NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

School of Mechanical and Manufacturing Engineering

Mobile Robotics

ASSIGNMENT# 03

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PROGRAMME	**PhD-RIME**
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1- Identify the robot of your interest in last 3 years paper and write it's functioning algorithm or working principal

TurtleBot 4

Figure 1: TurtleBot 4

The TurtleBot 4 is a ROS 2-based mobile robot intended for education and research. The TurtleBot 4 is capable of mapping the robot's surroundings, navigating autonomously, running AI models on its camera, and more.

It uses a Create® 3 as the base platform, and builds on it with the TurtleBot 4 shell and User Interface (UI) board. Inside the shell sits a Raspberry Pi 4B which runs the TurtleBot 4 software.

Figure 2: Raspberry Pi 4B

The UI Board offers status and user LEDs, user buttons, and a 128x64 user display. Additionally, it exposes 4 USB 3.0 (type C) ports, as well as additional power ports and some Raspberry Pi pins for the user.

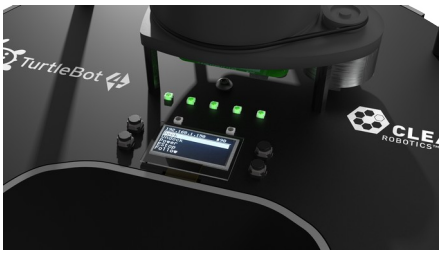

Figure 3: TurtleBot 4 UI Board

On top of the UI board sits a RPLIDAR A1M8 360 degree lidar, and an OAK-D-Pro camera. Above the sensors is the sensor tower, which allows the user to customize their TurtleBot4 with additional sensors or payloads.

TurtleBot 4 Lite

Figure 4: TurtleBot 4 Lite

The TurtleBot 4 Lite is a barebones version of the TurtleBot 4. It has just the necessary components for navigation, mapping, and AI applications. The TurtleBot 4 has the same Raspberry Pi 4B, which sits in the cargo bay of the Create® 3, as well as the same RPLIDAR A1M8. The camera on the TurtleBot 4 Lite is the OAK-D-Lite. Additional sensors and payloads can be attached to the Create® 3 faceplate, or placed inside the cargo bay.

Sensors

RPLIDAR A1M8

Figure 5: RPLIDAR A1M8

The RPLIDAR A1M8 is a 360 degree Laser Range Scanner with a 12m range. It is used to generate a 2D scan of the robots surroundings. Both the TurtleBot 4 and TurtleBot 4 Lite use this sensor.

OAK-D-Lite

Figure 6: OAK-D-Lite

The OAK-D-Lite camera from Luxonis uses a 4K IMX214 colour sensor along with a pair of OV7251 stereo sensors to produce high quality colour and depth images. The on-board Myriad X VPU gives the camera the power to run computer vision applications, object tracking, and run AI models.

OAK-D-Pro

Figure 7: OAK-D-Pro

The OAK-D-Pro offers all of the same features the OAK-D-Lite has, but uses higher resolution OV9282 stereo sensors and adds an IR laser dot projector and an IR illumination LED. This allows the camera to create higher quality depth images, and perform better in low-light environments.

TurtleBot 4 Robot (Functioning Algorithm)

1. The `turtlebot4_robot` metapackage is pre-installed on the TurtleBot 4 Raspberry Pi image.
2. The `turtlebot4_base` package contains the source code for the rclcpp node `turtlebot4_base_node` which runs on the physical robot. This node interfaces with the GPIO lines of the Raspberry Pi which allows it to read the state of the buttons, as well as write to the LEDs and display.
3. **GPIO Interface:** The TurtleBot 4 uses *libgpiod* to interface with the GPIO lines of the Raspberry Pi. The `gpiochip0` device represents the 40-pin header of the Raspberry Pi and is used for reading and writing to these pins.

4. **I2C Interface:** The linux I2C drivers are used to read and write data on the I2C buses of the Raspberry Pi. The display's SSD1306 driver is connected to the `i2c-3` device by default, but other buses are available too.
5. **SSD1306:** The SSD1306 is a driver for OLED displays. It receives commands over a communication bus (I2C for the TurtleBot 4) and controls how the physical display behaves. The TurtleBot 4 uses a modified version of this STM32 SSD1306 driver to write pixels, shapes and characters to the display.
6. **Configuration:** The `turtlebot4_base_node` pin definitions can be set with ROS parameters.