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What is an Autonomous Mobile Robot? What are AMRs?

An AMR is an Autonomous Mobile Robot with Natural Navigation able to redefine routes or paths and avoid obstacles. An AMR doesn't require predefined fixed paths. It can define its route on-the-fly. If an obstacle is detected, the AMR adjusts its path to navigate around the object.

What is an Automated Guided Vehicle? What are AGVs?

An AGV navigates automatically along given tracks (physical or virtual, magentic tape, reflectors triangulation, etc). AGVs stick to that path and cannot abandon it. In the case that the AGV safety sensors detect an obstacle, the AGV stops and waits for the obstacle to be removed.

AMR vs AGV comparison table	Automated Guided Vehicle (AGV)	Autonomous Mobile Robot (AMR)
Navigation	Infrastructure: wire guidance, reflective markers, Radio Frequency ID, etc. Magnetic tape, Laser Guidance, etc	Trackless Natural Navigation. All sensing is done onboard. Identifies the environment on-the-fly.
Obstacles	Obstacles stop AGVs	AMR goes around obstacles and finds what the best path according to its internal map
Flexibility	It is more complex to add new routes or destinations.	Easy to remap and define new destinations and goals
Vehicle cost	AGVs tends to be simpler thus less expensive than AMR.	AMRs are more expensive because of more accurate sensors and more sophisticated control software.
Installation and Commissioning cost	More complex, need more time and requires infrastructure cost (magnetic tape, wire, reflectors, etc)	Fast and easy to install. Lower cost compared to AGVs.
Reliability	AGVs stick to a path. AGVs are more reliable than AMRs.	Natural navigation is more sensitive to environment variations. The robot could lose its position.
Safety	B56.5-2019 in US / ISO 3691-4:2020 in UE	ANSI/RIA R15.08-1-2020

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AMR and AGV navigation system

AMR:

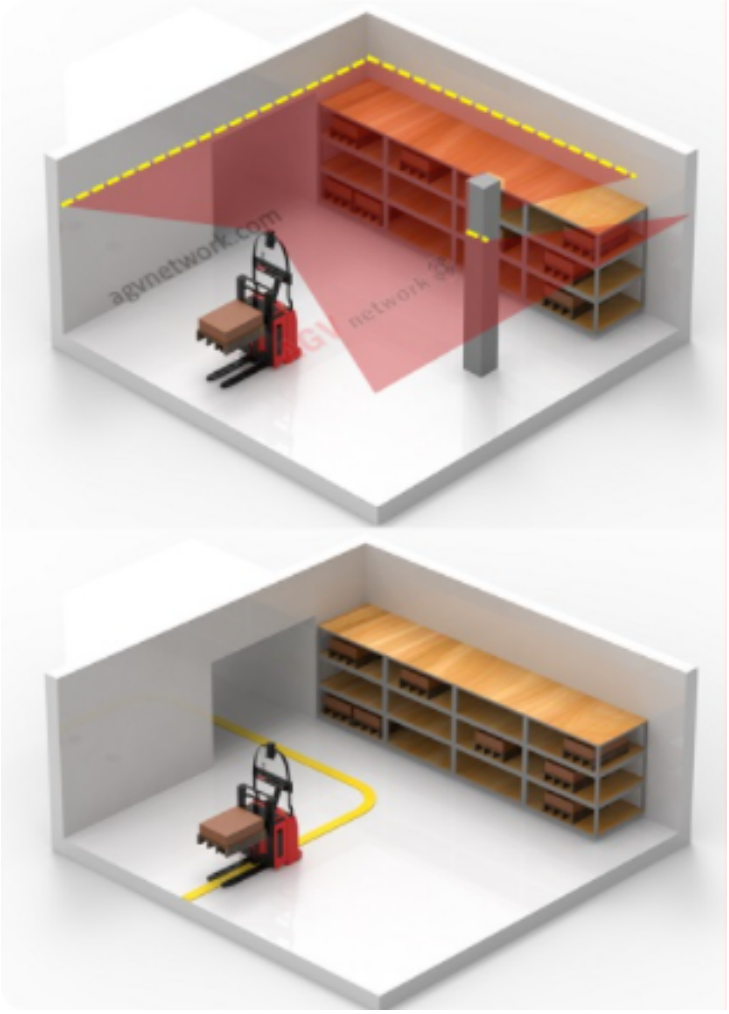
AMR has a natural navigation system ,able to redefine routes or paths and avoid obstacles, and does not require predefined fixed paths like AGV.

Natural navigation means that the robot maps the environment and is able to navigate and localise itself without need of hardware installation such as wires or magnetic tapes on the floor.

Using technology such as LiDAR sensors & Simultaneous Localization and Mapping (SLAM), an AMR will determine the best route between waypoints

AGV:

Traditionally guided by magnetic strips or wires installed on or under the floor



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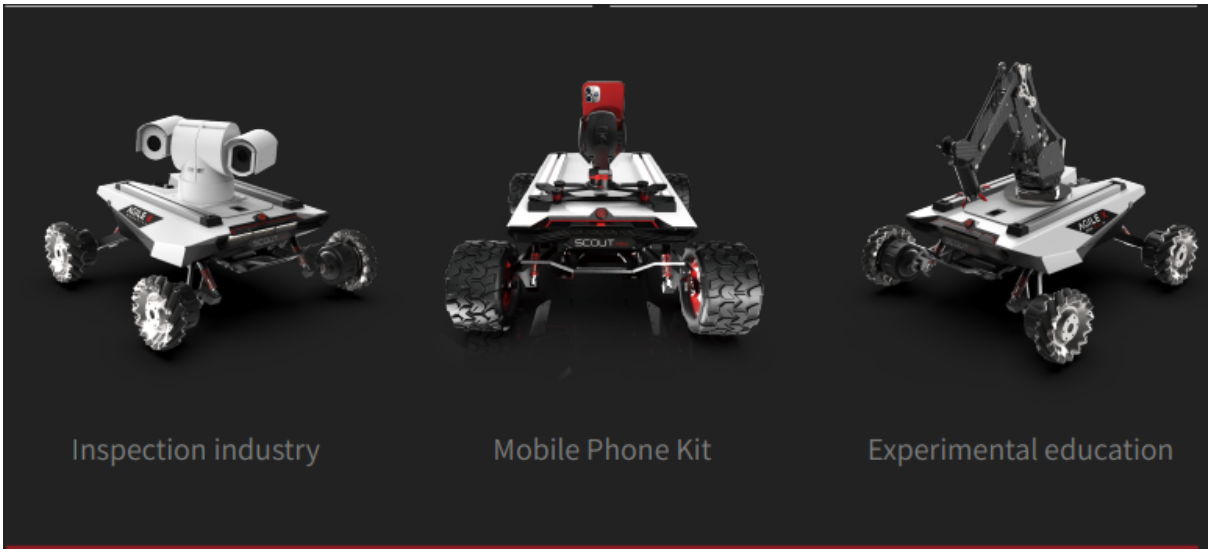
EXAMPLE OF UGV: AgileX Robotics SCOUT MINI



ROBOT BODY DESIGN VS TASKS

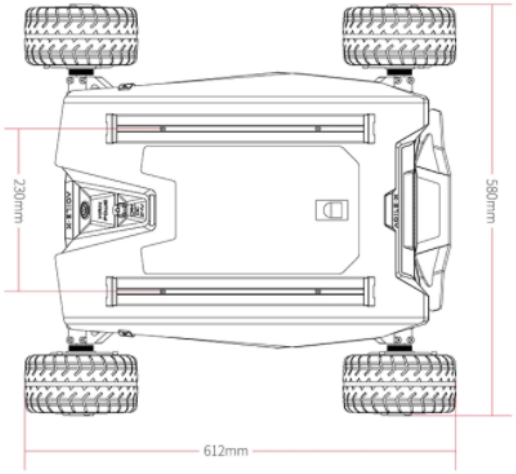
(Body shapes and materials used for different applications (Underwater, Ground, Air, Space). Regulation, Certification and Compliant needed?)

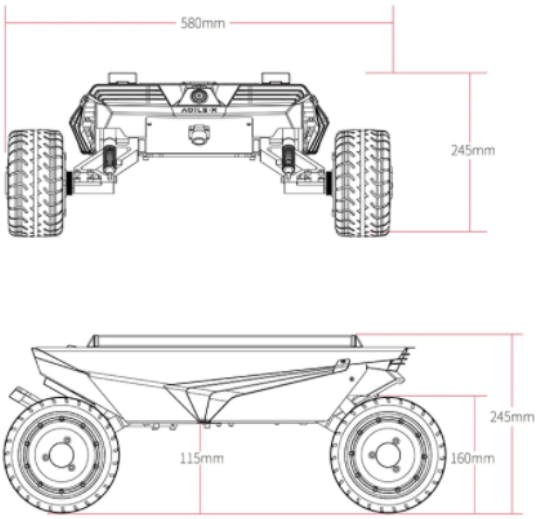
SCOUT MINI intelligent mobile chassis, with 4WD, strong off-road performance and compact body shape, truly achieves "dexterous and flexible". SCOUTMINI inherits the advantages of the SCOUT four-wheel differential chassis family, i.e. four-wheel drive, independent suspension, in-situ rotation and so on, and has made innovation in the design of hub motors. The minimum turning radius of the chassis is 0 m, and the climbing angle is close to 30 degrees. SCOUT MINI is still capable of excellent off-road performance although it is only half of SCOUT in size. In addition, it has a breakthrough high-speed, accurate, stable and controllable dynamic control system up to 20 km/h. SCOUTMINI development platform with its own control core, supports standard CAN bus communication, and can access standard CAN bus communication, as well as all kinds of external equipment. On such a basis, it supports secondary development such as ROS and more advanced access and the access of robot development systems. Equipped with standard aeromodelling aircraft, 24V@15Ah lithium battery power system, its endurance mileage is up to 10 km. Additional

components such as stereo camera, laser radar, GPS, IMUS, manipulator, etc. can be optionally installed on SCOUT MINI for expanded applications. SCOUT MINI is frequently used for unattended inspection, security, scientific research, prospecting, logistics, etc.

ACTUATORS/LOCOMOTIONS

(Types of actuator. To move the main body of the robot (Tires, motors, rotors, drivers etc.). Add on accessories to the robot (Manipulator, End Effector, Custom/Specific task, Servo, Dynamixal Servo, DC/AC Motor, Hydraulics, Pneumatics, Linear actuator etc.). Bearing, Sliders, Gears, Pulley System, Slip Ring, Linear etc))





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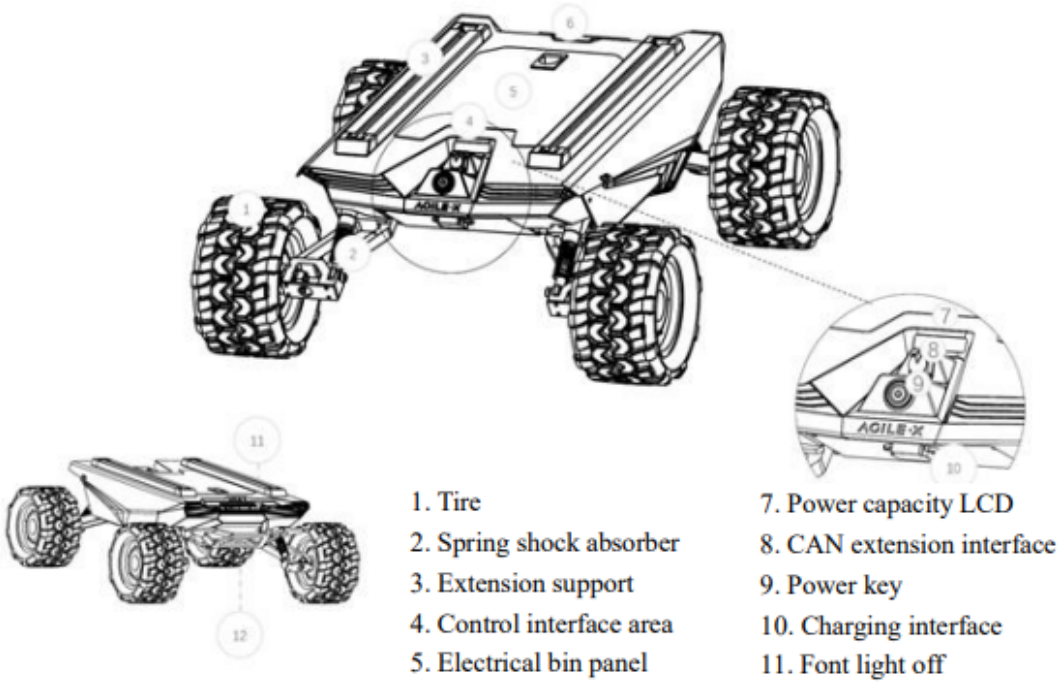

1. Tire
2. Spring shock absorber
3. Extension support
4. Control interface area
5. Electrical bin panel
6. Tail light off
7. Power capacity LCD
8. CAN extension interface
9. Power key
10. Charging interface
11. Font light off
12. Front fence

Based on the concept of modular and intelligent design as a whole, SCOUT MINI combines filled solid tires with independent suspension as its power module, which, along with powerful hub motor, enables the development platform of SCOUT MINI robot chassis to flexibly move on different ground surfaces with high passing ability and ground adaptability.

The hub motor saves the complex transmission structure design and makes it possible for the model to become more compact. Anti-collision fence is mounted in the front of the vehicle to protect the front and reduce possible damages to the vehicle body during a collision. The front of the vehicle is equipped with white lights, which can be illuminated. Electrical interfaces for DC power and communication interfaces are provided at the rear of the robot to facilitate secondary development. The electrical interfaces adopt waterproof plug-in components, not only allowing flexible connection between the robot and external components for customers but also allowing the use of the robot even under severe operating conditions. A standard aluminum extension support is installed at the top of the vehicle to facilitate the use of external equipment extension.

NAVIGATION SYSTEM & CONTROLLER

(Types of sensors/controller for perception and navigation. (Types of Computer (Edge AI Industrial PC, PC104, DAQ, Controller) Sensor (LIDAR, Camera IR/Color/Thermal, Depth Camera, Radar, Ultrasonic, Laser, Bumper Sensor, Magnetic Guide, IMU, Encoder etc))

Remote control instructions:
FS Remote controller
For this robot RC transmitter is used
1. Lever SWA:
2. Lever SWB: The lever SWB switches control mode
3. Lever SWC: is the manual control switch to control the light off
4. Lever SWD: controls speed mode
5. Left rocker: controls forward and backward movement
6. Right rocker: controls the vehicle for left rotation and right rotation
7. Power switch key 1
8. Power switch key 2
9. Mobile/Tablet fixing support interface
10. Ring interface 11. LCD panel

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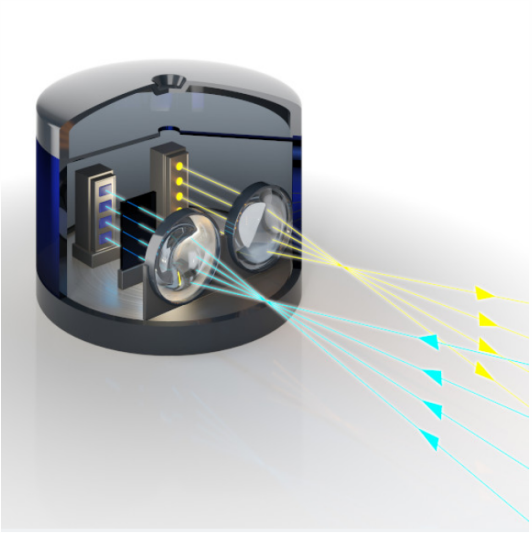
DATA COLLECTION

(Types of instruments for data collections. (Remote Sensing, Mapping, Surveillance, etc))

laser radar

Lidar is for “light detection and ranging.” It is sometimes called “ laser scanning” or “3D scanning.The technology uses eye-safe laser beams to create a 3D representation of the surveyed environment.



How does it work?

1. emits pulsed light waves into the surrounding environment.
2. These pulses bounce off surrounding objects and return to the sensor.
3. The sensor uses the time it took for each pulse to return to the sensor to calculate the distance it travelled.

Stereo Camera

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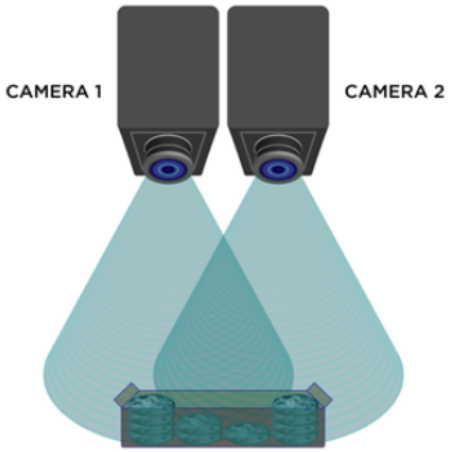
Stereo vision is a machine vision technique that can provide full field of view 3D measurements using two or more machine vision cameras. The foundation of stereo vision is similar to 3D perception in human vision and is based on triangulation of rays from multiple viewpoints.



DATA TRANSMISSION

(Types of communication devices and protocols. Cables (Digital vs Analog, RS232/485/422, BUS, CAN, HARP, I2C, ISP, Ethernet, OPTIC etc) vs Wireless (IR, Bluetooth, WIFI, BLE, RF, Satellite, Telco 4G/5G, GPRS & etc))

The type of communication used for this UGV is by using cables (USB to CAN) or (USB to Serial Port). The protocol is Digital Transfer Protocol. The communication interface for this robot are:

1. Default - Standard Controller Area Network 2.0B (CAN2.0B)
    - Carrier-sense, multiple access protocol
    - Communication baud rate of 500K
    - Motorola message format (Big Endian; MSB of the number is stored in memory at the lowest address, and the LSB at the highest address)
    - SCOUT MINI will feedback the current motion status information, chassis status information, etc. in real time.

Table 3.1 Feedback Frame of SCOUT MINI Chassis System Status

Command Name	**System Status Feedback Command**			
Sending node	Receiving node	**ID**	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	**0x151**	**20ms**	**None**
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Current status of vehicle body	unsigned int8	0x00 System in normal condition 0x01 Emergency stop mode (not enabled) 0x02 System exception	
byte [1]	Mode control	unsigned int8	0x00 Remote control mode 0x01 CAN command control mode [1] 0x02 Serial port control mode	
byte [2]	Battery voltage higher 8 bits	unsigned int16	Actual voltage X 10 (with an accuracy of 0.1V)	
byte [3]	Battery voltage lower 8 bits			
byte [4]	Failure information higher 8 bits	unsigned int16	See notes for details [**]	
byte [5]	Failure information lower 8 bits			
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	**Parity bit**	

2. Upgrade - Recommended Standard 232 (RS232).
    - Serial communication

Upgrade preparation:

- Serial cable X 1
- USB-to-serial port X 1
- SCOUT chassis X 1
- Computer (Windows operating system) X 1

Upgrade procedure:

- Before connection, ensure the robot chassis is powered off;
- Connect the serial cable onto the serial port at tail end of SCOUT MINI chassis;
- Connect the serial cable to the computer;
- Open the client software;
- Select the port number;
- Power on SCOUT MINI chassis, and immediately click to start connection (SCOUT MINI chassis will wait for 6 s before power-on; if the waiting time is more than 6 s, it will enter the application); if the connection succeeds, "connected successfully" will be prompted in the text box;
- Load Bin file;
- Click the Upgrade button, and wait for the prompt of upgrade completion;
- Disconnect the serial cable, power off the chassis, and then turn the power off and on again.

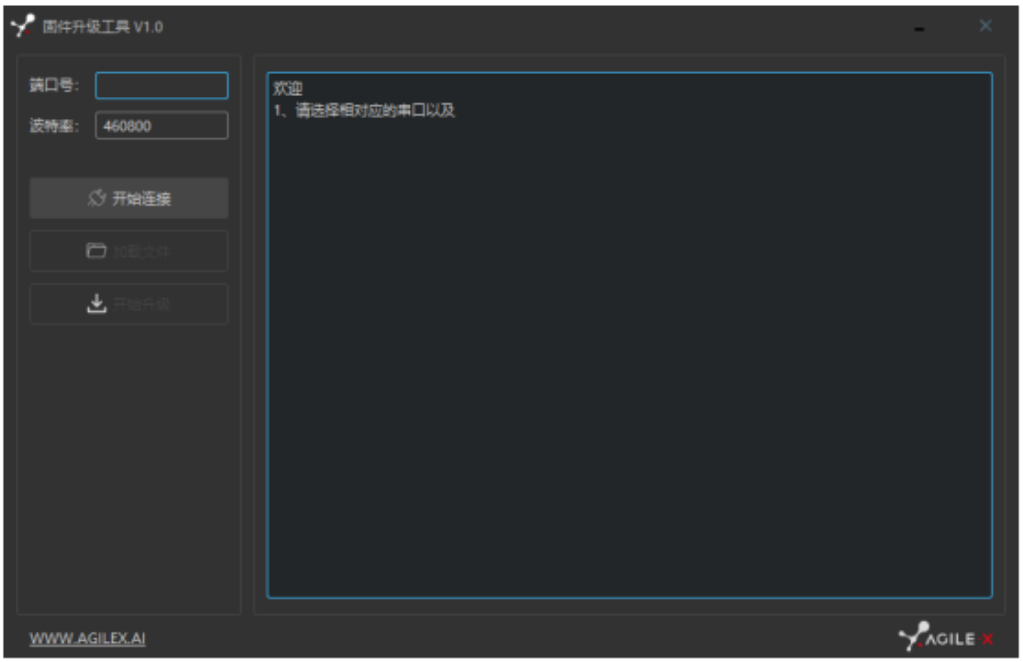


Figure 3.3 Client Interface of Firmware Upgrade

POWER SYSTEM MANAGEMENT

(Types of power supply. AC, DC cables. Batteries. Engin. Renewable Energy.)

The specification of power supply used for this UGV are:

Charger	AC 220V Independent Charger
Charging Time	2H
Outward Supply	24V
Battery	24V / 15Ah