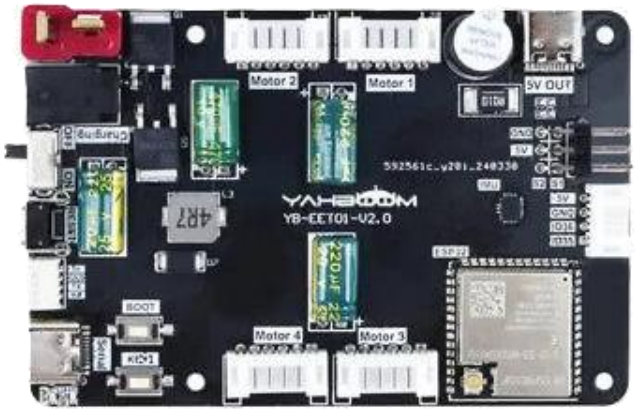
1 Introduction

This group project aims to provide students with hands-on experience in designing and fabricating a smart AI wheeled logistics robot that integrates robotic systems with a Vision AI system, employing 3D printing and laser material processing. Each group's smart robot should be equipped with an electric lifter, which allows it to carry and relocate a rack from one position to another. Each group will be provided with the following components:

Item	Description	QTY	Remark
1	Micro-ROS Controller Board for Raspberry Pi 5 	1	- Running micro-ROS firmware. - Controlling sensors and actuators. - Providing power to the Raspberry Pi 5. - https://www.yahboom.net/study/MicroROS-Board

Item	Description	QTY	Remark
2	USB Type A to Type C cable (for Pi 5 data) 	1	- Connect the micro-ROS controller board with the Raspberry Pi 5. - For USB-Serial communication
3	USB Type C to Type C cable (for Pi 5 power) 	1	- Connect the micro-ROS controller board with the Raspberry Pi 5. - For powering the Raspberry Pi 5 with a battery.

Item	Description	QTY	Remark
4	Raspberry Pi 5 8GB Board with heatsink and fan 	1	- Running Linux and ROS2. - Controlling the camera and Lidar. - Wi-Fi networking. - https://www.raspberrypi.com/documentation/computers/getting-started.html
5	32GB Memory Card (for Raspberry Pi 5) 	1	- Installed on the Raspberry Pi 5. - Storage for operating systems and user data.
6	USB Card Reader	1	- Read and write a memory card on a computer.

Item	Description	QTY	Remark
7	Raspberry Pi Camera Module 3 with cable 	1	- Connect to the Raspberry Pi 5. - https://www.raspberrypi.com/documentation/accessories/camera.html
8	Raspberry Pi 5 Power Supply 	1	- Powering the Raspberry Pi temporarily during the development stages. - The smart AI wheeled logistics robot must be battery-powered.

Item	Description	QTY	Remark
9	Raspberry Pi 5 Display Cable 	1	- Connect an external display (LCD) temporarily during the development stages.
10	MS200 Lidar with cable and adapter board  MS200 Laser Lidar  Serial adapter board  Connection cable	1	- Connect to Raspberry Pi 5 for map creation and autonomous navigation. - https://www.yahboom.net/study/MS200

Item	Description	QTY	Remark
11	USB Type A to Type C cable (for Lidar data) 	1	- Connect the MS200 Lidar to the Raspberry Pi 5.
12	Mecanum wheels (Left) 65mm 	2	

Item	Description	QTY	Remark
13	Mecanum wheels (Right) 65mm 	2	
14	Mecanum wheels adapter for 310 motor with screws 	4	- Connect a 65mm Mecanum wheel with a 310 DC Encoder Motor.
15	310 DC Encoder Motor with cable 	4	- The white colour connector plugs into the micro-ROS controller board. - The black colour connector plugs into the 310 motor. - Make sure the connection is correct before powering on the system. - PPR: 13. Gear ratio: 1:20. - An incorrect connection will burn the controller board.

Item	Description	QTY	Remark
16	7.4v Lithium battery 9900mAh with charger 	1	- Do not short the power leads. - Do not overcharge the battery. - Do not charge the battery unattended.
17	Battery Charger 	1	
18	CN to HK power plug adapter 	1	

Item	Description	QTY	Remark
19	MG996 Servo (180 degree) 	1	- For moving a platform up and down. - Wire: Black (GND), RED (+5V), Yellow (PWM).
20	USB Wi-Fi Dongle 	1	- For creating a Hotspot on the Raspberry Pi 5

2 A simplified block diagram showing the possible building blocks of a robot

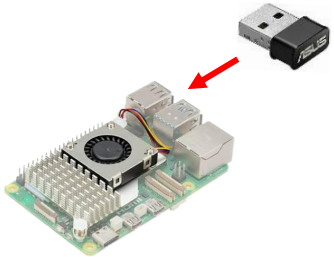
This block diagram is an example only. Each group should have their own unique robot design.

1.1 Driven by Servo and controlled by ESP32





2.1 Lidar will be connected with Raspberry Pi 5



Lifter Actuator

Lidar

Camera

Raspberry Pi 5

ROS2 Robotic Base

(ESP32 Micro-ROS)



4.1 A ROS2 device

4.2 Wi-Fi Hotspot

4.3 Controlling Lidar

4.3 Controlling Camera

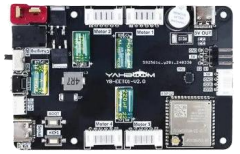
4.4 Control Micros-ROS device



3.1 Raspberry Pi 5's Camera Module V3







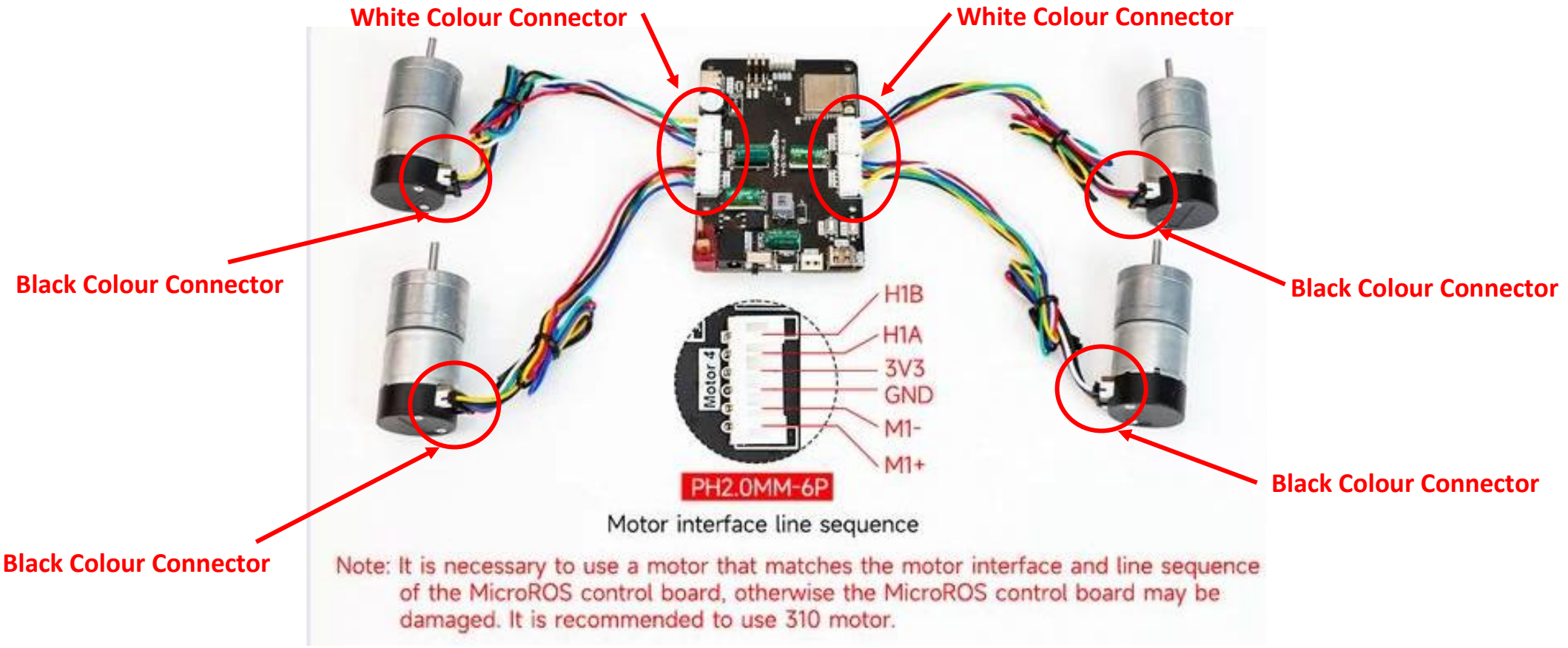
5.1 A Micro-ROS device

5.2 USB connected with Raspberry Pi 5

5.3 Controlling sensors and actuators

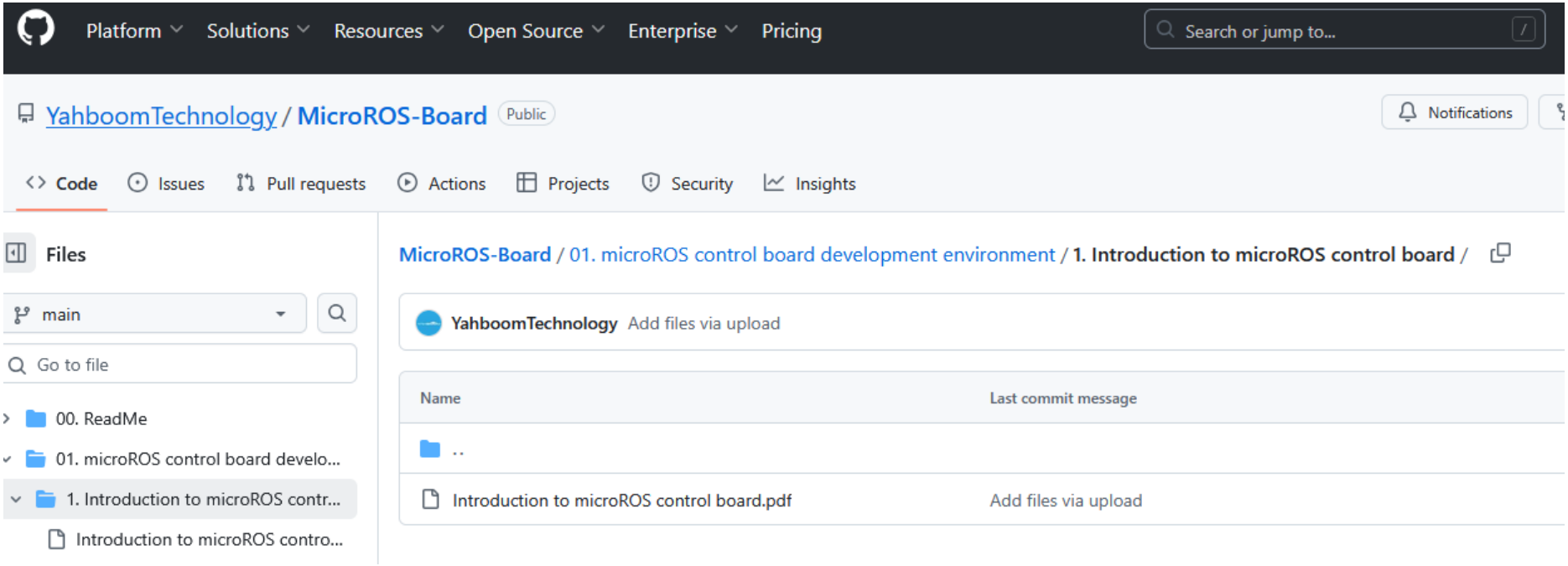
3 A connection diagram of the Micro-ROS Controller Board with 310 Encoder Motors.

Before powering up the system, double-check that all motor cables are installed in the correct order by verifying the connector colour. The motor cable has two connectors. The white colour connector is connected to the Micro-ROS controller board. The black colour connector is connected to the motor. Incorrect installation of motor cables may cause damage to the Micro-ROS controller board.

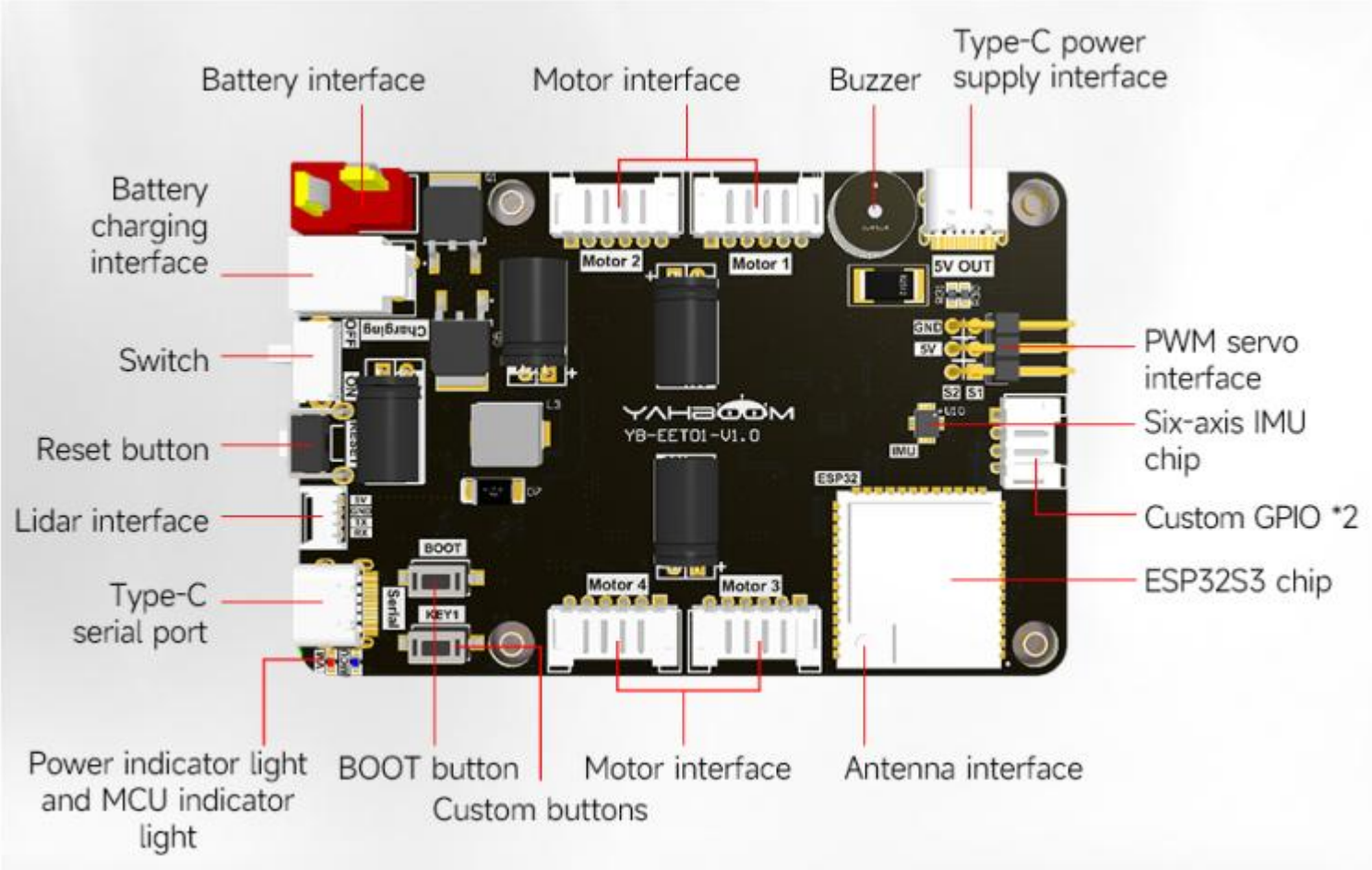


4 Hardware Resources of the Micro-ROS Controller Board

The vendor's GitHub website (https://github.com/YahboomTechnology/MicroROS-Board) provides details about the hardware of the controller board. The location is "01. microROS control board development environment/1. Introduction to microROS control board".



For example, there is a diagram that describes the available hardware resources.



The document also provides a pin assignment table.

Name of peripheral device	ESP32-S3-GPIO
Motor M1-PWM-M1A	GPIO4
MotorM1-PWM-M1B	GPIO5
MotorM1-encoder-H1A	GPIO6
MotorM1-encoder-H1B	GPIO7
MotorM2-PWM-M2A	GPIO15
MotorM2-PWM-M2B	GPIO16
MotorM2-encoder-H2A	GPIO47
MotorM2-encoder-H2B	GPIO48
MotorM3-PWM-M3A	GPIO9
MotorM3-PWM-M3B	GPIO10
MotorM3-encoder-H3A	GPIO11
MotorM3-encoder-H3B	GPIO12
MotorM4-PWM-M4A	GPIO13
MotorM4-PWM-M4B	GPIO14
MotorM4-encoder-H4A	GPIO1
MotorM4-encoder-H4B	GPIO2
BOOT button-IO0	GPIO0
Custom key-KEY1	GPIO42
Battery voltage detection-BAT	GPIO3
MCU indicator light-LED	GPIO45
Buzzer	GPIO46
Servo interface -S1	GPIO8
Servo interface -S2	GPIO21
IMU interrupts -INT	GPIO41
IMU-I2C-SCL	GPIO39
IMU-I2C-SDA	GPIO40
Radar RX-serial port 1-TXD1	GPIO17
Radar TX-serial port 1-RXD1	GPIO18
Type-C serial port RX-TXD0	GPIO43

Name of peripheral device	ESP32-S3-GPIO
Type-C serial port TX-RXD0	GPIO44
Custom GPIO	GPIO35
Custom GPIO	GPIO36
Custom indicator lights	D1
Custom indicator lights	D2

5 ROS2 Node for the Raspberry Pi Camera Modules

The ROS2 package "camera_ros" supports Raspberry Pi Camera Modules, including Camera Module 3. More information is available on the Github page https://github.com/christianrauch/camera_ros. Both "libcamera" and "camera_ros" packages should be built from source code.

6 Acknowledgement

1. Vendor's GitHub website for the Micro-ROS Controller Board.

URL: https://github.com/YahboomTechnology/MicroROS-Board