

# 安装指引手册 Installation Guidebook

## 机器人保护支架/绳的安装与使用指引 Guidelines for Installation and Use of Protective Brackets/ Ropes



**Unitree**

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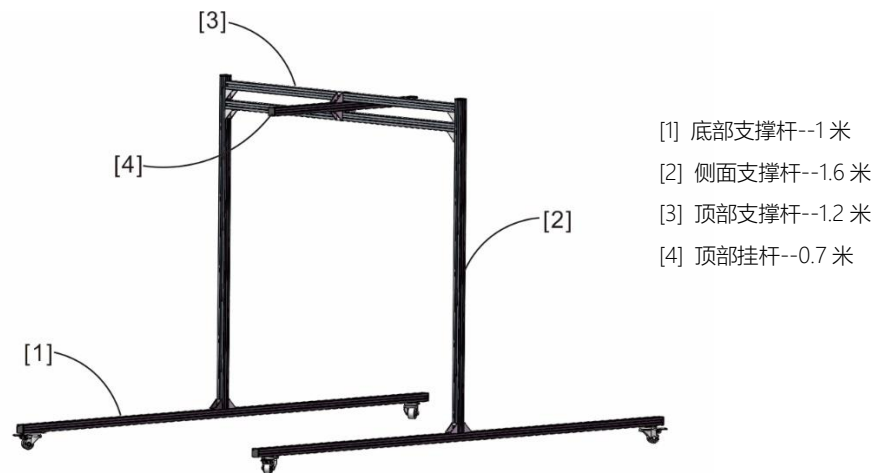
# ⚠ 注意! Notice!

1. 在未按软件手册中的要求用保护绳和保护架保护机器人时，请不要使用急停开关，否则将造成机器人严重损坏。由该原因造成的损坏，不在免费质保范围内。
1. When the protection rope and protective frame are not used to protect the robot according to the requirements of the software manual, please do not use the emergency stop switch, otherwise the robot will be seriously damaged. Damage caused by this reason is not covered by free warranty.
2. 收到机器人后，请先安装保护架保护绳，然后在使用机器人。
- 2 After receiving the goods, please install the protective rope first, and then use the robot.

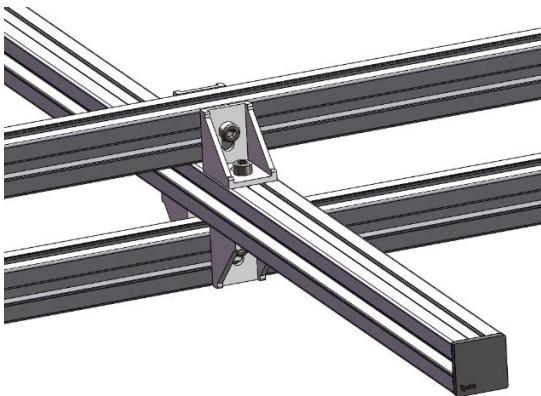


# 1. 如何安装保护支架和保护绳。

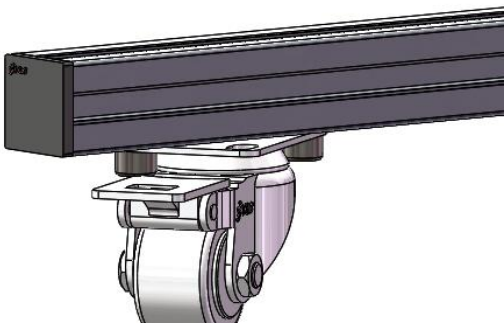
保护支架装配整体效果图及尺寸示意如下图：



顶部挂杆[4]与顶部支撑杆[3]连接示意图：



底部支撑杆的轮子安装示意图：



安装实际效果图：

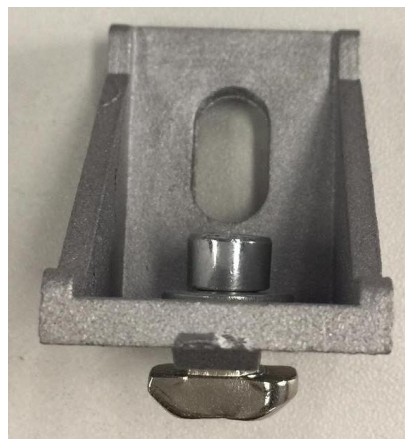
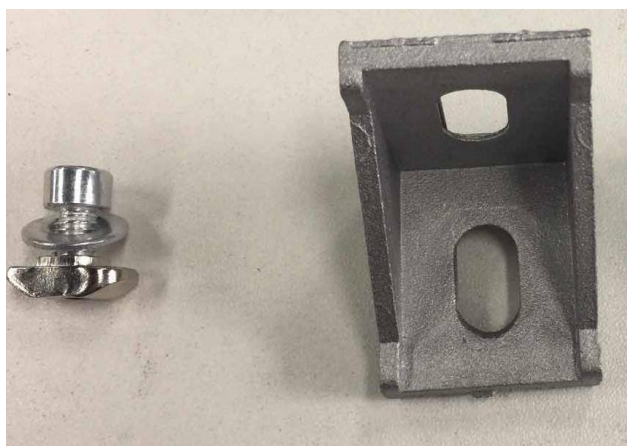


除了支架外，还会有 3 根尼龙绳用来悬吊机器人，包含两根长一些的（简称长绳），和一根短一些的（简称短绳）。

支架安装步骤：

1. 固定方法简介

螺钉、垫片和螺母套件放入对应的角码固定孔，拧螺丝的过程中，螺母会跟着一起转动，锁紧后跟铝合金支架固定住。



2. 安装底部支撑杆[1]的轮子

固定轮子对角线上的两个孔。

3. 安装左右的侧面支撑杆[2]

把侧面支撑杆[2]固定到底部支撑杆[1]

4. 安装顶部支撑杆[3]和顶部挂杆[4]

用顶部支撑杆[3]把两侧支架连接起来，先不要锁死。把顶部挂杆[4]位置定好后，再锁紧固定[3]和[4]。

5. 安装扎绳

在顶部挂杆两端安装两端的长绳（带锁扣）和中间的短绳（带挂钩）。绳子安装后用魔术贴固定，以放绳子在横向支架上活动。顶部挂杆两个末端分别装一个角码，用于限位。



绳（左）、锁扣（中）与挂钩（右）使用示意图：



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## 2. 如何使用保护架保护绳

机器人的开机与关机步骤请查阅使用手册，这里为启动细节作补充与说明。

### 2.1 地面启动

地面启动是最通用的启动方式，注意在启动前需要把腿放在正确的位置，整理机器人上的电线，以防拉扯损坏。详细内容请查看使用手册。

### 2.2 悬空启动

悬空启动需要保护支架配合，是调试时最常用的启动方式。建议开发者使用我们提供的保护调试支架以规避调试过程中的意外。在足够熟悉机器人之后，机器人可以摆脱支架，方便进行演示或执行复杂任务。

进行底层模式开发时，建议用挂钩将机器人吊离地面。此时需要用到两根短绳，一根穿过挂钩和支架，用来悬吊；另一根环绕机身前后的碳纤维管或穿过前后碳纤维板的圆孔，用来把机器人吊起。挂绳长度以腿伸直时不能触及地面为宜，防止腿部动作时与环境碰撞而损坏机身部件。此模式需要将支架的四个滚轮锁止。

开机时，不能让足端离机身过近，否则会被误认为地面启动模式，导致不能正确开机。正确做法是让各腿自然下垂，如下图。



开机后，足端的 led 灯微微发亮（绿色），表示足端的力传感器工作正常；如果不亮，说明力传感器异常或 led 灯损坏。



开机后，四条腿的平面会垂直于机身，并且大腿和小腿的关节刚度很大。如果刚度很小（外加扰动后，能推动关节旋转），则需人为调整四个足端至图示位置：



悬空状态下，可直接进行底层开发，但不支持高层开发。此时可以直接将机器人从挂钩上取下，轻轻放到地面上，机器人会自动进入站立模式，之后可进行高层控制。

进行高层模式开发时，建议用前后两个锁扣将机器人与支架相连。此时需要用到两根长绳，各自穿过机器人（前或后）的碳纤维板的圆孔，并和支架顶部的短杆相连，顶部与短杆连接处需要用粘扣带缠绕防止滑移。

正常（绳松弛）：



调节绳长，不能过长，以使机器人在断电情况下机身不能触碰到地面，如下图所示，最好在绳绷紧时机身离地面还有 20cm 的空隙；也不能过短，以使机器人能够在地面灵活动作。可以根据需要，打开或锁止支架的滚轮。

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摔倒（绳拉紧）：



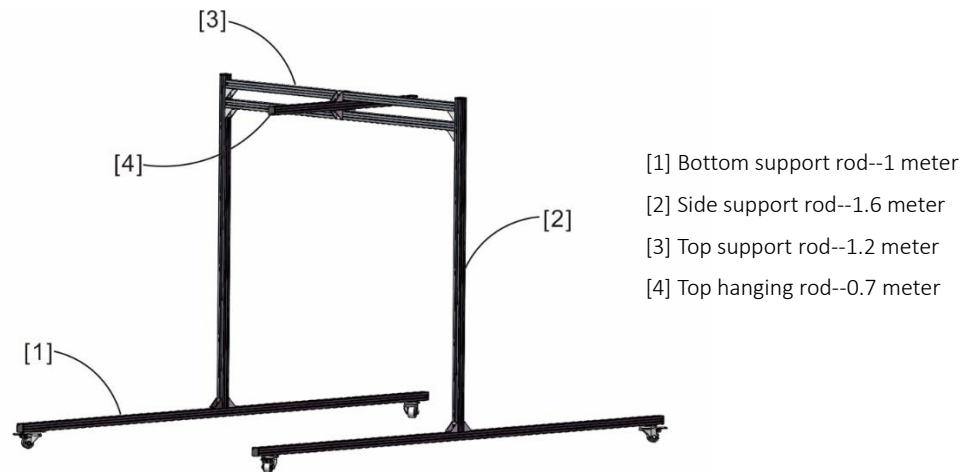
如果在机器人站立或行走时，直接将机器人拎起悬空，或者从高处掉落，机器人会切换到摔倒保护模式。



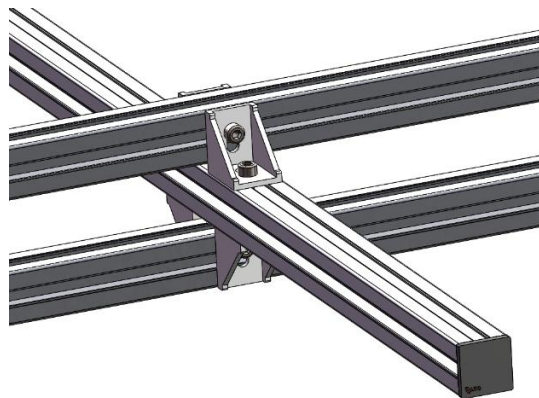
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## 1. How to install protective bracket and rope.

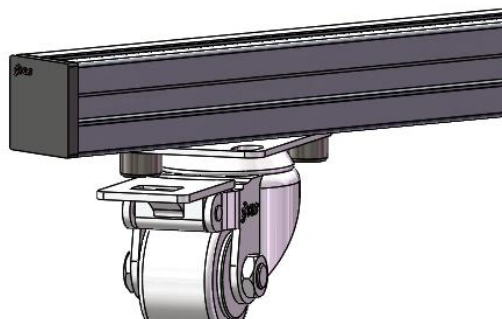
We also provide a bracket for developers to prevent from falling down accidentally when debugging and developing. The assembly diagram is as follows:



Connection diagram of the top hanging rod [4] and the top support rod [3]:



Schematic diagram of the wheel mounting of the bottom support rod:



Final effect diagram:

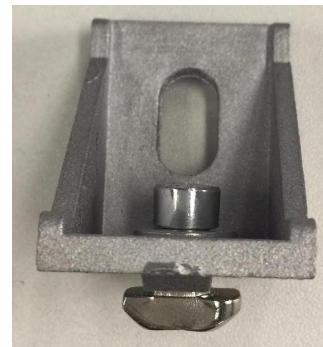
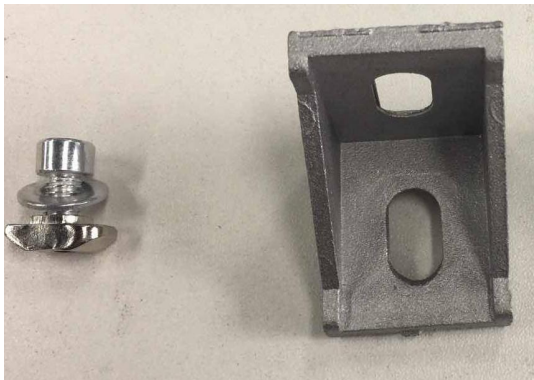


In addition to the bracket, three nylon ropes will be used to suspend the robot, including two longer ones (called long ropes) and one shorter ones (called short ropes).

Bracket mounting step :

1. Introduction to the fixed method

The screws, washers and nut sets are placed in the corresponding corner fixing holes. During the screwing process, the nuts will rotate together, and the locking will be fixed with the aluminum alloy bracket.



2. Install the wheel of the bottom support rod [1]

Secure the two holes on the diagonal of the wheel.

3. Install the left and right side support bars [2]

Fix the side support bar [2] to the bottom support bar [1]

4. Install top support bar [3] and top hanger [4]

Connect the brackets on both sides with the top support rod[3] and do not lock them first. After fixing the position of the top hanging rod [4], lock and fix [3] and [4].

5. Install the tether

Install a long rope (with a buckle) and a middle lanyard (with a hook) at the ends of the top hanger. After

the rope is installed, it is fixed with a Velcro to move the rope on the horizontal bracket. A corner code is attached to each end of the top hanging rod for the limit position.



Schematic diagram of rope (left), lock (middle) and hook (right):



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## 2. Suspended startup

Suspended startup is made for debugging, which needs the support bracket to cooperate with. Developers are advised to use the debugging support bracket we provide to avoid accidents during debugging. After being familiar with the robot enough, the robot can get rid of the bracket for complex tasks.

When developing under low level control mode, it is suggested that the robot is lifted off the ground by a hook. Here need two short ropes, one through the hook and bracket, are needed for suspension, and the other through the carbon fiber tube around the fuselage or through the circular hole of the carbon fiber plate around the fuselage to hang the robot. The length of ropes should be adjusted that legs can not touch the ground when straight, which prevent the damage of the fuselage parts caused by the collision between the legs and the environment. This mode requires locking the four rollers of the bracket.

When booting, the foot should not be too close to the fuselage. Otherwise, it will be mistaken for ground startup mode, leading to incorrect startup. The correct way is to let the legs droop naturally, as shown below:



After booting, the led at the foot is slightly bright (green), indicating that the force sensor is working normally; if not, it indicates that the force sensor is abnormal or the led is damaged.

After booting, the plane of the four legs will be perpendicular to the fuselage, and the joint stiffness of

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the thigh and calf is very large. If the stiffness is small (after disturbance, the joint can rotate), then it is necessary to adjust the four feet ends to the graphic position by hands:



In the suspended state, the low level commands can run directly, but the high level commands are not supported. At this time, the robot can be directly removed from the hook and gently placed on the ground. The robot will automatically enter the standing mode, and then can be controlled at a high level.

When developing under low level control mode, it is suggested that the robot is connected with the bracket by two lock catches. Here need two long ropes, each of them passes through the circular holes of the carbon fiber board of the robot (front or rear) and connects with the short rod at the top of the bracket. The connections between the top and the short rod needs to be wrapped with adhesive tape to prevent slipping.

Normal (rope slack):



Adjust the length of ropes, not too long, so that the fuselage can not touch the ground when fall or the power is cut off. As shown in the figure below, it is better to have a gap of 20cm from the ground when the rope is tightened; also not too short, so that the robot can move flexibly. Open or lock the rollers of the bracket as needed.

Fall (rope tension):



When the robot is standing or walking, it will switch to fall protection mode when lifted directly in the air or dropped from a high place.