unitree_legged_sdk manual

2021.12.4

1. Introduction

The unitree_legged_sdk is mainly used for communication between PC (with Linux system) and Controller board.

It also can be used in other PCs with UDP.

- **notics**: support robot: Go1, not support robot: Laikago, Aliengo, A1. (Check release v3.2 for support)

1.1 Usage of control robot

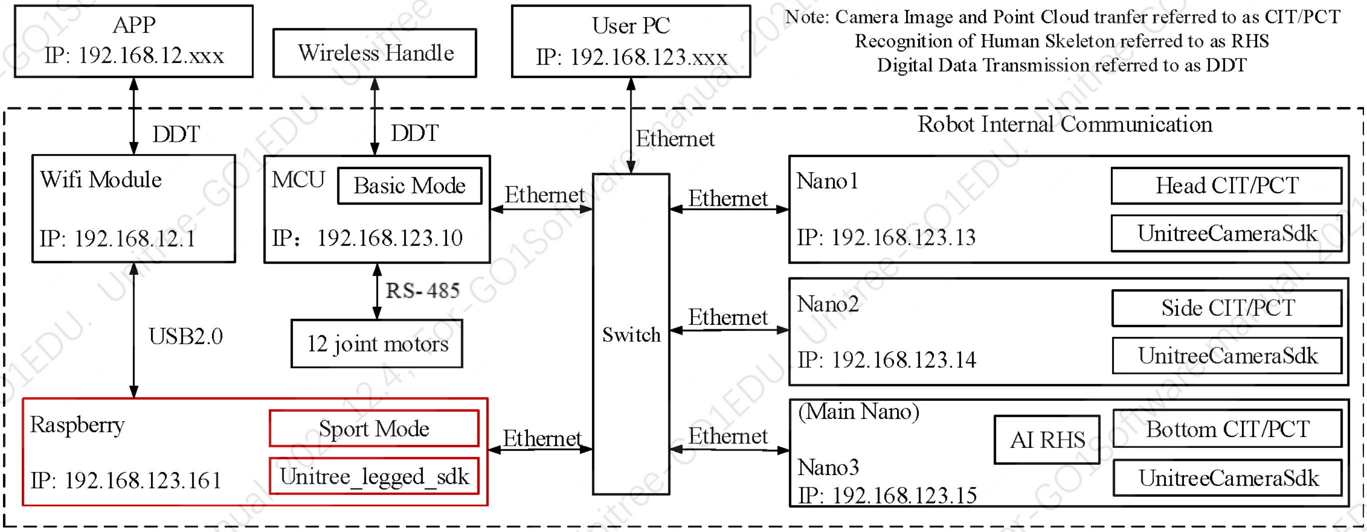
There are four steps that use this software development kit (SDK) to control robot.

- Communication
- Dependencies
- Build
- Run

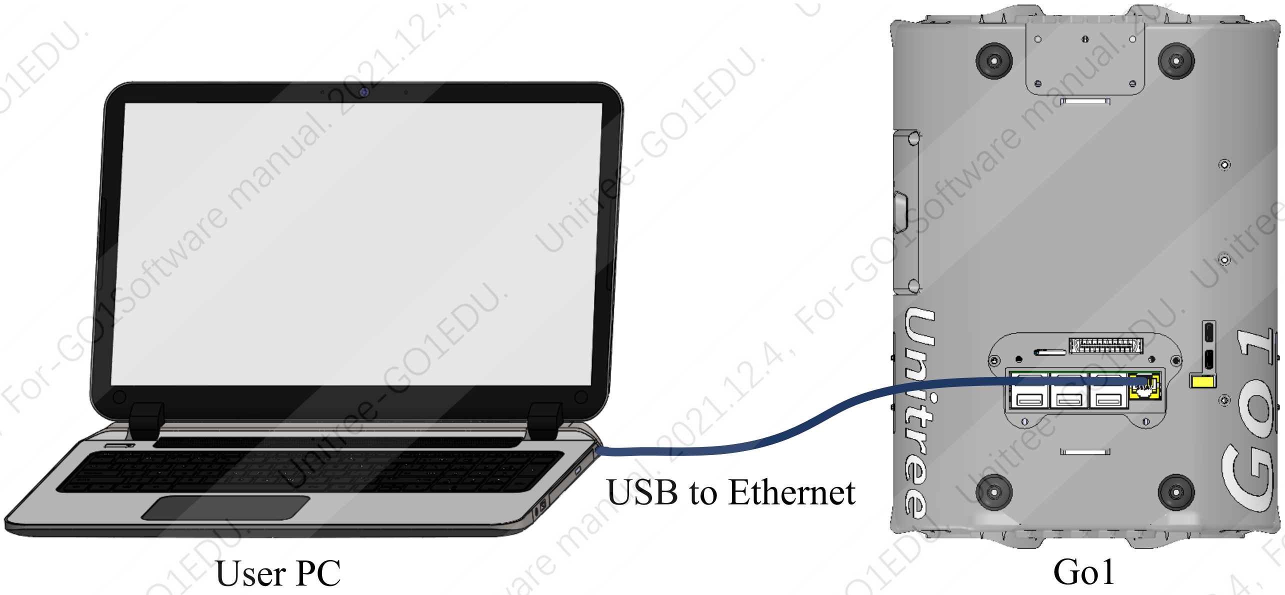
1.1.1 Communication

Establish communication between PC and Controller board.

If you're using the PC(Raspberry in the red box below) on Go1, you can skip this section, but this is not recommended.



- Use own PC(with Ubuntu system) USB port to connect Go1's Ethernet port.



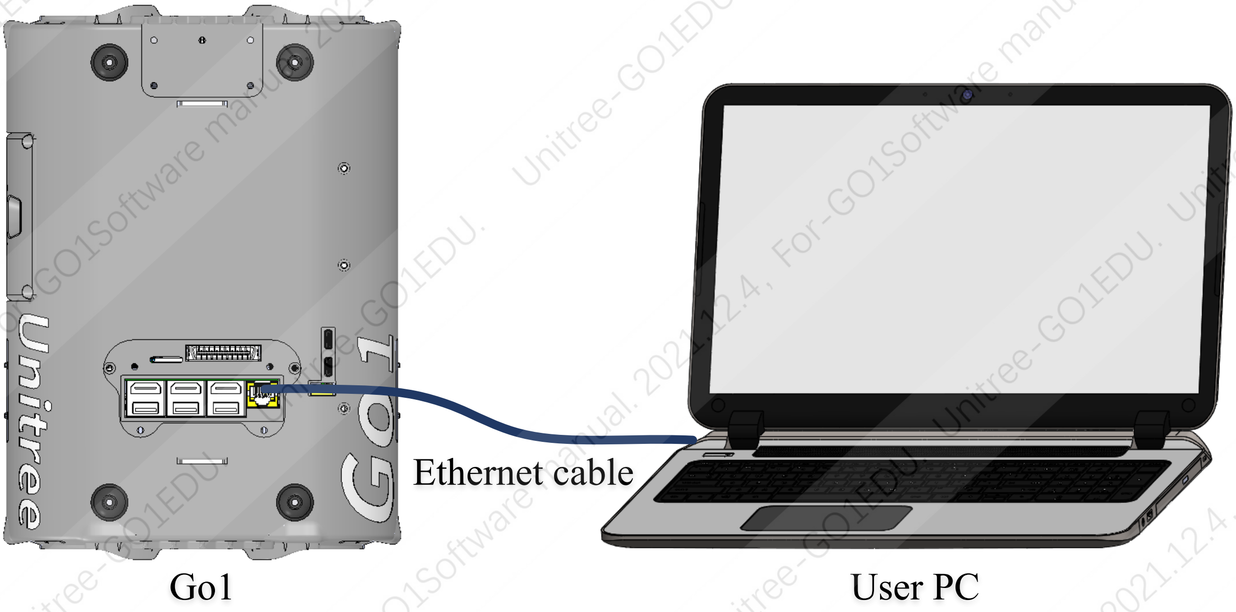
Then open terminal and execute following commands:

```
# Run this command after you plug in the USB hub,
# you can find an extra device ID. For example, enpxxx
ifconfig
```

```
sudo ifconfig enpxxx down   # enpxxx is your PC usb port
sudo ifconfig enpxxx 192.168.123.162/24
sudo ifconfig enpxxx up
ping 192.168.123.161
```

if you can recive message like "64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=xxx ms", you are connected.

- Use own PC(with Ubuntu system) Ethernet port to connect Go1's Ethernet port.



Then open terminal and execute following command:

```
sudo ifconfig eth0 down # eth0 is your PC Ethernet port
sudo ifconfig eth0 192.168.123.162/24
sudo ifconfig eth0 up
ping 192.168.123.161
```

if you can recive message like "64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=xxx ms", you are connected.

1.1.2 Dependencies

If you're using the PC on Go1, you can skip this section.

- Boost (version 1.5.4 or higher)
- CMake (version 2.8.3 or higher)
- LCM (version 1.4.0 or higher)

```
# Download LCM package, then:
cd lcm-x.x.x
mkdir build
cd build
cmake ../
make
sudo make install
```

1.1.3 Build

Open the terminal in the unitree_legged_sdk folder and execute following command.

```
mkdir build
cd build
cmake ../
make
```

1.1.4 Run

Open the terminal to run the binary file in the "build/bin" folder.

- high-level example can be run directly, for example:

```
# Run examples with 'sudo' for memory locking.
# WARNING: Make sure the robot is in Sport mode.
sudo ./example_walk
```

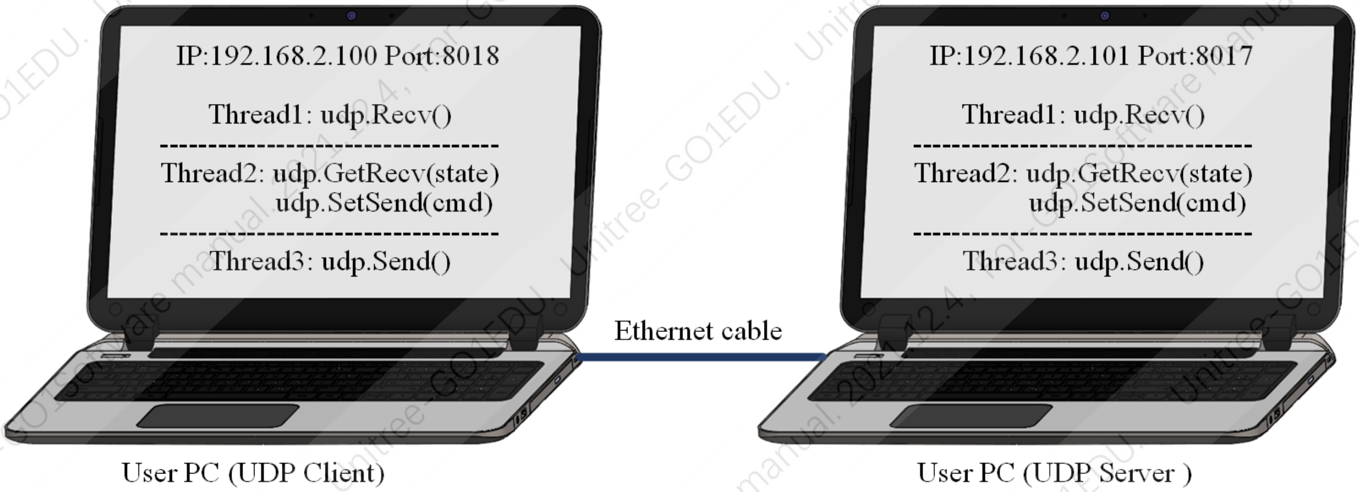
- Before running the low-level examples, please switch Go1's control mode to Basic mode using wireless handle.

```
# WARNING: Make sure the robot is hung up and in Basic mode.
sudo ./example_postion
```

1.2 Other Usage

1.2.1 Communication between PCs with UDP

Connect two computers with a network cable (or USB to Ethernet hub), and set the PC's Ethernet IP address as below.



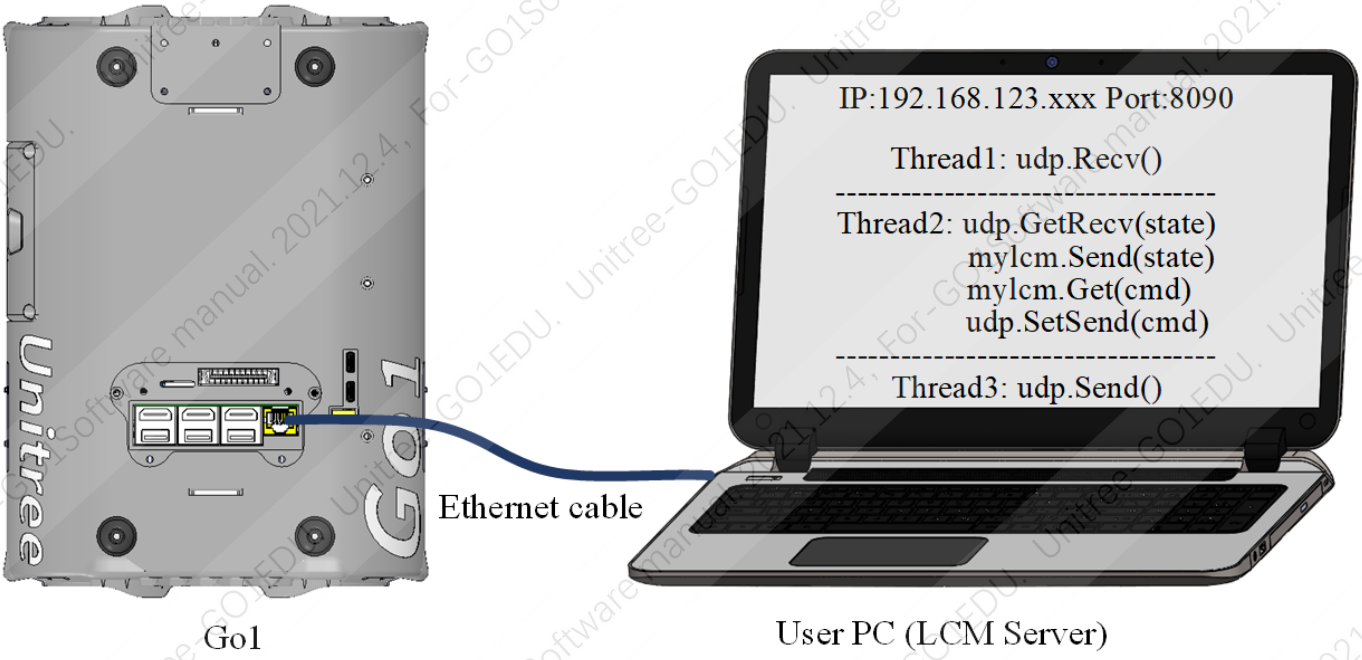
Then open the terminal on different PC to run the binary file in the "build/bin" folder.

```
# UDP Client
sudo ./udp_send_test
```

```
# UDP Server
sudo ./udp_recv_test
```

1.2.2 Communication between PCs with LCM and UDP

Connect two computers with a network cable (or USB to Ethernet hub), and set the PC's Ethernet IP address as below.



Then open the terminal and run the binary file in the "build/bin" folder.

```
# Warnning: Make sure robot in Sport mode
sudo ./lcm_server HIGHLEVEL
```

```
# Warnning: Make sure robot in Basic mode
sudo ./lcm_server LOWLEVEL
```

1.3 File System

The files in "*include/unitree_legged_sdk/*" defines constant, variable, class, API functions, etc.

include/unitree_legged_sdk/	description

include/unitree_legged_sdk/	description
a1_const.h aliengo_const.h go1_const.h	Defines the limits of the robot's 12 joint motors
quadruped.h	Defines robot type, control level type, leg nunber and joint number
unitree_joystick.h	Defines key and joystick variable data type
comm.h	defines common class, such as LowState, LowCmd, HighState and HighCmd class, to store user command or robot sates data
safety.h	Defines Safety class, keep the robot in a safe environment
udp.h	Defines UDP class, user can communication between PC and Controller board through UDP object, it also can be used in other PCs
lcm.h	Defines LCM class, user can send command and receive robot states data on one PC through LCM object
lcm_server.h	Defines Lcm_Server_Low class and Lcm_Server_High class, except communication through UDP object, user can also communication through LCM object
loop.h	Defines LoopFunc class, users can generate different threads for different objects through LoopFunc object
unitree_legged_sdk.h	Included all of the above header files

A "*build/bin/*" folder will be added to the file system after "*1.1.3 Build*" section, which contains executables files generated by examples in the "*example/*" folder.

examples/	description	notics
example_position.cpp	Example of low-level position control of robot, the calf of right front leg will flapping	Basic mode
example_torque.cpp	Example of low-level torque control of robot, the thigh joint of right front leg will move to zero position and be in impedance control state	Basic mode
example_velocity.cpp	Example of low-level velocity control of robot, the calf of right front leg will flapping	Basic mode
example_walk.cpp	Example of high-level control of robot, the robot will do a series of movements	Sport mode
example_wirelessHandle.cpp	Example of wireless handle communication, joystick data will be printed on the screen When key A is pressed	Basic mode
lcm_server.cpp	Example of LCM communication server, contains low-level and high-level communication	
multi_pc_udp_recv.cpp	Example of UDP communication server, running client(multi_pc_udp_send.cpp) on the another PC	

examples/	description	notics
multi_pc_udp_send.cpp	Example of UDP communication client, running server(multi_pc_udp_send.cpp) on another PC.	

2. Header file

More detailed about some of the "*unitree_legged_sdk*" header files.

2.1 comm.h

This file is a part of Unitree robots software development kits(unitree_legged_sdk), defines common class, such as LowState, LowCmd, HighState and HighCmd class, to store user command or robot sates data.

Refer to this link for more information.

2.2 udp.h

This file is a part of Unitree robots software development kits(unitree_legged_sdk), defines UDP class, user can communication between PC and Controller board through UDP object, it also can be used in other PCs. refer to **Section 3.3.1** for detailed usage

Refer to this link for more information.

2.3 lcm.h

Defines LCM class, user can send command and receive robot states data on one PC through LCM object，refer to **Section 3.3.2** for detailed usage

Refer to this link for more information.

3. Examples

3.1 Low-level control examples of robot

example_position.cpp、example_velocity.cpp and example_torque.cpp examples is running on Basic mode of robot.

Refer to example_position、example_velocity、example_torque for more information.

3.2 High-level control examples of robot

example_walk.cpp is running on Sport mode of robot.

Refer to this link for more information.

3.3 Communication examples of robot

- multi_pc_udp_send.cpp、 multi_pc_udp_recv.cpp is running on different PC.

  Refer to multi_pc_udp_send、multi_pc_udp_recv for more information.

- lcm_server.cpp

  Refer to this link for more information.