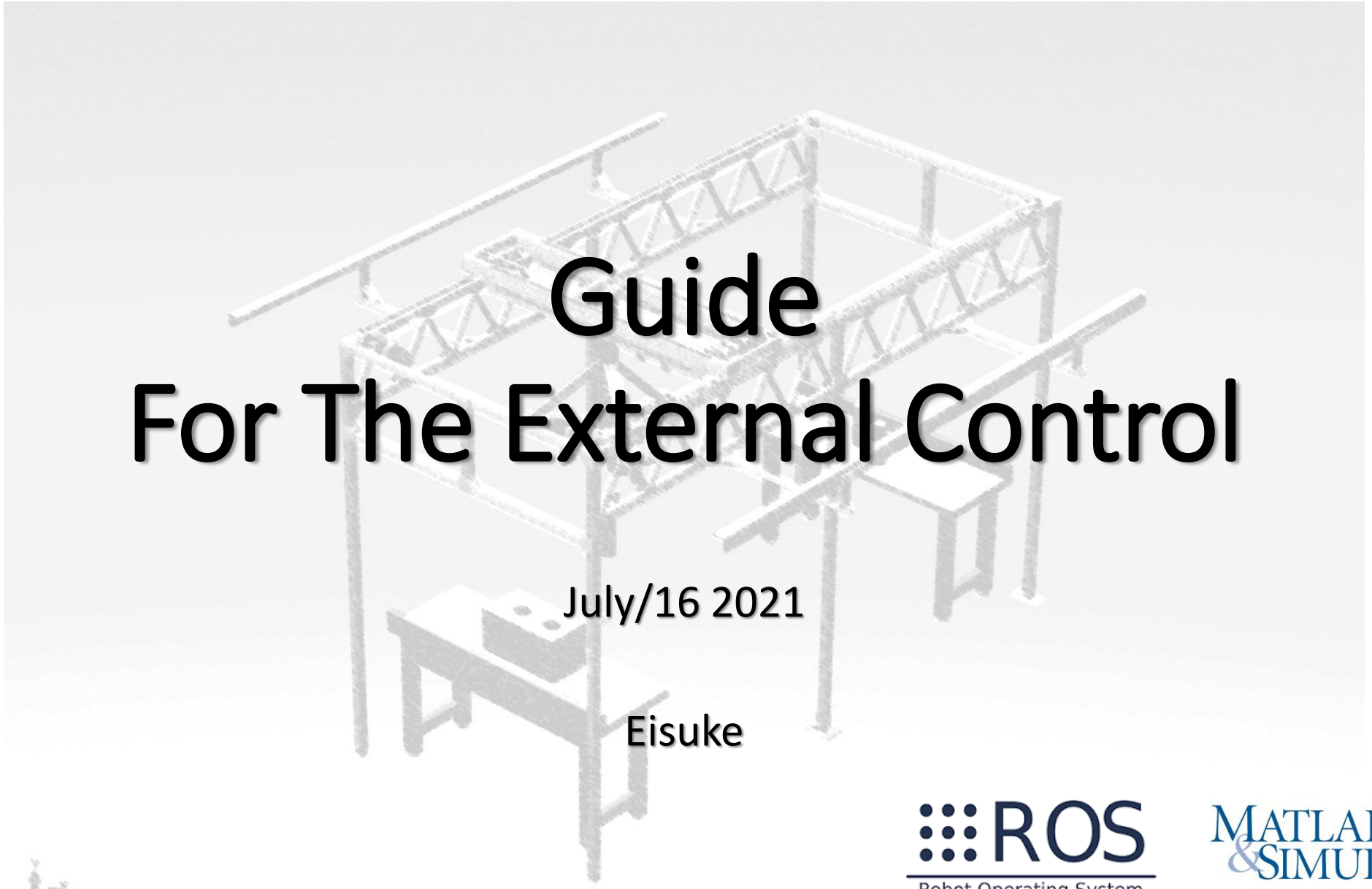


Guide
For The External Control

July/16 2021

Eisuke

ROS
Robot Operating System

MATLAB & SIMULINK

- How to connect with the ROS
- How to connect with the Simulink
- Table of CAN messages
- CAN Hardware topology
- CAN Software topology
- Supplemental Materials

How to connect with the ROS

How to connect with the ROS 1/4

Preparing the environment **(Following procedures are not required after the 2nd time)**

1. Prepare a ROS environment of the “melodic” on your laptop etc.

2. Install ROS packages as follows
   - ros_control: https://github.com/ros-controls/ros_control
   - ros_canopen: https://github.com/ros-industrial/ros_canopen

3. Turn on the crane power (breaker) switch.

How to connect with the ROS 2/4

Launching the ROS node on the Pi (Crane external controller)

1. Connect the crane external controller from your laptop etc. via SSH or VNC
   - IP address: 192.168.137.2
   - Username: pi
   - Password: raspberry

2. Activate the Socketcan driver with a following command
   - sudo ip link set can0 up type can bitrate 500000

3. Run the ROS nodes with following commands
   - rosrun socketcan_bridge topic_to_socketcan_node can0
   - rosrun socketcan_bridge socketcan_to_topic_node can0

   Note: Unfortunately, “socketcan_bridge_node” doesn’t work.

How connect with the ROS 3/4

Testing your environment **(Following procedures are not required after the 2nd time)**

1. Copy "**can_communication_test**" folder to your laptop's catkin_ws/src folder

2. Build the package with a following command
   - catkin build can_communication_test

3. Run the package on your laptop with a following command
   - rosrun can_communication_test can_receive_test.py

4. Press the east and west buttons on the crane pendant and make sure the "**X-axis speed 4.00.. rps**" or "**-4.00.. rps**" is displayed on the screen. Similarly, for north and south, "**2.00.. rps**" or "**-2rps**".

Note: If you see wrong speeds, there is a problem with endian processing.

Shutdown

Restart the Raspberry Pi with "sudo reboot" command.

How connect with the ROS 4/4

Using your ROS node

1. Perform the procedure “How to use (ROS) 2/4”

2. Press and release the function 1 button on the crane pendant (Enable external mode). You will see the indicator light change to orange.

3. Hold 1 second and release the start button on the crane pendant. The counts of encoders will reset. You will see the all indicator lights lamp up for 2 seconds.

4. Run your ROS node package.

Note: As a safety measure, if there is no communication to CAN for 0.5 seconds, the crane will stop. This means you need to control at a cycle of at least 2Hz.

Shutdown

Restart the Raspberry Pi with “sudo reboot” command.

How to connect with the Simulink

How to connect with the Simulink 1/2

Preparing the environment **(Following procedures are not required after the 2nd time)**

1. Install the add-on "**MATLAB/Simulink Support Package for Raspberry Pi Hardware**" on MATLAB and install it. You can skip "Hardware setup".

2. Check connection between your MATLAB and the Raspberry Pi (Crane external controller) with a following command. If you can't see errors, the connection is fine. If not modifiy the configuration parameters. IP address etc.
   - raspi

3. Copy the sample model files to your workspace.

4. Turn on the crane power (breaker) switch.

5. Press and release the function 1 button on the crane pendant (Enable external mode). You will see the indicator light change to orange.

6. Hold 1 second and release the start button on the crane pendant. The counts of encoders will reset. You will see the all indicator lights lamp up for 2 seconds.

How to connect with the Simulink 2/2

Running the Simulink model

1. Open the Simulink model file "**Control_Crane_Sample_07162021.slx**".

2. Open the block "**MCP2515 Configuration**", and set the parameters as follows.
   - Bus speed: 500 kbps
   - Oscillator Clock: 16 MHz
   - Channel: spidev0.0
   - Bus clock: 8~20MHz

3. Open the block "**MCP2515 Send/Receive**" and set the "**SPI channel**" to "**spidev0.0**". Also, the other parameters ex. CAN ID, Data length , etc. can be changed, If you want.

4. Click "**Monitor & Tune**" on the "**Hardware**" Tab. In default, you can see the motor signals on the scope, and real crane motion.

Note: You can't use the ROS node and the Simulink model at the same time.

Table of CAN messages 1/2

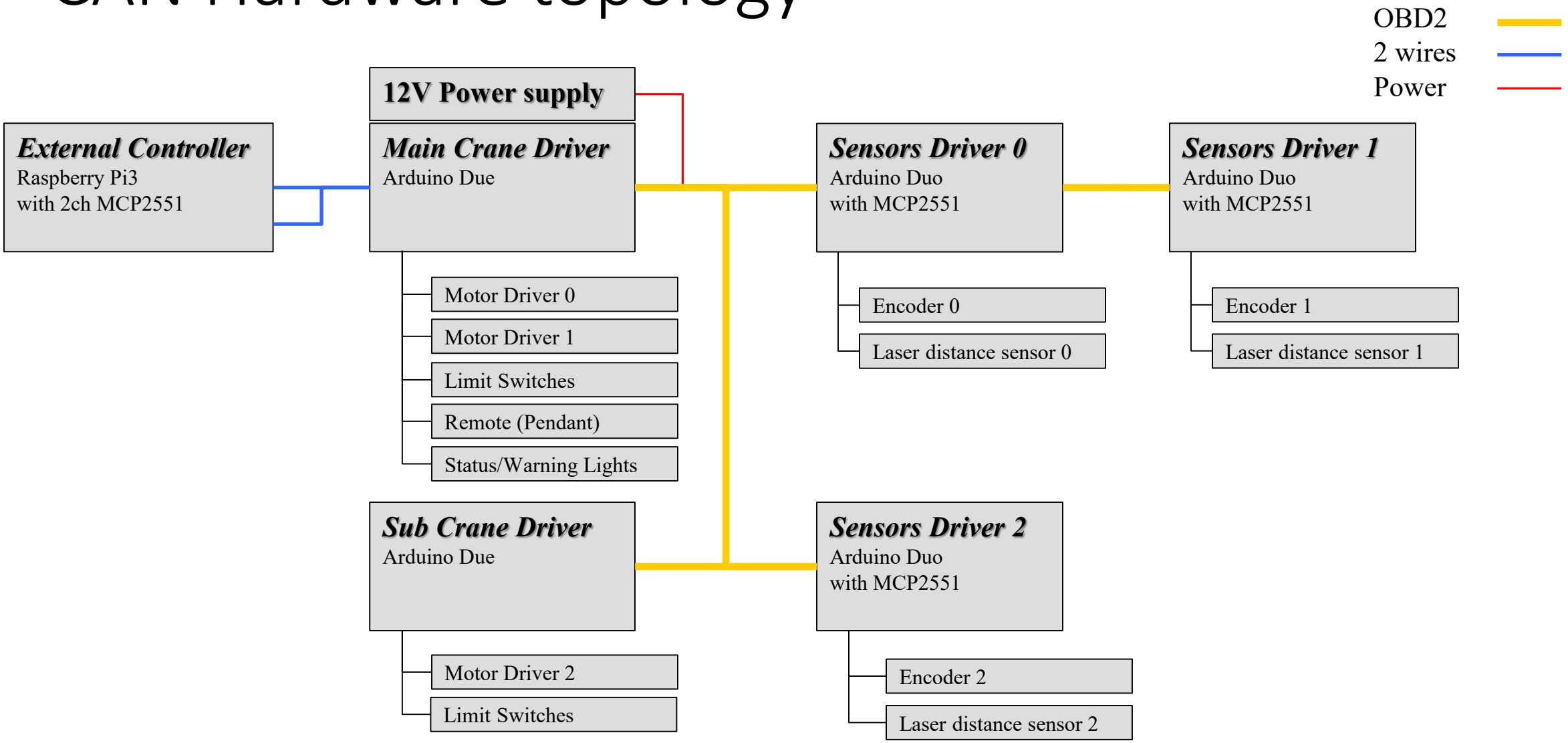
CAN ID	Signal Name	Units	Direction	Data Length	Data Type	Remark
0x01	Control X-axis speed	rad/sec	Write	8	double	
0x02	Control Y-axis speed	rad/sec	Write	8	double	
0x10	Main crane driver & Pendant status	-	Read	3	bool	See next page
0x11	X-axis actual control speed(Motor 0)	rad/sec	Read	8	double	
0x12	X-axis actual control speed(Motor 1)	rad/sec	Read	8	double	
0x13	Y-axis actual control speed(Motor 2)	rad/sec	Read	8	double	
0x20	Sub crane driver status	-	Read	1	bool	See next page
0x21	Y-axis actual control speed	rad/sec	Read	8	double	Do not send data to this ID
0x100	Reset Encoder 0 counts	-	Write	1	bool	
0x101	Laser distance sensor 0	mm	Read	4	int32	
0x102	Encoder 0 PPR counts	counts	Read	4	int32	PPR means 'Pulses Per Revolution'
0x103	Encoder 0 Incremental counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x104	Encoder 0 Absolute counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x105	Encoder 0 speed counts	counts/sec	Read	4	int32	
0x200	Reset Encoder 1 counts	-	Write	1	bool	
0x201	Laser distance sensor 1	mm	Read	4	int32	
0x202	Encoder 1 PPR counts	counts	Read	4	int32	PPR means 'Pulses Per Revolution'
0x203	Encoder 1 Incremental counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x204	Encoder 1 Absolute counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x205	Encoder 1 speed counts	counts/sec	Read	4	int32	
0x300	Reset Encoder 2 counts	-	Write	1	bool	
0x301	Laser distance sensor 2	mm	Read	4	int32	
0x302	Encoder 2 PPR counts	counts	Read	4	int32	PPR means 'Pulses Per Revolution'
0x303	Encoder 2 Incremental counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x304	Encoder 2 Absolute counts	counts	Read	4	int32	300mm / 2048counts / 1rev
0x305	Encoder 2 speed counts	counts/sec	Read	4	int32	

Note: CAN ID is a hexadecimal number. Not decimal. Be careful.

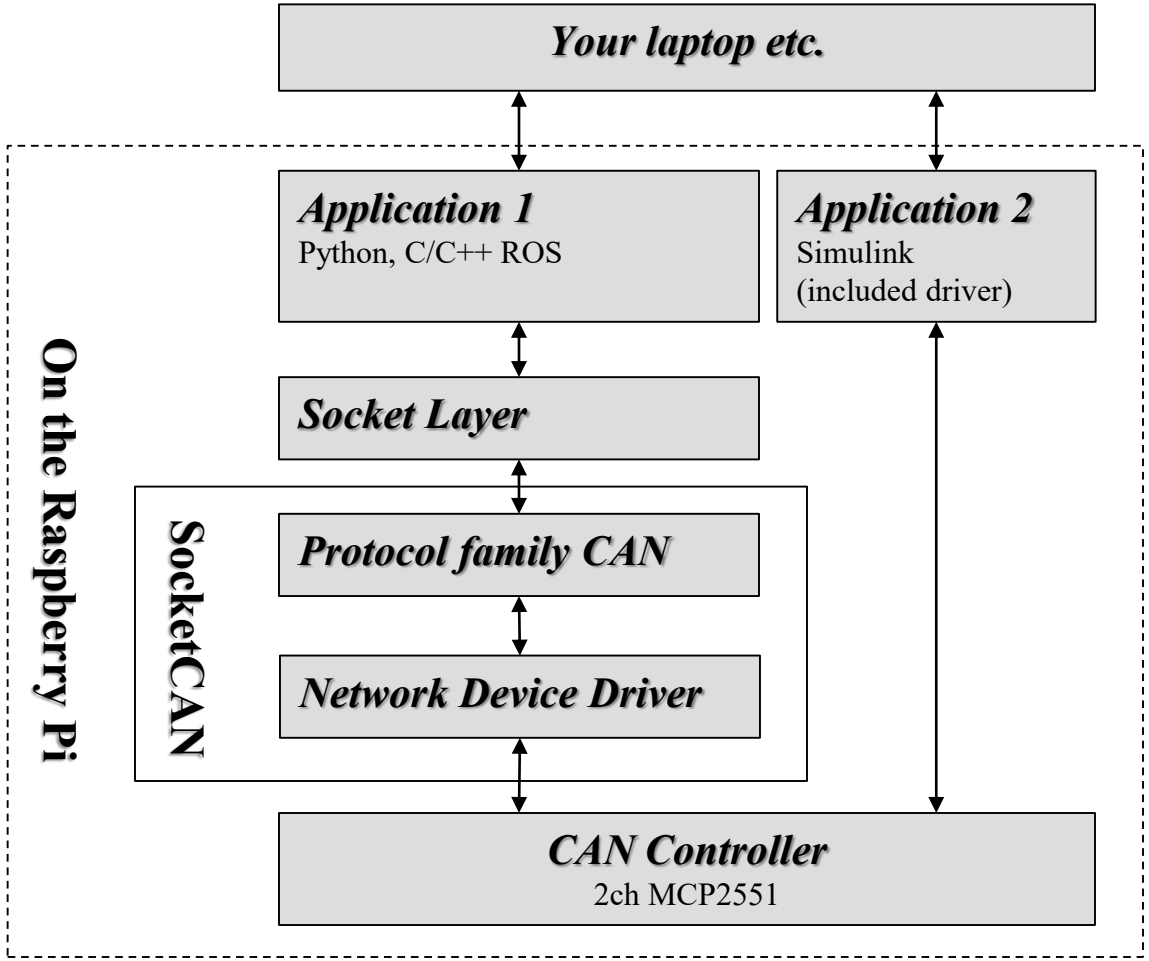
Table of CAN messages 2/2

CAN ID	Bytes	Bits	Signal Name	True / False means	Remarks
0x10	1	1	Main	Enabling / Disableing	
		2	East	Pushing / Releasing	+ X-axis
		3	West	Pushing / Releasing	- X-axis
		4	R0	Pushing / Releasing	
		5	R1	Pushing / Releasing	Enable/Disable external input mode.
		6	R2	Pushing / Releasing	Enable/Disable double speed mode.
		7	Up	Pushing / Releasing	
		8	Down	Pushing / Releasing	
	2	1	North	Pushing / Releasing	+ Y-axis
		2	South	Pushing / Releasing	- Y-axis
		3	Double speed	Enabling / Disableing	
	3	1	Motor 0 Alarm	Warning / Normal	Cannot operate on warning.
		2	Motor 0 Pend	In position / moving	In position signal from the motor driver.
		3	Motor 1 Alarm	Warning / Normal	Cannot operate on warning.
		4	Motor 1 Pend	In position / moving	In position signal from the motor driver.
		5	Limit switch 0 right	Contacting / Releasing	
		6	Limit switch 0 left	Contacting / Releasing	Motor side
		7	Limit switch 1 right	Contacting / Releasing	
		8	Limit switch 1 left	Contacting / Releasing	Motor side
0x20	1	1	Motor 2 Alarm	Warning / Normal	Cannot operate on warning.
		2	Motor 2 Pend	In position / moving	In position signal from the motor driver.
		3	Limit switch 2 right	Contacting / Releasing	
		4	Limit switch 2 left	Contacting / Releasing	Motor side

CAN Hardware topology



CAN Software topology

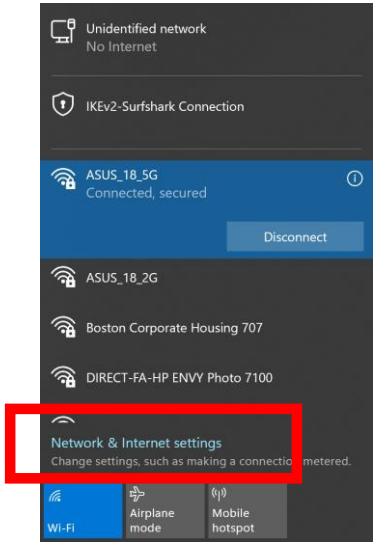


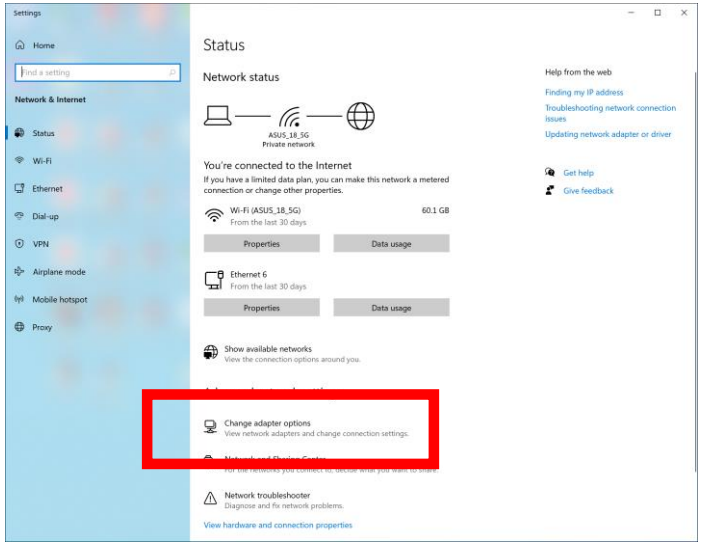
Supplemental Materials

Instruction of how to connect the VNC

VNC provides a GUI on your PC that operates a single board computer similar to a remote desktop.

It uses wired Ethernet for connection. It is recommended to use an adapter that converts Ethernet to USB3.1 as shown in the figure on the right. It will provide you with an easy to connect environment without breaking your network environment. The adapter can be found on my desk.

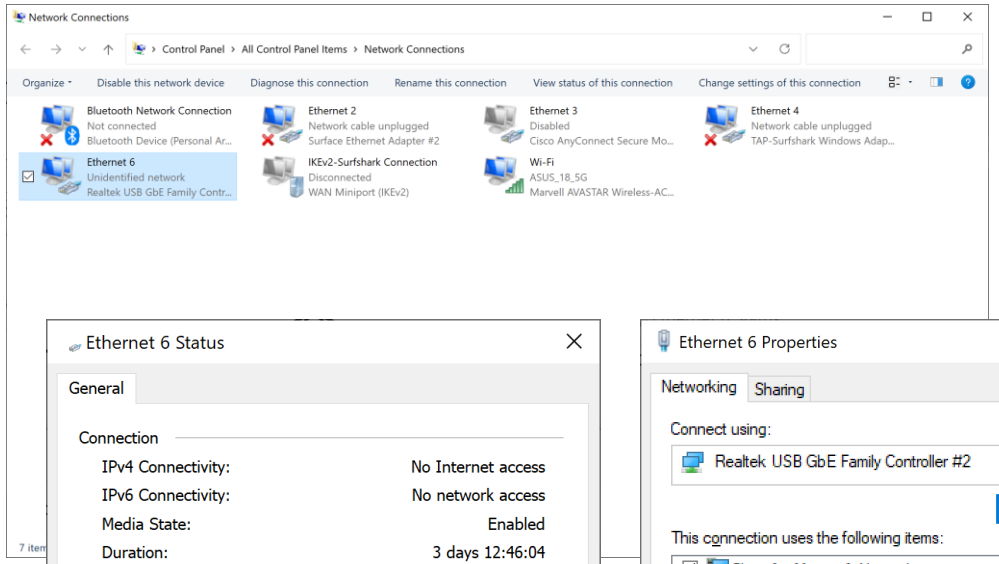




<u>Configure the ethernet adapter</u>

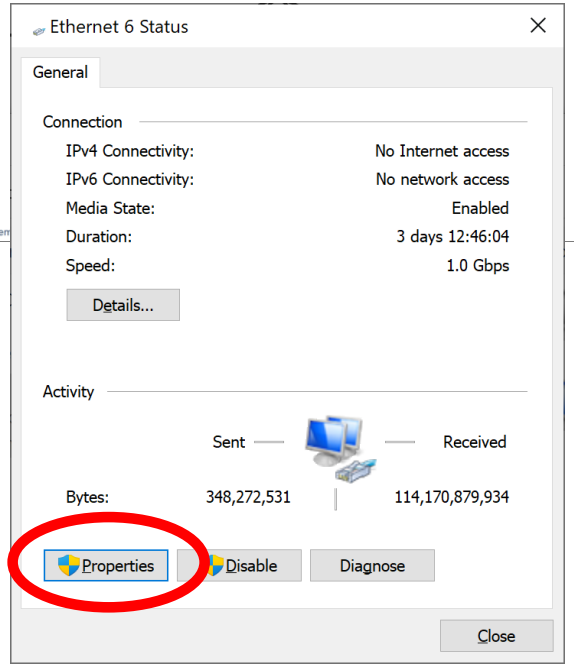
1. Connect the ethernet USB adaptor to your laptop.
2. Click the network icon on the taskbar and select “Network & Internet settings”.
3. Click “Change adapter options”.

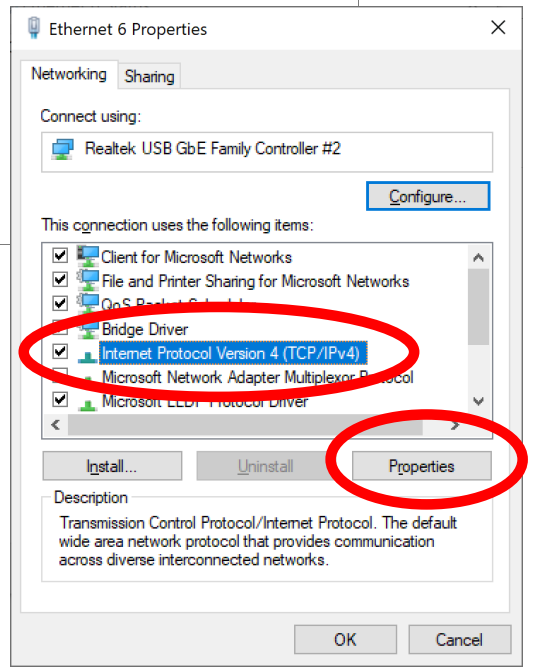
Instruction of how to connect the VNC

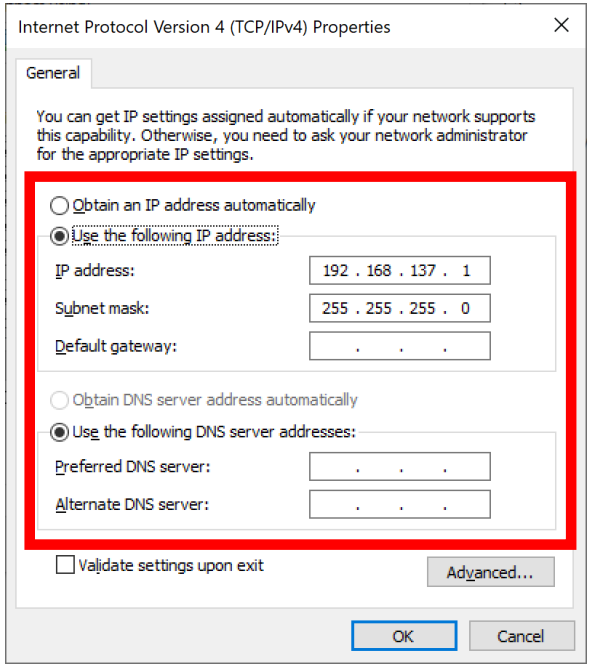


4. Double click the “Ethernet X” (The USB adaptor equip ”Realtek USB GbE…” chip. You can see.)

5. Click the “Properties”. Select “Internet Protocol…IPv4)” and click the “Properties”.







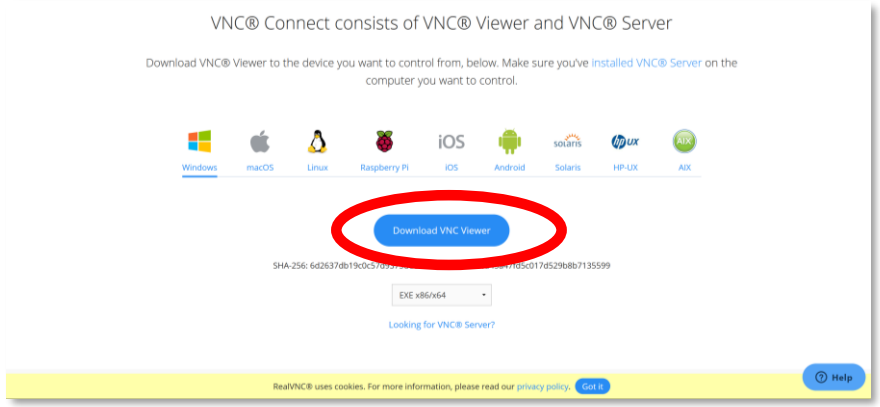
6. Select “Use the following IP address:”

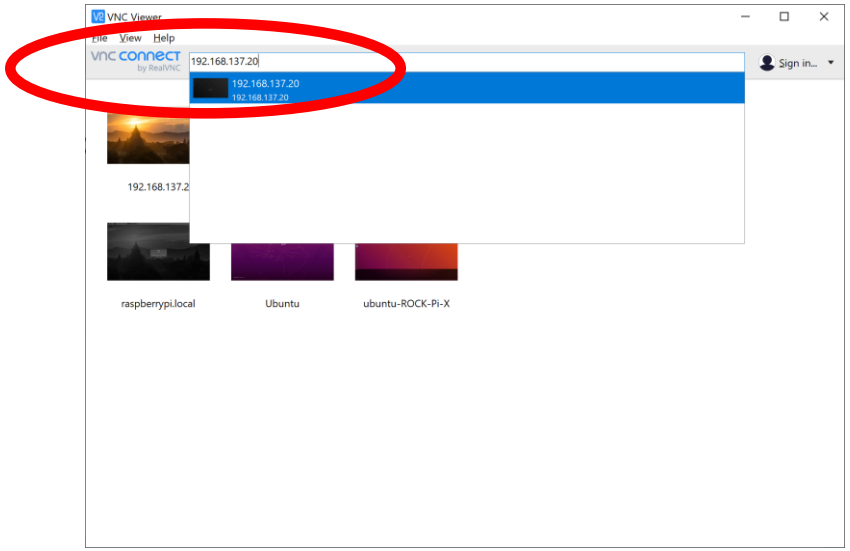
7. Fill “**192.168.137.1**” to the IP address.

8. Fill “**255.255.255.0**” to the Subnet mask. And click “OK”.

It’s done. The settings will be retained even if the USB adapter is removed.

Instruction of how to connect the VNC





1. Access the following URL.
   https://www.realvnc.com/en/connect/download/viewer/
   And download the VNC viewer.

2. Install and start the VNC viewer.

3. Fill "**192.168.137.2**" to upper.

4. You will see "Encryption", click the continue.

5. Fill the username and pass as follows: "**pi**","**raspberry**"

You can operate Ubuntu on the single board computer via VNC.

IP address and User/Password list

- Raspberry Pi for the crane control

  IP Address: 192.168.137.2
  Username: pi
  Password: raspberry

- Jetson Xavier NX

  IP Address: 192.168.137.12
  Username: jetson
  Password: nvidia

- Single board computer (ROCK Pi X)

  IP Address: 192.168.137.20
  Username: ubuntu
  Password: dlab