



The Home-Environment Technological-Agent (Theta)

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Introduction

The Home - Environment Technological - Agent (Theta) is an autonomous service robot adapted to address domestic tasks. This innovative robot is built upon a modified wheelchair provided by Freedom, combining the domains of service robotics and autonomous wheelchairs.

To meet the challenges of the LARC/CBR competition, Theta is equipped with sensors and processing devices. The YDLIDAR X4 and rotary encoders enable localization and mapping, while a Microsoft Kinect facilitates computer vision-related tasks by providing RGB and Depth information. Human-Robot Interaction (HRI) is accomplished through a voice interaction utilizing a microphone and a speaker, and feedback expressed through facial emotions.

Theta Robot Specifications:

Processing Device: Theta uses a computer running Ubuntu 20.04 and ROS Noetic. ROS provides essential features like message-passing, language independence, and modularity for the development of interconnected robot modules.

Robot Control and Odometry: Theta's base frame, originally a modified wheelchair, features motorized rear wheels for odometry and swivel front wheels for stability. Control is achieved through a joystick, and the computer communicates with the wheelchair frame via ROS topics and an ESP32 microcontroller. Odometry is determined using Hall effect sensors and published as ROS topics, allowing for integrated navigation and future adaptability.

Robot Vision

Follow Me: Theta achieves person tracking by integrating OpenNI and Nite with ROS. OpenNI serves as middleware for the Kinect Sensor, while Nite is accessed through the `openni_tracker` package in ROS, providing transforms for the user's skeleton joints.

Face Detection: Theta uses python's `face_recognition` package to enable face detection skills. It requires a single photo of the operator to be taken after recognizing him.

Object Detection: The latest neural network model used by Theta to recognize object is YOLOv8.

Human-Robot Interaction

Affective Loop: Theta has a set of animated facial expressions to indicate emotional states or to inform the user of Theta's current status. These facial expressions follow an Affective Loop.



Speech Recognition and Synthesis: Theta uses `whisper` to convert speech to text, `coqui` to convert text to speech, and `porcupine` to understand a wake word.

Conclusion

The Home - Environment Technological - Agent (Theta) is a service robot developed by the UFPel PinguimBots @Home team in collaboration with Freedom. Future improvements for Theta include redesigning the robot frame to address current flaws, adding a manipulator and additional sensors, and enhancing Human-Robot Interaction (HRI). The team aims to extend their research to autonomous wheelchairs that can navigate independently and provide assistance in domestic environments.;

A. Hardware

- The base consists on a modified wheelchair manufactured by Freedom.
- A pair of rotary encoders made from hall effect sensors.
- A Kinect camera.
- A YDLIDAR.
- A ESP 32 which communicates the rotary encoders to the computer and the latter to the joystick controller.
- A monitor, a microphone and a speaker to perform HRI.
- A computer with an Ryzen 9 processor and 32 GB of RAM.
- A Failsafe Button that cuts the power off from the motors and activate the breaks.

B. Software

- Ubuntu 20.04 running ROS noetic Noemia.
- OpenCV, `face_recognition` and YOLOv8 for image recognition tasks.
- ROS Navigation Stack.
- `Whisper`, `Coqui` and `Porcupine` for Speech Recognition tasks.
- OpenNI and Nite to perform skeleton tracking.

