HUNTER2.0 USER MANUAL

HUNTER 2.0

AgileX Robotics Team

USER MANUAL   V.2.0.2   2023.08

Document version

No.	Version	Date	Edited by	Reviewer	Notes
1	V.2.0.0	2023/03/12	吴忠义		Document creation, image update
2	V.2.0.1	2023/04/19	吴忠义		Sync GitHub commands

3	V.2.0.2	2023/08/21	吴忠义		1. Delete DB9 (RS232) related content 2. Update the firmware upgrade tutorial 3. Pictures and instructions of the remote control 4. Increase the precautions when charging
4	V2.0.3	2023/09/07	何士玉		Optimize layout
5	V2.0.4	2023/09/08	吴忠义		1.Synchronization parameter list 2.Robot charging diagram 3.Updated product dimensions description diagram

This chapter contains important safety information, before the robot is powered on for he first time, any individual or organization must read and understand this information before using the device. If you have any questions about use, please contact us at support@agilex.ai . Please follow and implement all assembly instructions and guidelines in the chapters of this manual, which is very important. Particular attention should be paid to the text related to the warning signs.

Safety Information

The information in this manual does not include the design, installation and operation of a complete robot application, nor does it include all peripheral equipment that may affect the safety of the complete system. The design and use of the complete system need to comply with the safety requirements established in the standards and regulations of the country where the robot is installed. HUNTER 2.0 integrators and end customers have the responsibility to ensure compliance with the applicable laws and regulations of relevant countries, and to ensure that there are no major dangers in the complete robot application. This includes but is not limited to the following:

Effectiveness and responsibility

- Make a risk assessment of the complete robot system.

- Connect the additional safety equipment of other machinery defined by the risk assessment together.

- Confirm that the design and installation of the entire robot system's peripheral equipment, including software and hardware systems, are correct.

- This robot does not have a complete autonomous mobile robot, including but not limited to automatic anti-collision, anti-falling, biological approach warning and other related safety functions. Related functions require integrators and end customers to follow relevant regulations and feasible laws and regulations for safety assessment , To ensure that the developed robot does not have any major hazards and safety hazards in actual applications.

- Collect all the documents in the technical file: including risk assessment and this manual.

Environmental Considerations

- For the first-time use,please read this manual carefully to understand the basic operating content and operating specifica-tion.

- No passengers.

- For remote control operation, select a relatively open area to use HUNTER 2.0, because HUNTER 2.0 is not equipped with any automatic obstacle avoidance sensor. Please keep a safe distance of more than 2 meters when operating HUNTER 2.0.

- Use HUNTER 2.0 always between -10°C~45°C ambient temperature.

- If HUNTER 2.0 is not configured with separate custom IP protection, its water and dust protection will be IP22 ONLY.

Pre-work Checklist

- Make sure each device has sufficient power.

- Make sure HUNTER 2.0 does not have any obvious defects.

- Check if the remote controller battery has sufficient power.

- When using, make sure the emergency stop switch has been released.

Operation

- In remote control operation, make sure the area around is relatively spacious.

- Make sure to operate the Hunter 2.0 within the visual range. The maximum load of HUNTER 2.0 is 150KG. When in use, ensure that the payload does not exceed 150KG.

- When installing an external extension on HUNTER 2.0, confirm the position of the center of mass of the extension and make sure it is at the center of rotation.

- Please charge in time when the device is low battery alarm. When HUNTER 2.0 has a defect, please immediately stop using it to avoid secondary damage.

- When HUNTER 2.0 has had a defect, please contact the relevant technical to deal with it, do not handle the defect by yourself.

- Always use HUNTER 2.0 in the environment with the protection level requires for the equipment.

- It is forbidden to push the chassis in the parking status, and the parking can be manually released in an emergency status.

- When charging, make sure the temperature is above 0°C.

Maintenance

- Regularly check the pressure of the tire, and keep the tire pressure is maintained at 0.8bar.

- If the tire is severely worn or burst, please replace it in time.

- If the battery plan not to use for a long time, it need to be charged periodically in every 2 to 3 months.

Attention

This section includes some precautions that should be paid attention to for HUNTER 2.0 use and development.

Battery

- The battery supplied with HUNTER 2.0 is not fully charged in the factory setting, but its specific power capacity can be displayed on the voltmeter at real end of HUNTER 2.0 chassis or read via CAN bus communication interface. The battery recharging can be stopped when the green

LED on the charger turns green. Note that if you keep the charger connected after the green LED gets on, the charger will continue to charge the battery with about 0.1A current for about 30 minutes more to get the battery fully charged;

- Please do not charge the battery after its power has been depleted, and please charge the battery in time when low battery level alarm is on;

- Static storage conditions: The best temperature for battery storage is -10°C to 45°C; in case of storage for no use, the battery must be recharged and discharged once about every 2 months, and then stored in full voltage state. Please do not put the battery in fire or heat up the battery, and please do not store the battery in high-temperature environment;

- Charging: The battery must be charged with a dedicated lithium battery charger; lithium-ion batteries cannot be charged below 0°C (32°F) and modifying or replacing the original batteries are strictly prohibited.

- HUNTER 2.0 only supports the replacement and use of the battery provided by us, and the battery can be charged separately.

Notes while charging

- When charging, do not cover the charger with anything, and do not block the air inlet and outlet.

- The charger should be placed in a place out of reach of children.

- When charging, the charger and battery should be used in an indoor environment with good ventilation and heat dissipation. It is strictly prohibited to use it in an environment with humidity, high temperature, or flammable and explosive gases.

- Please do not carry the charger with you while driving to avoid vibration damage.

- There is high voltage inside the casing. Non-professionals are not allowed to disassemble it.

- Please read the instructions carefully before use. The manufacturer is not responsible for any damage caused by failure to operate in the correct manner.

Operational environment

- The operating temperature of HUNTER 2.0 is -10°C to 45°C; Please do not use it below -10°C and above 45°C ;

- The requirements for relative humidity in the use environment of HUNTER 2.0 are: maximum 80%, minimum 30%;

- Please do not use it in the environment with corrosive and flammable gases or closed to combustible substances;

- Do not place it near heaters or heating elements such as large coiled resistors, etc.;

- Except for specially customized version (IP protection class customized), HUNTER 2.0 is not water-proof, thus please do not use it in rainy, snowy or water-accumulated environment;

- The elevation of recommended use environment should not exceed 1,000m;

- The temperature difference between day and night of recommended use environment should not exceed 25°C;

Electrical/extension cords

- For the extended power supply on top, the current should not exceed 10A and the total power should not exceed 240W;

- For the extended power supply of top and tail, each ports must not be greater than 24V10A, the total output current must not be greater than 15A, total power should not exceed 360W.

- When the system detects that the battery voltage is lower than the safe voltage class, external power supply extensions will be actively switched to. Therefore, users are suggested to notice if external extensions involve the storage of important data and have no power-off protection.

Other notes

- When handling and setting up, please do not fall off or place the chassis upside down;

- For non-professionals, please do not disassemble the chassis without permission.

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1 HUNTER 2.0 Introduction

HUNTER 2.0 is designed as a programmable UGV(UNMANNED GROUND CHASSIS) upon Ackermann model, of which the chassis is based on Ackermann steering. Therefore, it has similar characteristics to cars but has more significant advantages on Portland cement and asphalt roads over them. Compared to the four-wheel differential chassis, HUNTER 2.0 chassis has a higher load carrying capacity and can reach higher movement speed with less wear of structure and tires for long-term operation. Although HUNTER 2.0 is not designed as suitable for all kinds of terrains, it is equipped with a rocker arm suspension which can pass common obstacles such as speed bumps, etc. Additional components such as stereo camera, laser radar, GPS, IMU and robotic manipulator can be optionally installed on HUNTER 2.0 for advanced navigation and computer vision applications. HUNTER 2.0 is frequently used for autonomous driving education and research, indoor and outdoor security patrolling, environment sensing, general logistics and transportation.

1.1 Component list

Name	Quantity
HUNTER 2.0 Robot body	x1
Battery charger(AC 220V)	x1
Aviation plug(male, 4-pin)	x1
Remote control transmitter(optional)	x1
USB to CAN communication module	x1

1.2 Tech specifications

Parameter Types	Items	Values
Mechanical specifications	L × W × H (mm)	980 × 745 × 370
	Wheelbase (mm)	650
	Front/rear wheel base (mm)	605
	Weight of chassis body (kg)	65/70
	Battery Type	Lithium battery
	Battery parameters	24V 30Ah/60Ah
	Power drive motor	DC brushless 2 ×400W
	Steering drive motor	DC brushless 400W
	Parking mode	Power off electromagnetic band type brake
	Steering	Front wheel Ackermann
	Maximum steering angle	33°
	Suspension form	Front wheel non-independent suspension
	Steering motor reduction ratio	-
	Steering motor encoder	-
	Drive motor reduction ratio	1：40
	Drive motor sensor	Magnetic braiding 2500
Performance parameters	IP Grade	IP22

	Maximum speed (km/h)	1.5
	Minimum turning radius (mm)	33°
	Maximum gradeability (°)	10°
	Ground clearance (mm)	100mm
	Maximum battery life (h)	8
	Maximum distance (km)	20KM (24V30Ah battery） 40KM (24V60Ah battery）
	Charging time (h)	3h (24V30Ah battery） 6h (24V60Ah battery）
	Working temperature (°C)	-10~40
Control	Control mode	Remote control Control Command control mode
	RC transmitter	2.4G/extreme distance 200M
	System interface	CAN

1.3 Requirement for development

FS RC transmitter is provided (optional) in the factory setting pf HUNTER 2.0, which allows users to control the chassis of robot to move and turn; CAN interfaces on HUNTER 2.0 can be used for user's customization.

2 The Basics

The section provides a brief introduction to the HUNTER 2.0 mobile robot platform, as shown in Figure 2.1 and 2.2
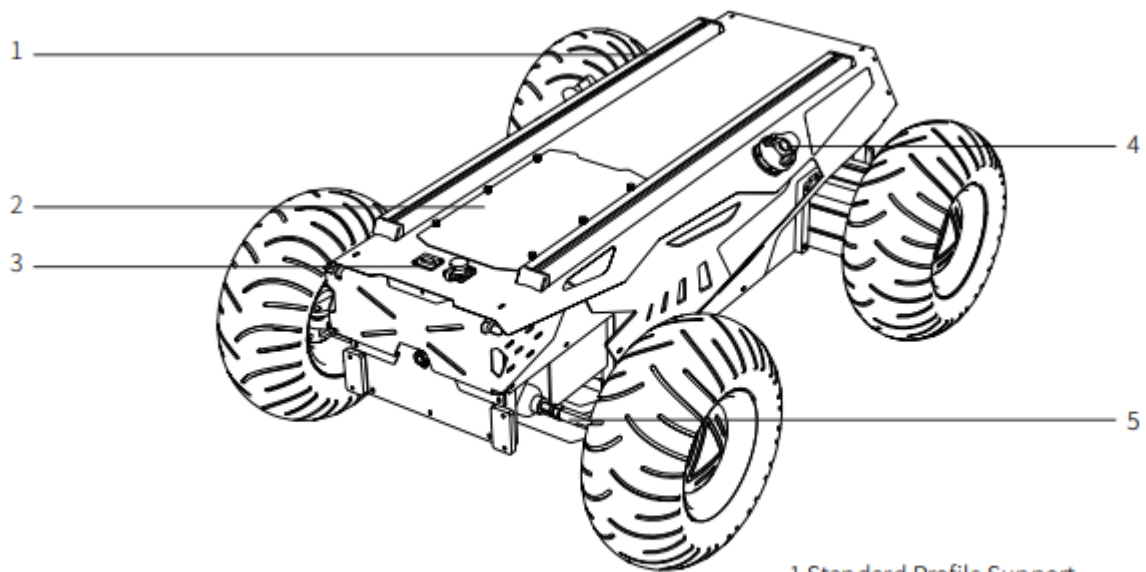
Figure 2.1 Front View

1.Standard Profile Support
2.Top Cabin Panel
3.Top Extend Interface
4.Emergency Stop Switch
5.Ackermann Front Wheel Steering

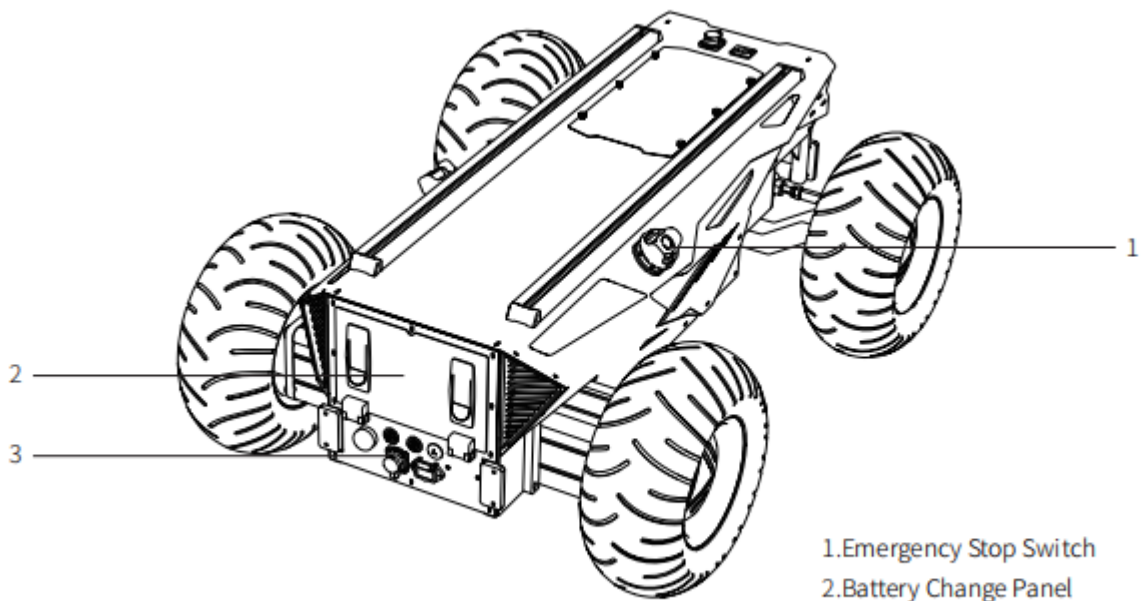1.Emergency Stop Switch
2.Battery Change Panel
3.Rear Panel

Figure 2.2 Rear View

Designed as a complete intelligent module, HUNTER 2.0 combines inflatable rubber wheels with independent suspension as its power module, which, along with powerful DC brushless servo motor, enables the chassis of HUNTER 2.0 robot to flexibly move on different ground surfaces with high passing ability and ground adaptability. An emergency stop switch is mounted at the rear end of chassis body, which can shut down power of the robot immediately when the robot behaves abnormally. Water-proof connectors for DC power and communication interfaces are provided both on top and at the rear of the robot, which not only allow flexible connection between the robot and external components but also ensures necessary protection to the internal of the robot even under severe operating conditions.

2.1 Status indication

Users can identify the status of chassis body through the voltmeter, the beeper and lights mounted on HUNTER 2.0. For details, please refer to Table 2.1.

Status	Description
Voltage	The current battery voltage can be read from the voltmeter on the rear electrical panel.
Replace battery	When the battery voltage is lower than 24.5V (if the BMS is connected, the SOC is judged to be lower than 15%) , the chassis body will give a beep-beep-beep sound as a warning. When the battery voltage is detected as lower than 24V(if the BMS is connected, the SOC is judged to be lower than 10%), HUNTER 2.0 will actively cut off the power supply to external extensions and drive to prevent the battery from being damaged. In this case, the chassis will not enable movement control and accept external command control.
Robot powered on	Rear lights are switched on.

2.2 Instructions on electrical interfaces

2.2.1 Top electrical interface

HUNTER 2.0 provides two 4-pin aviation connectors and one DB9 (RS232) connector. (The current version can be used for upgrade of firmware but do not support for command).The position of the top aviation connector and DB9 interface is shown in Figure 2.3.
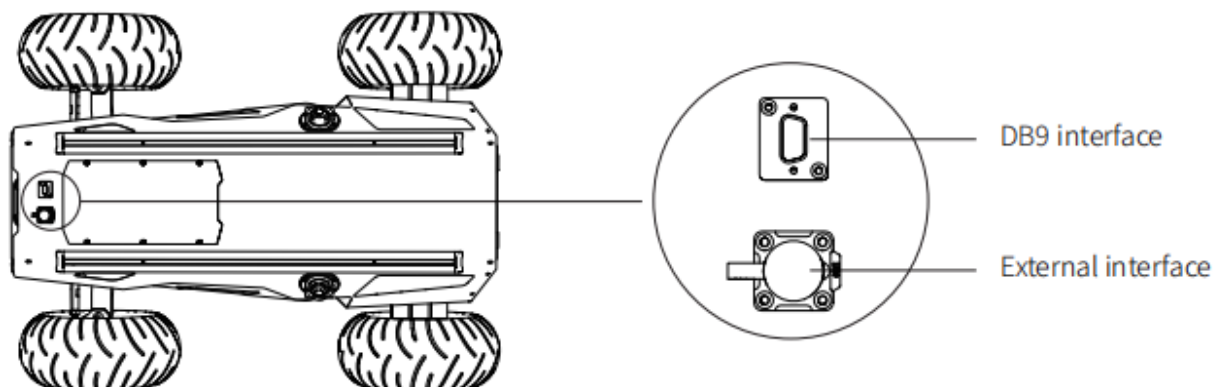

Figure 2.3 Schematic Diagram of HUNTER 2.0 Electrical Interface on Top

HUNTER 2.0 has each aviation extension interface respectively on top and at rear end which is configured with a set of power supply and a set of CAN communication interface. These interfaces can be used to supply power to extended devices and establish communication. The specific definitions of pins are shown in Figure 2.4.

It should be noted that, the extended power supply here is internally controlled, which means the power supply will be actively cut off once the battery voltage drops below the pre-specified threshold voltage. Therefore, users need to notice that HUNTER 2.0 platform will send a low voltage alarm before the threshold voltage is reached and also pay attention to battery recharging during use.
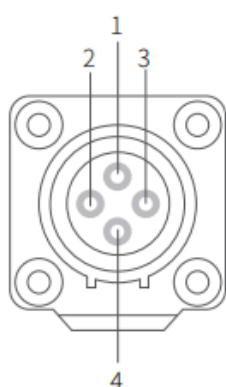
Pin No.	Pin Type	Function and Definition	Remarks
1	Power	VCC	Power positive, voltage range 21-26.8V, singly maximum current 10 A, total current is less than 15A
2	Power	GND	Power negative
3	CAN	CAN_H	CAN bus high
4	CAN	CAN_L	CAN bus low

Figure 2.4 Description of Top Aviation Interface Pins

2.2.2 Rear electrical interface

The extension interface at rear end is shown in Figure 2.6, where Q1 is the power display; Q2 is the switch of manual parking release; Q3 is the power switch; Q4 is the buzzer; Q5 is CAN and 24V power extension interface; Q6 is charging interface.
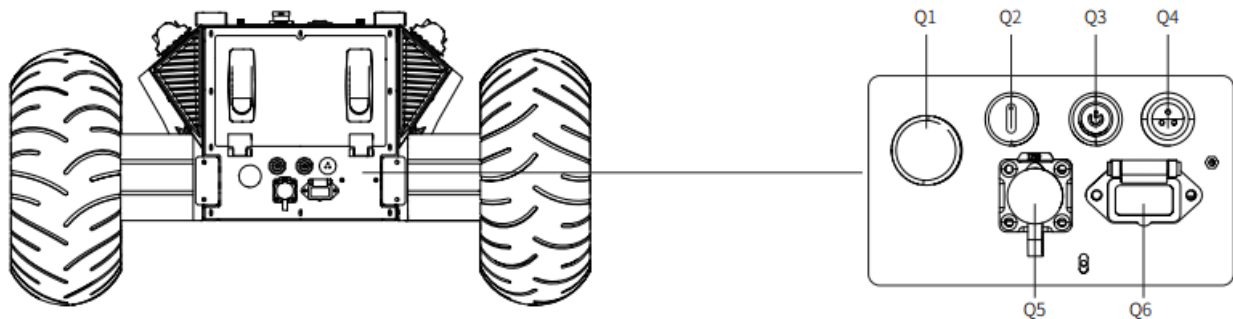

Figure 2.6 Rear View

Specific definitions for pins of Q5 are shown in Figure 2.7. The rear panel provides the same CAN communication interface and 24V power interface with the top one (two of them are internally inter-connected). The pin definitions are given in Figure 2.7.
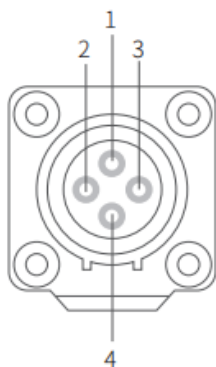
Pin No.	Pin Type	Function and Definition	Remarks
1	Power	VCC	Power positive, voltage range 21-26.8V, single maximum current 10 A, total current is less than 15A
2	Power	GND	Power negative
3	CAN	CAN_H	CAN bus high
4	CAN	CAN_L	CAN bus low

Figure 2.7 Description of Rear Aviation Interface Pins

2.3 Remote control instructions

FS RC transmitter is provided (optional) for HUNTER 2.0. In this product, we use the left-hand-throttle design. Refer to Figure 2.8 for its definition and function.

The functions of the buttons are defined as follows: SWC and SWD are temporarily not enabled, among which SWA is the parking switch lever. Move it to the top to release the parking mode, and move it to the bottom to activate the parking mode (remote control can be performed normally only after the parking mode is released).); SWB is the control mode selection lever. When it is moved to the top, it is the command control mode, and when it is moved to the middle, it is the remote control mode; S1 is the throttle button, which controls the HUNTER 2.0 to move forward and backward; S2 controls the steering of the front wheels, and POWER is the power button. , press and hold simultaneously to turn on. KEY1 is to clear the error message of the car, and KEY2 is to enter the setting interface of the remote control.

Note: The mapping of the remote control has been set before leaving the factory, please do not change it at will.

Figure 2.8 Schematic Diagram of Buttons on FS RC transmitter

Remote control interface description:

Hunter : model

Vol: battery voltage

Car: chassis status

Batt: Chassis power percentage

P: Park

Remoter: remote control battery level

Fault Code: Error information (Represents byte [5] in 211 frame)

2.4 Instructions on control demands and movements

A reference coordinate system can be defined and fixed on the chassis body as shown in Figure 2.9 in accordance with ISO 8855.

As shown in Figure 2.9, the chassis body of HUNTER 2.0 is in parallel with X axis of the established reference coordinate system. In the remote control mode, push the remote control stick S1 forward to move in the positive X direction, push S1 backward to move in the negative X direction. When S1 is pushed to the maximum value, the movement speed in the positive X direction is the maximum, When pushed S1 to the minimum, the movement speed in the negative direction of the X direction is the maximum; the remote control stick S2 controls the steering of the front wheels of the car body, push S2 to the left, and the chassis turns to the left, pushing it to the maximum, and the steering angle is the largest, S2 Push to the right, the car will turn to the right, and push it to the maximum, at this time the right steering angle is the largest. In the control command mode, the positive value of the linear velocity means movement in the positive direction of the X axis, and the negative value of the linear velocity means movement in the negative direction of the X axis; the steering angle is the steering angle of the inner wheel.
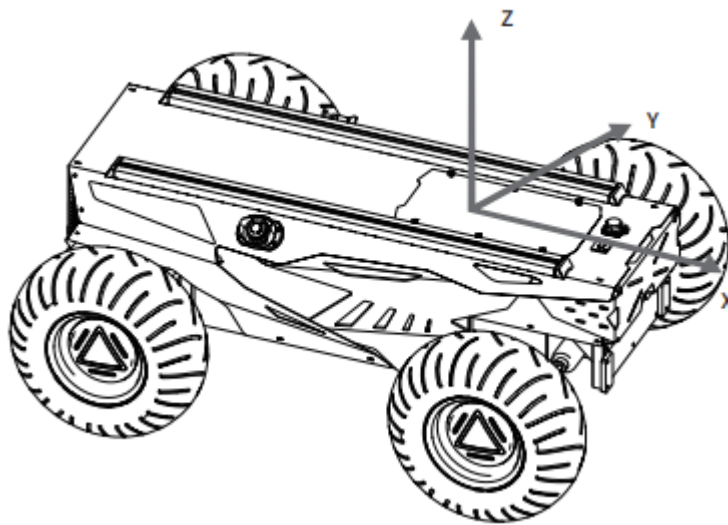
Figure 2.9 Schematic Diagram of Reference Coordinate System for Chassis Body

3 Getting Started

This section introduces the basic operation and development of the HUNTER 2.0 platform using the CAN bus interface.

3.1 Use and operation

The basic operating procedure of startup is shown as follows:

Check

- Check the condition of HUNTER 2.0. Check whether there are significant anomalies; if so, please contact the after-sale service personal for support;

- Check the state of emergency-stop switches. Make sure both emergency stop buttons are released;

- For first-time use, check whether Q3 (drive power supply switch) on the rear panel has been pressed down; if so, please release it, and then the drive will be powered off.

Startup

- Press Q3 button, and normally, the voltmeter will display correct battery voltage and front and

rear lights will be both switched on;

- Check the battery voltage, the normally voltage range is 24~26.8V, if there is continuous "beep-beep-beep..." sound from beeper,it means the battery voltage is low, please charge the battery.

Shutdown

- Press the button Q3 to cut off the power supply.

Emergency stop

- Press down emergency push button on the top of HUNTER 2.0 chassis body.

Basic operating procedure of remote control

- After the chassis of HUNTER 2.0 mobile robot is started correctly, turn on the RC transmitter and push the SWB to the remote control mode, then, HUNTER 2.0 platform movement can be controlled by the RC transmitter.

Parking

- The parking brake adopts a power off electromagnetic band type brake to realize the parking function, so when the chassis is running, the parking function must be turned off before moving;

- In the remote control mode, SWA is the parking function switch. You can control movement after turning the stick to the top to turn off the parking function. Turn the stick to the bottom to turn on the parking mode, if the chassis speed is not 0 at this time, it will automatically decelerate to 0 and turn on the parking function.

- In the command mode, the parking mode is the default when the power is turned on. At this time, there is no response to the speed command, and the parking release command needs to be sent before the speed command can be sent for control. If you need to park after the motion control is completed, just send a parking command.

- When the emergency stop is triggered, the parking will automatically start. At this time, released the emergency stop, no matter where the remote control SWA is located, it needs to be unlocked again for normal movement. If the power fails to be re-powered after a power failure (such as low battery voltage), you can use the Q2 knob switch to manually unlock the parking to

facilitate moving the chassis or trailer. It should be noted that the manual (tail knob switch Q2) unlocking the parking has the highest priority, which will invalidate the parking in the program, so it is limited to special circumstances. Please close it in time after use.

- Ramp parking, when HUNTER 2.0 is on the slope, if the speed is 0, HUNTER 2.0 will check the current automatically. When it reaches a certain value and continues for a period of time, HUNTER 2.0 will turn on the ramp parking function automatically. After receiving the motion command again, the ramp parking will relieve automatically and start to running.

3.2 Charging and battery replacement

HUNTER 2.0 products are equipped with a 10A charger by default, which can meet the charging needs of customers. During normal charging, there is no indicator light on the chassis to indicate the charging status of the vehicle. Please judge whether it is currently charging according to the charger status indicator light.

The detailed operating procedure of charging is shown as follows:

1. Make sure the electricity of HUNTER 2.0 chassis is powered off. Before charging, please make sure the power switch in the rear control console is turned off;

2. Insert the charger plug into Q6 charging interface on the rear control panel;

3. Connect the charger to power supply and turn on the switch in the charger. Then, the robot enters the charging state.

Note: For now, the battery needs about 4 hours to be fully recharged from 21V, and the voltage of fully-recharged battery is about 26.8V.
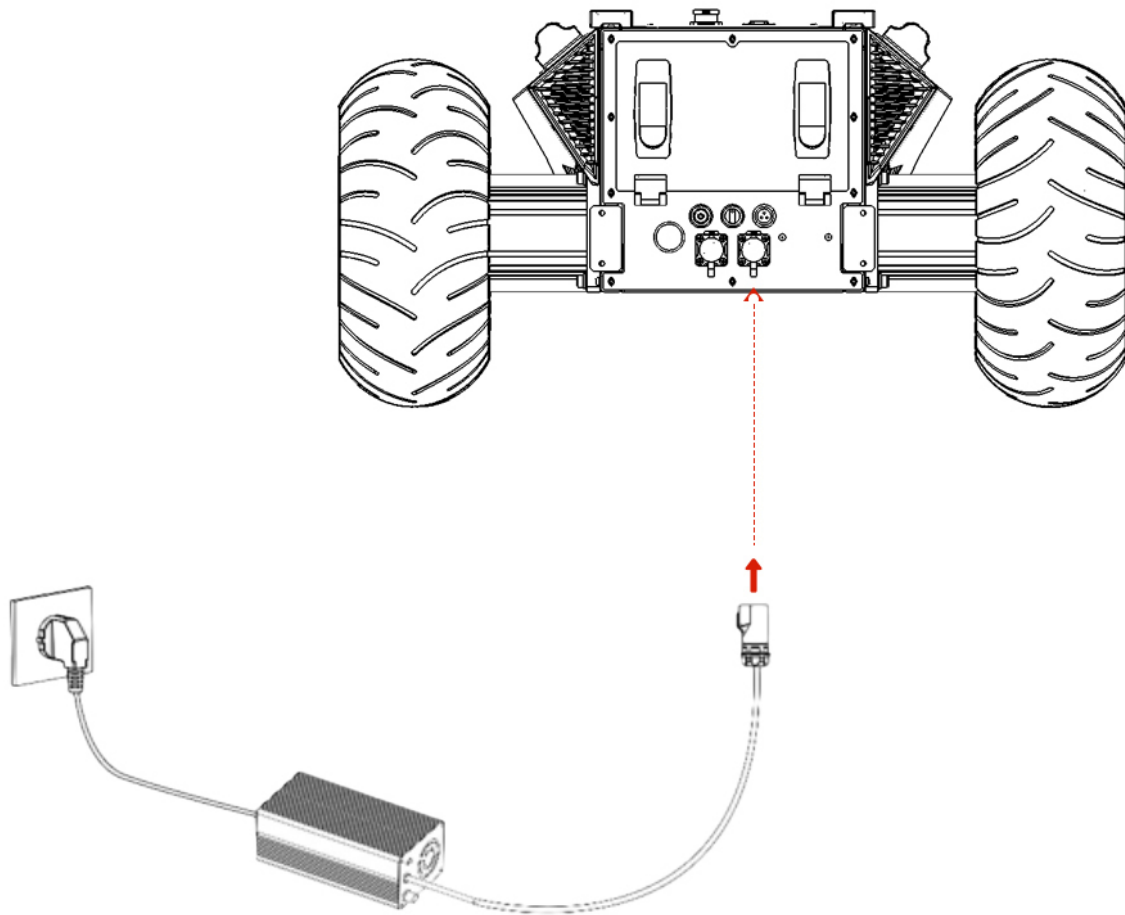
Battery replacement

- Turn off the power switch of the HUNTER 2.0 chassis.

- Press the button lock on the battery replacement panel and open the battery panel.

- Unplug the currently connected battery interface, respectively (XT60 power connector) (BMS connector) lock.

- Take out the battery, pay attention to this process, the battery is forbidden to hit and collide.

- Install the battery that will be used, and then plug the connector back.

- Turn off the power to replace panel, press the lock.
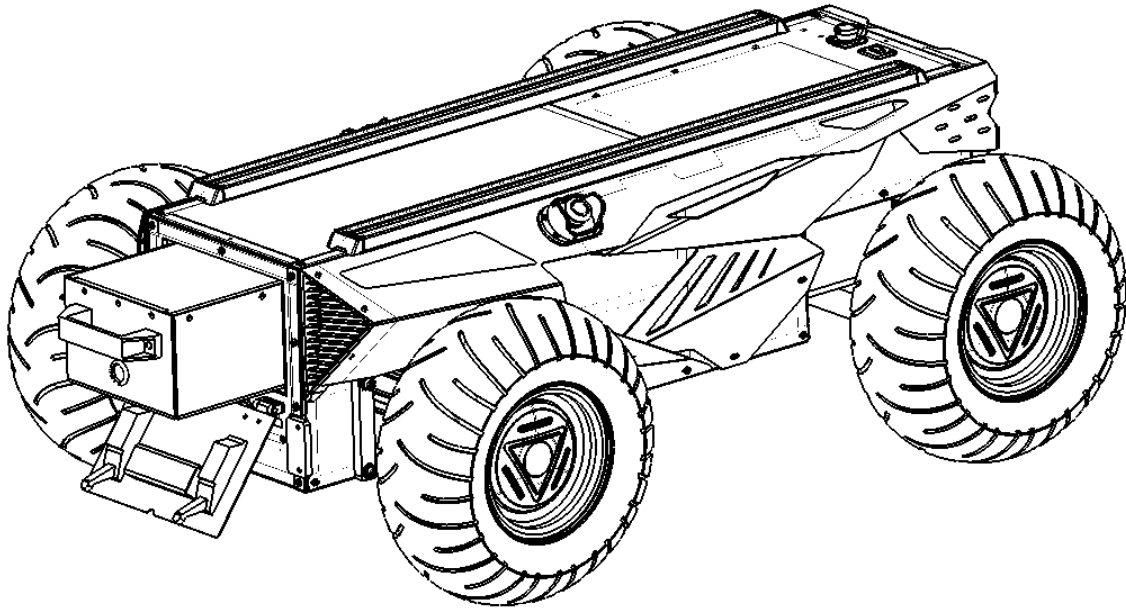
3.3 Development

HUNTER 2.0 provides CAN interfaces for user customization. Users can use it   to conduct command control over the chassis body.

3.3.1 CAN message protocol

HUNTER 2.0 adopts CAN2.0B communication standard which has a communication baud rate of 500K and Motorola message format. Though external CAN bus interface, the moving linear speed and the rotational angle of chassis can be controlled; HUNTER 2.0 will feedback on the current movement status information and its chassis status information in real time.

The system status feedback command includes the feedback information about current status of chassis body, control mode status, battery voltage and system failure. The description is given in Table 3.1.

Table 3.1 Feedback Frame of HUNTER 2.0 Chassis System Status

Command Name	System Status Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)

Steer-by-wire chassis	Decision-making control unit	0x211	100ms	None
Data length	0×08			

Position	Function	Data type	Description
byte [0]	Current status of chassis body	unsigned int8	0×00 System in normal condition 0×01 Emergency stop mode 0×02 System exception
byte [1]	Mode control	unsigned int8	0×00 Standby mode 0×01 CAN command control mode 0×03 Remote control mode
byte [2] byte [3]	Battery voltage higher 8 bits Battery voltage lower 8 bits	unsigned int16	Actual voltage × 10 (with an accuracy of 0.1V)
byte [4] byte [5]	Failure information higher 8 bits Failure information lower 8 bits	unsigned int16	See notes for details [Description of Failure Information]
byte [6]	Parking(brake) state	unsigned int8	0×00 Brake unlocked state 0×01 Brake locked state
byte [7]	Parity bit (checksum)	unsigned int8	00-255added once every command sent counting loops, which will be

Description of Failure Information

Byte	Bit	Meaning
byte [4]	bit [0]	Status error of drive (0: No failure 1: Failure)
	bit [1]	Upper communication connection status (0: No failure 1: Failure)
	bit [2]	Reserved, default 0
	bit [3]	Reserved, default 0
	bit [4]	Reserved, default 0
	bit [5]	Reserved, default 0
	bit [6]	Reserved, default 0
	bit [7]	Reserved, default 0
byte [5]	bit [0]	Battery under-voltage failure (0: No failure 1: Failure)
	bit [1]	Reserved, default 0
	bit [2]	Remote control loss protection (0: No failure 1: Failure)
	bit [3]	Steering motor drive communication failure (0: No failure 1: Failure)
	bit [4]	Rear right motor drive communication failure (0: No failure 1: Failure)
	bit [5]	Rear left motor drive communication failure (0: No failure 1: Failure)
	bit [6]	Reserved, default 0
	bit [7]	Front wheel steering encoder disconnection failure (0: No failure 1: Failure)

The command of movement control feedback frame includes the feedback of current linear speed and turning angle of chassis body. For the detailed content of protocol, please refer to Table 3.2.

Table 3.2 Movement Control Feedback Frame

Command Name	Movement Control Feedback Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	0x221	20ms	None
Date length	0×08			
Position	Function	Data type	Description	
byte [0] byte [1]	Moving speed higher 8 bits Moving speed lower 8 bits	signed int16	Actual speed × 1000 (with an accuracy of 0.001m/s)	
byte [2]	Reserved	-	0x00	
byte [3]	Reserved	-	0x00	
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6] byte [7]	Corner higher 8 bits Corner lower 8 bits	signed int16	Actual internal steering angle ×1000 (unit 0.001rad)	

The control frame includes linear speed control command, front wheel internal steering angle control command. For its detailed content of protocol, please refer to Table 3.3.

Table 3.3 Control Frame of movement Control Command

Command Name	Control Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)

Decision-making control unit	Chassis node	0x111	20ms	500ms
Date length	0×08			
Position	Function	Data type	Description	
byte [0] byte [1]	Linear speed higher 8 bits Linear speed lower 8 bits	signed int16	Chassis moving speed, unit mm/s (effective value+-1500)	
byte [2]	Reserved	—	0x00	
byte [3]	Reserved	—	0x00	
byte [4]	Reserved	—	0x00	
byte [5]	Reserved	—	0x00	
byte [6] byte [7]	Corner higher 8 bits Corner lower 8 bits	signed int16	Internal steering angle unit 0.001rad (effective value+ -576)	

PS: In CAN command mode, it is necessary to ensure that the 0X111 command frame is sent with a cycle less than 500MS (recommended cycle is 20MS), otherwise HUNTER2.0 will determine that the control signal heartbeat is lost and report an error (0X211 feedback upper layer communication is lost), and the system will report an error After that, it will enter the standby mode. If the 0X111 control frame returns to the normal sending cycle at this time, the upper layer communication loss error can be automatically cleared, and the control mode returns to the CAN control mode. The mode setting frame is used to set the control interface of HUNTER 2.0. The specific content of the protocol is shown in Table 3.4

Table 3.4 Control mode setting instructions

Command Name	Control Mode Setting Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)

Decision-making control unit	Chassis node	0x421	None	None
Date length	0×01			
Position	Function	Date type	Description	
byte [0]	Control mode	unsigned int8	0×00 Standby mode 0×01 CAN command mode Power-on enters standby mode default	

Description of control mode: In case the HUNTER 2.0 is powered on and the RC transmitter is not connected, the control mode is defaulted to standby mode. At this time, the chassis only receives control mode command, and does not respond other commands. To use CAN for control need to switch CAN command mode at first. If the RC transmitter is turned on, the RC transmitter has the highest authority, can shield the control of command and switch the control mode.

Status setting frame is use to clear the system errors. The detailed content of the protocol is as follows.

Table 3.5 Status Set Frame

Command Name		Status Setting Command		
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	0x441	None	None
Date length	0×01			
Position	Function	Date type	Description	

byte [0]	Errors clearing command	unsigned int8	0×00 Clear all not serious failure 0×01 Clear steering motor drive communication failure 0×02 Clear rear right motor drive communication failure 0×03 Clear rear left motor drive communication failure 0×05 Clear battery under-voltage failure 0×06 Clear steering encoder communication failure 0×07 Clear remote control signal loss failure

[Note] Example data: The following data is only used for testing

1.The chassis moves forward at 0.15m/s (It need to unlock parking by command before running)

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x96	0x00	0x00	0x00	0x00	0x00	0x00

2.The chassis steering 0.2rad

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x00	0x00	0x00	0x00	0x00	0x00	0xC8

The chassis status information will be feedback, and what's more, the information about motor current, encoder and temperature are also included. The following feedback frame contains the information about motor current, encoder and motor temperature.The motor numbers of the four motors in the chassis correspond to: steering No. 1, right rear wheel No. 2, and left rear wheel No. 3

Table 3.6 Motor driver high-speed information feedback frame

Command Name	Motor Drive High Speed Information Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Chassis node	0x251~0x253	20ms	None
Date length	0×08			
Position	Function	Data type	Description	
byte [0] byte [1]	Motor speed higher 8 bits Motor speed lower 8 bits	signed int16	Current speed of the motor Unit RPM	
byte [2] byte [3]	Motor current higher 8 bits Motor current lower 8 bits	signed int16	Motor current Unit 0.1A	
byte [4] byte [5] byte [6] byte [7]	Position highest bits Position second-highest bits Position second-lowest bits Position lowest bits	signed int32	Current position of the motor Unit: pulse	

Table 3.7 Motor driver low speed information feedback frame

Command Name	Motor Drive Low Speed Information Feedback Frame

Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	0x261~0x263	100ms	None
Date length	0×08			

Position	Function	Data type	Description	
byte [0] byte [1]	Drive voltage higher 8 bits Drive voltage lower 8 bits	unsigned int16	Current voltage of drive unit 0.1V	
byte [2] byte [3]	Drive temperature higher 8 bits Drive temperature lower 8 bits	signed int16	Unit 1°C	
byte [4]	Motor temperature	signed int8	Unit 1°C	
byte [5]	Drive status	unsigned int8	See the details in [Drive control status]	
byte [6]	Reserved	—	0x00	
byte [7]	Reserved	—	0x00	

The specific contents of the drive status information are shown in Table 3.8.

Table 3.8 Drive status description

Drive Status		
Byte	Bit	Description

	bit [0]	Whether the power supply voltage is too low (0:Normal 1:Too low)
byte [5]	bit [1]	Whether the motor is overheated (0:Normal 1:Overheated)
	bit [2]	Whether the drive is over current (0:Normal 1:Over current)
	bit [3]	Whether the drive is overheated (0:Normal 1:Overheated)
	bit [4]	Sensor status (0:Normal 1:Abnormal)
	bit [5]	Drive error status (0:Normal 1:Error)
	bit [6]	Drive enable status (0:Normal 1:Disability)
	bit [7]	Reserved

Parking control command is use to control the motor brake of the driving wheel. The detailed content of the protocol is as follows.

Table 3.9 Parking control Command

Command Name	Parking Control Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	0×131	None	None
Date length	0×01			
Position	Function	Date type	Description	
byte [0]	Parking command	unsigned int8	0×00 Turn off parking (unlock the brake) 0×01 Turning on parking (lock the brake) The brake need to be unlocked to control the speed of the chassis	

Steering zero point setting and feedback instructions are used to calibrate the zero position. The specific content of the agreement is shown in Tables 3.10 and 3.11.

Table 3.10 Steering zero point setting command

Command Name	Steering Zero Setting Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	0x431	None	None
Date length	0×01			
Position	Function	Date type	Description	
byte [0]	Setting current position to zero	unsigned int8	Setting current position to zero Fixed value: 0×AA	

Table 3.11 Steering zero point setting feedback command

Command Name	Steering Zero Setting Feedback Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	0x43A	None	None
Date length	0×01			
Position	Function	Date type	Description	
byte [0]	Reply the steering zero setting	unsigned int8	0×EE Setting current position to zero successfully	

The BMS data feedback frames are shown in Tables 3.12 and 3.13.

Table 3.12 BMS data feedback

Command Name	BMS Data Feedback				
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)	
Steer-by-wire	Decision-making control unit	0x361	500ms	None	
chassis	0×08				
Date length	Function	Date type		Description	
byte [0]	Battery SOC	unsigned int8		Range 0~100	
byte [1]	Battery SOH	unsigned int8		Range 0~100	
byte [2] byte [3]	Battery voltage higher 8 bits Battery voltage lower 8 bits	unsigned int16		Unit: 0.01V	
byte [4] byte [5]	Battery current higher 8 bits Battery current lower 8 bits	signed int16		Unit: 0.1A	

Position	Function	Data type	Description
byte [6] byte [7]	Battery temperature higher 8 bits Battery temperature lower 8 bits	signed int16	Unit: 0.1°C

Table 3.13 BMS status feedback

Command Name	BMS Data Feedback			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	0x362	500ms	None
Date length	0×04			
Position	Function	Data type	Description	
byte [0]	Alarm Status 1	unsigned int8	BIT1: Overvoltage BIT2: Undervoltage BIT3: High temperature BIT4: Low temperature BIT7: Discharge overcurrent	
byte [1]	Alarm Status 2	unsigned int8	BIT0: Charge overcurrent	
byte [2]	Warning Status 3	unsigned int8	BIT1: Overvoltage BIT2: Undervoltage BIT3: High temperature BIT4: Low temperature BIT7: Discharge overcurrent	
byte [3]	Warning Status 4	unsigned int8	BIT0: Charge overcurrent	

The odometer information feedback frame is shown in Table 3.14.

Table 3.14 Mileage feedback

Command Name	Mileage Feedback			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	0x311	20ms	None
Date length	0×08			
Byte	Function	Data type	Description	
byte [0] byte [1] byte [2] byte [3]	Left wheel mileometer highest bit Left wheel mileometer second-highest bit Left wheel mileometer second-lowest bit Left wheel mileometer lowest bit	signed int32	Chassis left wheel mileometer feedback, unit:mm	

Position	Function	Data type	Description
byte [4] byte [5] byte [6] byte [7]	Right wheel mileometer highest bit Right wheel mileometer second-highest bit Right wheel mileometer second-lowest bit Right wheel mileometer lowest bit	signed int32	Chassis right wheel mileometer feedback, unit:mm

The remote control information feedback frame is shown in Figure 3.15.

Table 3.15 Remote control information feedback frame

Command Name		Remote Control Information Feedback Frame		
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	0x241	20ms	None
Date length	0×08			
Position	Function	Data type	Description	

			bit[0-1]: SWA:2- Up 3-Down
byte[0]	SW feedback	unsigned int 8	bit[2-3]: SWB : 2-Up 1-Middle 3-Down
			bit[4-5]: SWC : 2-Up 1-Middle 3-Down
			bit[6-7]: SWD：2-Up 3-Down
byte [1]	Alarm Status 2	signed int8	Range[-100,100]
byte [2]	Alarm Status 2	signed int8	Range[-100,100]
byte [3]	Warning Status 1	signed int8	Range[-100,100]
byte [4]	Warning Status 2	signed int8	Range[-100,100]

3.3.2 CAN cable connection

2 aviation male plugs are supplied along with HUNTER 2.0 as shown in Figure 3.2. Users need to lead wires out by welding on their own. FAor wire definitions, please refer to Table 3.2.

Red:VCC(battery positive)
Black:GND(battery negative)
Blue:CAN_L
Yellow:CAN_H

Figure 3.2 Schematic Diagram of Aviation Male Plug

3.3.3 Implementation of CAN command control

Correctly start the chassis of HUNTER 2.0 mobile robot, and turn on RC transmitter. Then, switch to the command control mode, i.e. toggling S1 mode of RC transmitter to the top. At this point, HUNTER 2.0 chassis will accept the command from CAN interface, and the host can also parse the current state of chassis with the real-time data fed back from CAN bus. For the detailed content of protocol, please refer to CAN communication protocol.
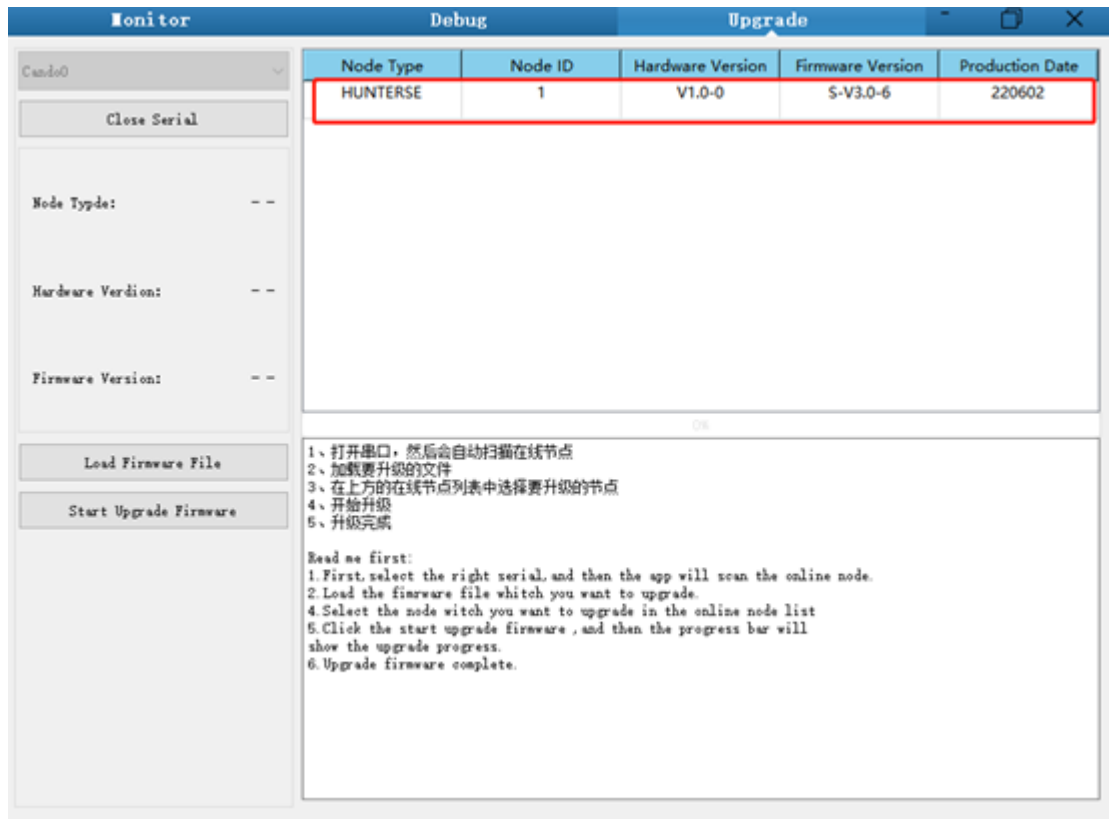
3.4 Firmware upgrades

In order to facilitate users to upgrade the firmware version used by HUNTER 2.0 and bring customers a more complete experience, HUNTER 2.0 provides a firmware upgrade hardware interface and corresponding client software.

Upgrade Preparation

- Agilex CAN debugging module X 1
- Micro USB cable X 1
- HUNTER 2.0 chassis X 1
- A computer (WINDOWS OS (Operating System)) X 1

Upgrade Process

1.Plug in the USBTOCAN module on the computer, and then open the AgxCandoUpgradeToolV1.3_boxed.exe software (the sequence cannot be wrong, first open the software and then plug in the module, the device will not be recognized).

2.Click the Open Serial button, and then press the power button on the car body. If the connection is successful, the version information of the main control will be recognized, as shown in the figure.

3.Click the Load Firmware File button to load the firmware to be upgraded. If the loading is successful, the firmware information will be obtained, as shown in the figure
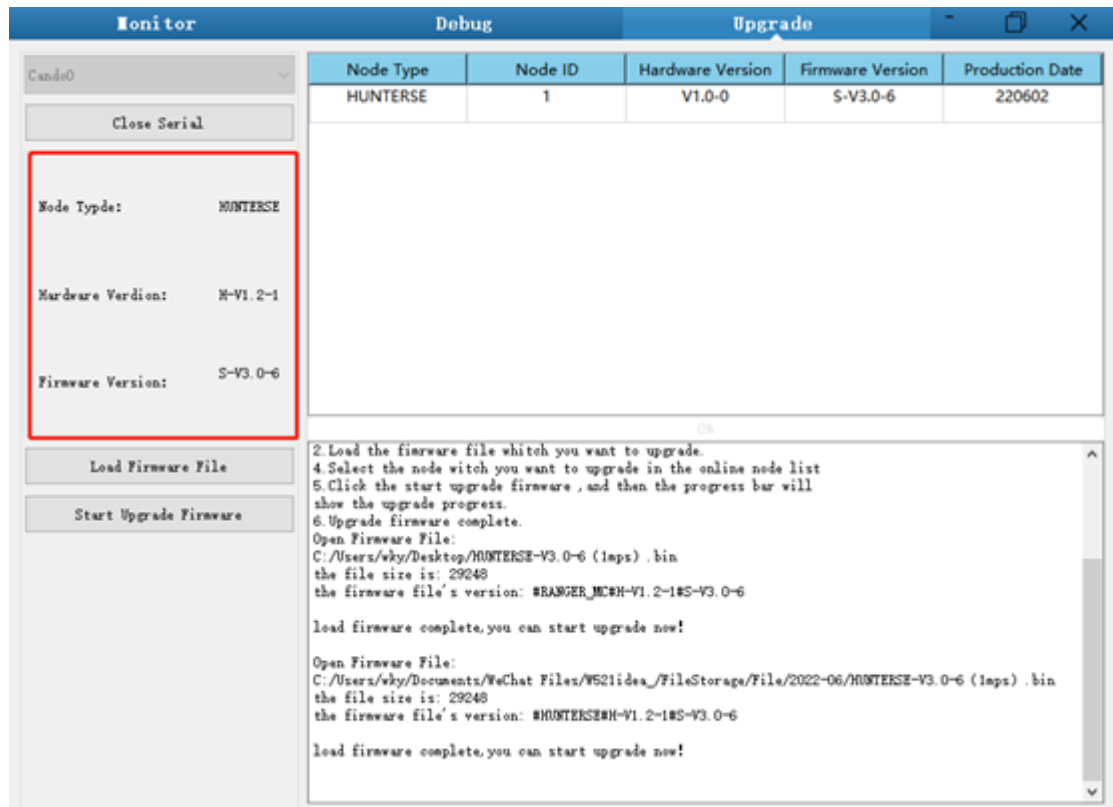
4.Click the node to be upgraded in the node list box, and then click Start Upgrade Firmware to start upgrading the firmware. After the upgrade is successful, a pop-up box will prompt.
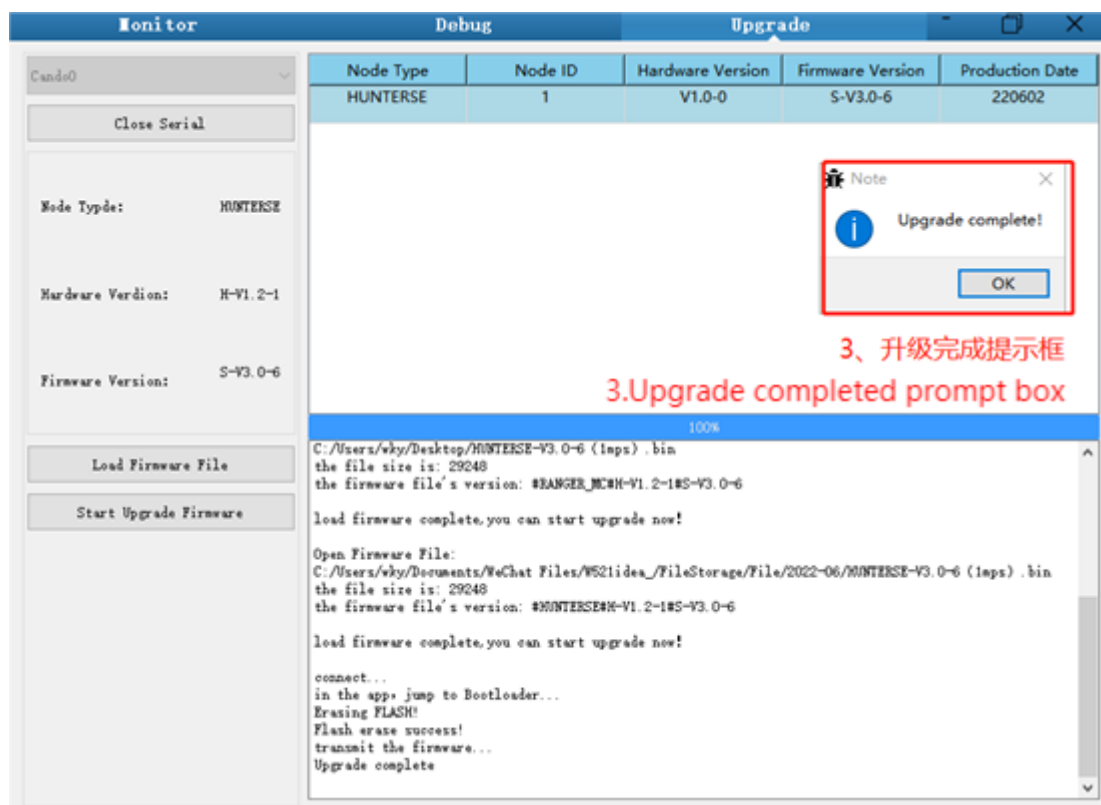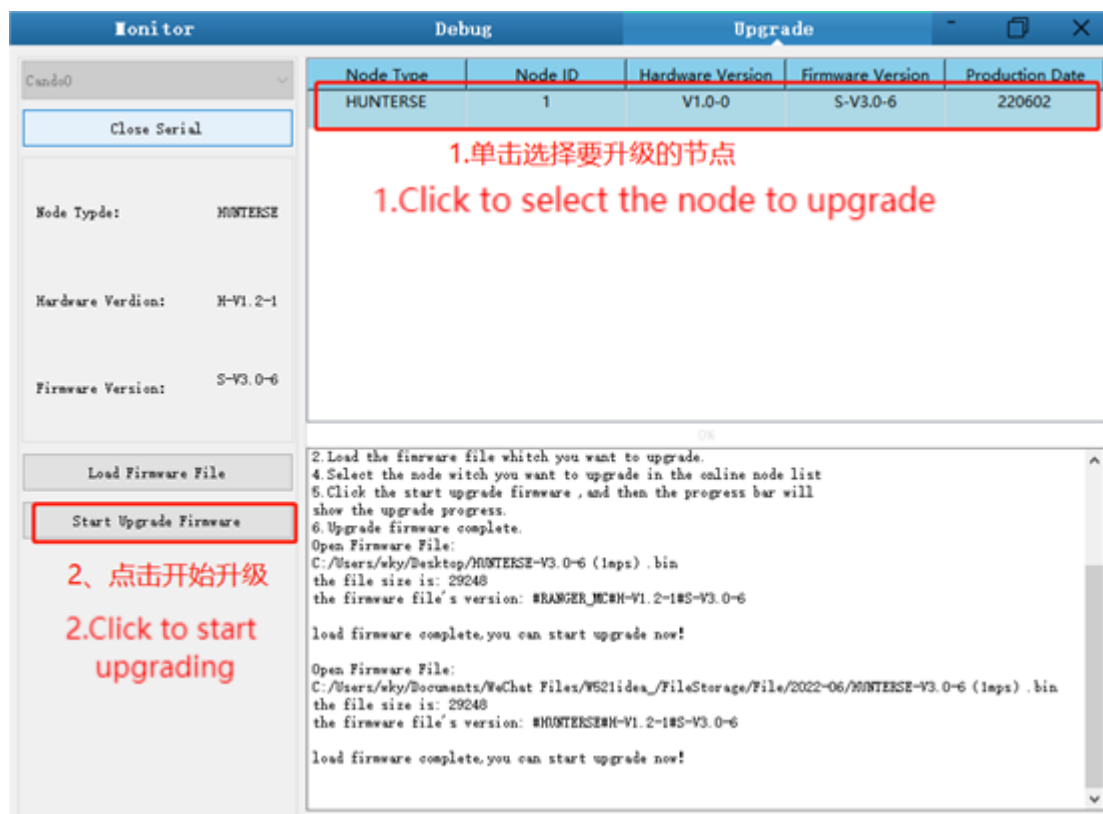
3.5 HUNTER 2.0 ROS Package

ROS provide some standard operating system services, such as hardware abstraction, low-level device control, implementation of common function, interprocess message and data packet management. ROS is based on a graph architecture, so that process of different nodes can receive, and aggregate various information (such as sensing, control, status, planning, etc.) Currently ROS mainly support UBUNTU.

Development Preparation

Hardware preparation

- CANlight can communication module ×1
- Thinkpad E470 notebook ×1
- AGILEX HUNTER 2.0 mobile robot chassis ×1
- AGILEX HUNTER 2.0 remote control FS-i6s ×1
- AGILEX HUNTER 2.0 top aviation power socket ×1

Use example environment description

- Ubuntu 18.04 LTS
- ROS melodic
- Git

Hardware connection and preparation

- Lead out the CAN wire of the HUNTER 2.0 top aviation plug or the tail plug, and connect CAN_H and CAN_L in the CAN wire to the CAN_TO_USB adapter respectively;
- Turn on the knob switch on the HUNTER 2.0 mobile robot chassis, and check whether the emergency stop switches on both sides are released；
- Connect the CAN_TO_USB to the usb point of the notebook. The connection diagram is shown in Figure 3.4.

Figure 3.4 CAN connection diagram

ROS installation and environment setting

For installation details, please refer to

http://wiki.ros.org/kinetic/Installation/Ubuntu

Test CANABLE hardware and CAN communication

Setting CAN-TO-USB adaptor

- Enable gs_usb kernel module

```
sudo modprobe gs_usb
```

- Setting 500k Baud rate and enable can-to-usb adaptor

```
sudo ip link set can0 up type can bitrate 500000
```

- If no error occurred in the previous steps, you should be able to use the command to view the can device immediately

```
ifconfig -a
```

- Install and use can-utils to test hardware

```
sudo apt install can-utils
```

- If the can-to-usb has been connected to the HUNTER 2.0 robot this time, and the car has been turned on, use the following commands to monitor the data from the HUNTER 2.0 chassis

```
candump can0
```

Please refer to:

[1]　https://github.com/agilexrobotics/agx_sdk

[2]　https://wiki.rdu.im/_pages/Notes/Embedded-System/Li-nux/can-bus-in-linux.html

AGILEX HUNTER 2.0 ROS PACKAGE download and compile

- Download ros package

```
$ sudo apt install -y ros-$ROS_DISTRO-teleop-twist-keyboard
```

- Clone compile hunter_ros code

```
$ cd ~/catkin_ws/src
$ git clone https://github.com/agilexrobotics/ugv_sdk.git
$ git clone https://github.com/agilexrobotics/hunter_ros.git
$ cd ..
$ catkin_make
```

Please refer to: https://github.com/agilexrobotics/hunter_2_ros

Start the ROS node

- Start the based node

```
$ roslaunch hunter_bringup hunter_robot_base.launch
```

- Start the keyboard remote operation node

```
$ roslaunch hunter_bringup hunter_teleop_keyboard.launch
```

Github ROS development package directory and usage instructions

*_base:: The core node for the chassis to send and receive hierarchical CAN messages. Based on the communication mechanism of ros, it can control the movement of the chassis and read the status of the bunker through the topic.

*_msgs: Define the specific message format of the chassis status feedback topic.

*_bringup: startup files for chassis nodes and keyboard control nodes, and scripts to enable the usb_to_can module.

4 Q&A

Q: HUNTER 2.0 is started up correctly, but why cannot the RC transmitter control the chassis body to move?

A: First, check whether the drive power supply is in normal condition, whether the drive power switch is pressed down and whether E-stop switches are released; then, check whether the control mode selected with the top left mode selection switch on the RC transmitter is correct, check whether the parking switch is turn off.

Q: HUNTER 2.0 remote control is in normal condition, and the information about chassis status and movement can be received correctly, but when the control frame protocol is issued, why cannot the chassis body control mode be switched and the chassis respond to the control frame protocol?

A: Normally, if HUNTER 2.0 can be controlled by a RC transmitter, it means the chassis movement is under proper control; if the chassis feedback frame can be accepted, it means CAN extension link is in normal condition. Please check the CAN control frame sent to see whether the data check is correct and whether the control mode is in command control mode. You can check the status of error flag from the error bit in the chassis status feedback frame.

**Q: HUNTER 2.0 gives a "beep-beep-beep..." sound in operation, how to deal with this problem?**

A: If HUNTER 2.0 gives this "beep-beep-beep" sound continuously, it means the battery is in the alarm voltage state. Please charge the battery in time.

5 Product Dimensions

5.1 Illustration diagram of product external dimensions
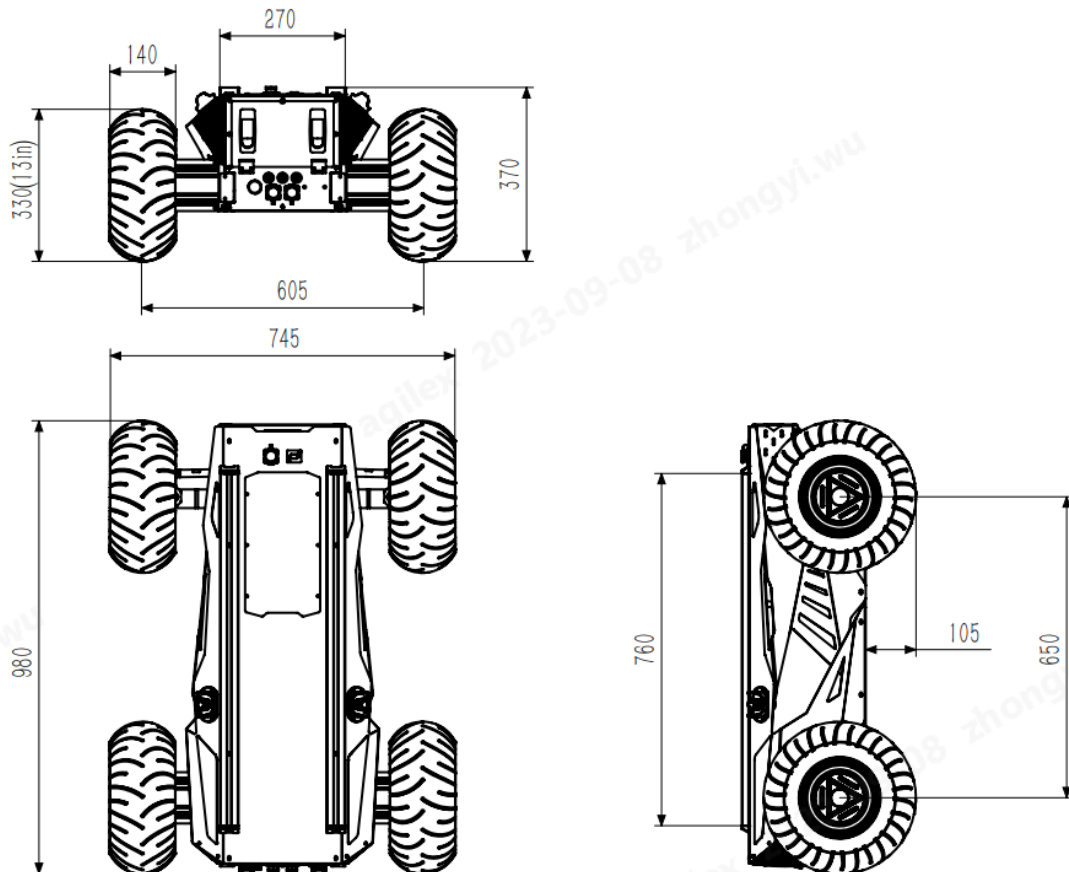
5.2 Illustration diagram of top extended support dimensions

16

270

230

760

40
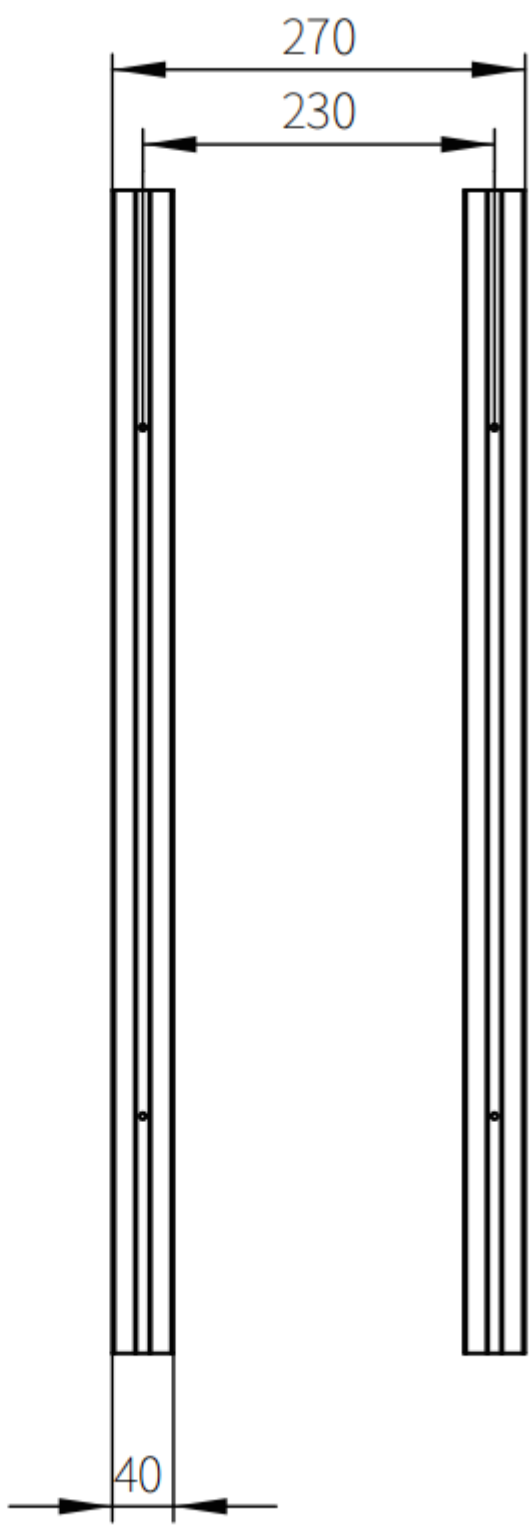
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