicking in other modes has no effect. After releasing the emergency stop, the robot will enter damping mode.
Switching Mode	Under Wheel-Foot conPguration, switching between Ground mode / Stair mode	Wheel-Foot conPguration	Share Button	Long press for 2s

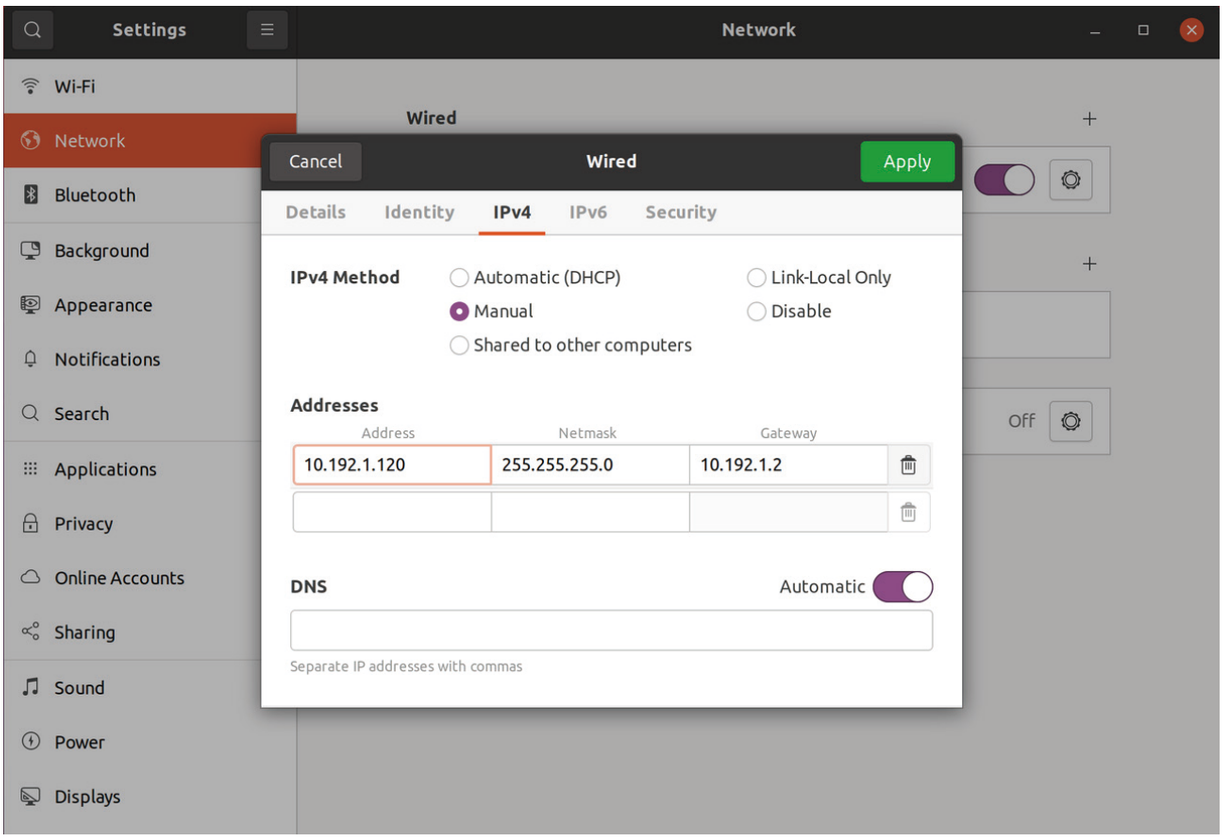
Establishing a Connection to the Robot

Communication Structure Diagram



Wired Connection

- Attach an Ethernet cable to the robot's rear Gigabit Ethernet port for connectivity.
- Modify the IP address of your personal computer to ensure it is within the same subnet as the robot to establish a connection with the robot.



For example, to ensure compatibility with the robot's network, set the IP address of your personal computer to 10.192.1.120.

Wireless Connection

- Once the robot has completed its boot-up process, connect your personal computer to the robot's Wi-Fi network, which generally follows the naming convention of "P441C_01" or "PF_P441C_01".
- Enter the Wi-Fi password “12345678”.

Robot Software Upgrade

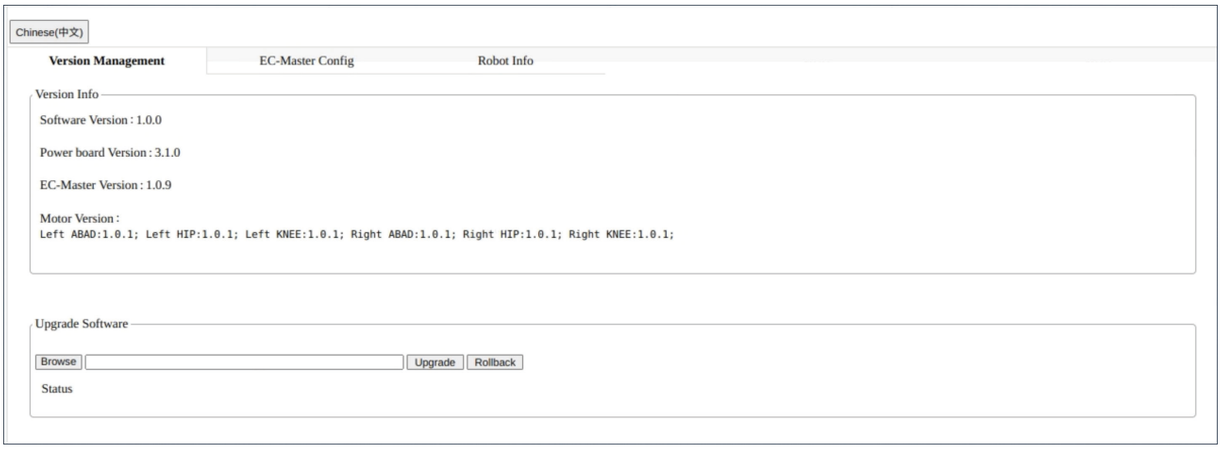
Please go to the LimX Robot Manager page through the browser and select the version of the robot software that you have downloaded in advance for the upgrade. The steps are as follows:

Connection and IP settings:

- Connect your personal computer to the robot by following the instructions in the "Establishing a Connection to the Robot" section.
- Verify that the robot can successfully respond to the Shell command "ping 10.192.1.2" to ensure network communication with your computer.

Visit the LimX Robot Manager page:

- Enter the following address in your browser's address bar: http://10.192.1.2:8080 to access the LimX Robot Manager page.



Select and upgrade the software:

- Select the file you have downloaded for the upgrade and proceed with the upgrade process.
- Once the upgrade is complete, the robot's host computer will automatically restart.

Scan the QR code to follow
LimX' s WeChat Official account

This manual is subject to updates without prior notice.
You can check the latest version on LimX' s website

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