Multimodal Visual Understand (Text Version)

1. Course Content

1. Learn to use the robot's visual understanding capabilities
2. Study new key source code

2. Preparation

2.1 Content Description

> This lesson uses Jetson Orin NANO as an example. For Raspberry Pi and Jetson-Nano boards, you need to open a terminal on the host computer and enter the command to enter the Docker container. Once inside the Docker container, enter the commands mentioned in this lesson in the terminal. For instructions on entering the Docker container from the host computer, refer to **[01. Robot Configuration and Operation Guide] -- [4.Enter Docker (For JETSON Nano and RPi 5)]**. For RDKX5 and Orin boards, simply open a terminal and enter the commands mentioned in this lesson.

📝 This example uses `model: "qwen/qwen2.5-vl-72b-instruct:free","qwen-vl-latest"`

⚠ The responses from the large model may not be exactly the same for the same test command and may differ slightly from the screenshots in the tutorial. To increase or decrease the diversity of the large model's responses, refer to the section on configuring the decision-making large model parameters in the **[03.AI Model Basics] -- [5.Configure AI large model]** .

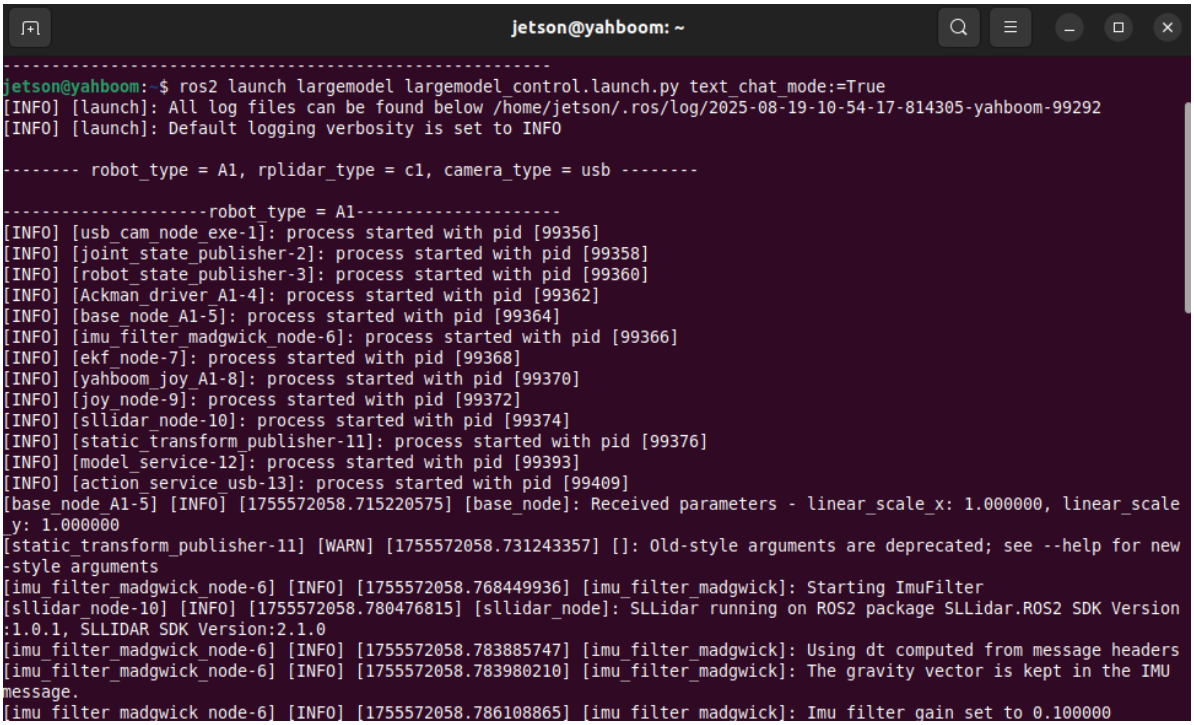
3. Running the Example

3.1 Starting the Program

For Raspberry Pi PI5 and jetson nano, you need to enter the Docker container first. For RDKX5 and Orin main controllers, this is not necessary.

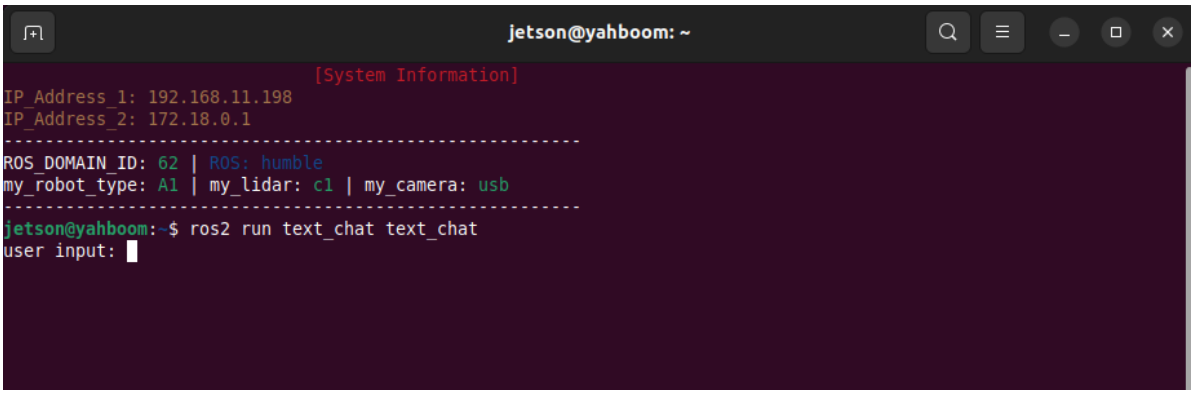
Open a terminal on the vehicle and enter the following command:

```
ros2 launch largemodel largemodel_control.launch.py text_chat_mode:=True
```



Open another terminal and start the program:

```
ros2 run text_chat text_chat
```



3.2 Test Examples

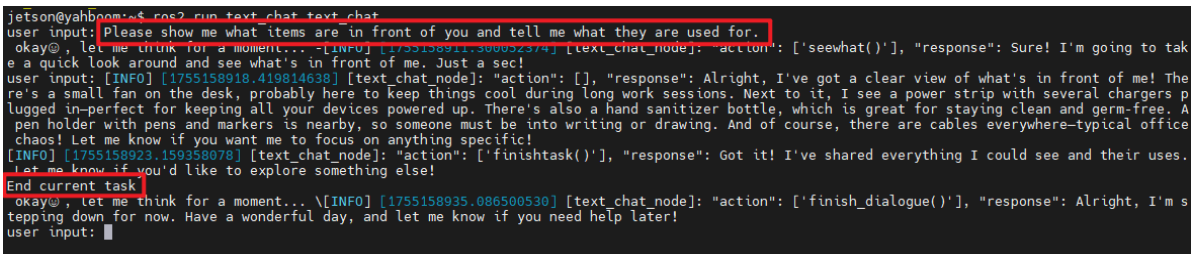
Here are two reference test cases; users can create their own test commands.

- Please show me what items are in front of you and tell me what they are used for.
- Please look in front of you to see if there is a blue cube and a pack of tissues. If yes, nod your head. If not, shake your head.

⚠ Please do not include a period or any other characters at the end of the text you enter!

3.2.1 Example 1

Enter a test case in the text interface. After the model considers the answer, it responds to the user and performs actions according to the user's instructions.

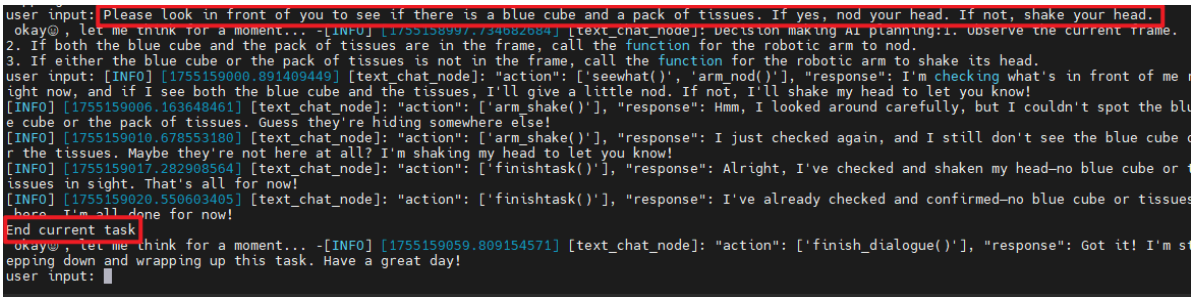


After completing a task, the robot enters a waiting state. Pressing the `ENTER` key allows you to continue the conversation. The command you enter is directly passed to the execution layer model, and all conversation history is retained. We can enter the "End Current Task" command again to end the robot's current task cycle and start a new one.

3.2.2 Example 2

Similar to Example 1, enter Example 2 in the terminal. The model will respond and execute the actions according to the command.

Example 2 uses the gimbal servo USB camera version as an example. Nodding and shaking the head can also be replaced with commands such as moving the robot forward or backward.



4. Source Code Analysis

Source code location:

Jetson Orin Nano:

```
#NUWA camera users
/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_nuwa.py
#USB camera users
/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_usb.py
```

```
/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/model_service.py
```

RDK X5：

```
#NUWA camera users
/home/sunrise/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_nuwa.py
#USB camera users
/home/sunrise/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_usb.py
```

```
/home/sunrise/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/model_service.py
```

Jetson Nano, Raspberry Pi:

You need to first enter Docker.

```
#NUWA camera users
/root/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_
nuwa.py
#USB camera users
/root/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/action_service_
usb.py
```

```
/root/yahboomcar_ros2_ws/yahboomcar_ws/src/largemodel/largemodel/model_service.p
y
```

action_service.py

In the **init_ros_communication** method of the CustomActionServer class, a publisher for the topic "seewhat_handle" is created to publish visual processing signals.

```
# Create a publisher and publish the seewhat_handle topic
self.seewhat_handle_pub = self.create_publisher(String, 'seewhat_handle', 1)
```

- USB Camera，action_service_usb.py

  Created a topic subscriber for /usb_cam/image_raw to receive the color image from the camera

```
#Image Topic Subscribers
self.subscription = self.create_subscription(
    Image, self.image_topic, self.image_callback, 1
)
```

- nuwa depth camera，action_service_nuwa.py

  Created a topic subscriber for /ascamera_hp60c/camera_publisher/rgb0/image to receive the color image from the depth camera

```
#Image Topic Subscribers
self.subscription = self.create_subscription(
    Image, self.image_topic, self.image_callback, 1
)
```

The image_callback callback function continuously subscribes to the depth camera's color image.

When the action server calls the **seewhat** method, it publishes a signal to the seewhat_handle topic, notifying the model server's model_service node to upload an image to the multimodal large model.

```
def seewhat(self):
    self.save_single_image()
    msg = String(data="seewhat")
    self.seewhat_handle_pub.publish(
        msg
    )  # Normalize, publish the seewhat topic, and call the large model by
model_service
```

This will call the **save_single_image** method to save a single image file, image.png.

Image save path:

Jetson Orin Nano, Jetson Orin NX:

```
/home/jetson/yahboomcar_ros2_ws/yahboomcar_ws/install/largemodel/share/largemode
l/resources_file/image.png
```

Jetson Nano and Raspberry Pi need to enter docker first:

```
/root/yahboomcar_ros2_ws/yahboomcar_ws/install/largemodel/share/largemodel/resou
rces_file/image.png
```

```
def image_callback(self, msg):#Image callback function
        self.image_msg = msg

def save_single_image(self):
    """
    保存一张图片 / Save a single image
    """
    if self.image_msg is None:
        self.get_logger().warning("No image received yet.")  # No images
received yet...
        return
    try:
        # 将ROS图像消息转换为OpenCV图像 / Convert ROS image message to OpenCV image
        cv_image = self.bridge.imgmsg_to_cv2(self.image_msg, "bgr8")
        # 保存图片 / Save the image
        cv2.imwrite(self.image_save_path, cv_image)
        display_thread = threading.Thread(target=self.display_saved_image)
        display_thread.start()

    except Exception as e:
        self.get_logger().error(f"Error saving image: {e}")  # Error saving
image...
```

model_service.py

In the **init_ros_communication** method of the LargeModelService class,

a subscriber to the topic "seewhat_handle" is created to receive visual processing signals.

```
#Create a Seehat subscriber
self.seewhat_sub = self.create_subscription(String,'seewhat_handle',
self.seewhat_callback,1)
```

When the seewhat_callback callback function receives the visual processing signal, it calls the **dual_large_model_mode** method, and then calls the **instruction_process** method to request inference and upload an image from the depth camera to the multimodal large model.

```
def seewhat_callback(self, msg):
    if msg.data == "seewhat":
        if (
            self.regional_setting == "China"
        ):  # 在线模型推理方式：决策层推理+执行层监督 / Online model inference method:
Decision layer reasoning + Execution layer supervision
            self.dual_large_model_mode(type="image")
        else:
            self.dual_large_model_international_model(type="image")
```

```
def instruction_process(self, prompt, type, conversation_id=None):
    """
    根据输入信息的类型（文字/图片），构建不同的请求体进行推理，并返回结果）
    Based on the type of input information (text/image), construct different
request bodies for inference and return the result.
    """
    json_str = None
    prompt_seewhat = self.prompt_dict[self.language].get("prompt_2")
    if self.regional_setting == "China":
        if type == "text":
            raw_content = self.model_client.multimodalinfer(prompt)
        elif type == "image":
            raw_content = self.model_client.multimodalinfer(
                prompt_seewhat, image_path=self.image_save_path
            )
        json_str = self.extract_json_content(raw_content)
    elif self.regional_setting == "international":
        if type == "text":
            result = self.model_client.TaskExecution(
                input=prompt,
                map_mapping=self.map_mapping,
                language=self.language_dict[self.language],
                conversation_id=conversation_id,
            )
            if result[0]:
                json_str = self.extract_json_content(result[1])
                self.conversation_id = result[2]
            else:
                self.get_logger().info(f"ERROR:{result[1]}")
        elif type == "image":
            result = self.model_client.TaskExecution(
                input=prompt_seewhat,
                map_mapping=self.map_mapping,
                language=self.language_dict[self.language],
                image_path=self.image_save_path,
                conversation_id=conversation_id,
            )
            if result[0]:
                json_str = self.extract_json_content(result[1])
                self.conversation_id = result[2]
            else:
                self.get_logger().info(f"ERROR:{result[1]}")
```