Simulation-Based Engineering Lab
University of Wisconsin-Madison

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ART WALL-E

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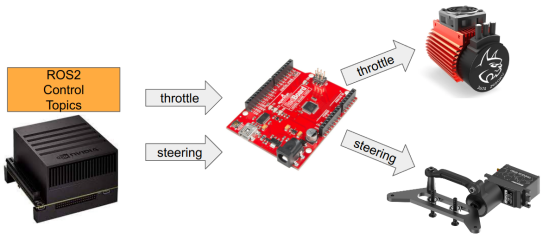
1 Vehicle Platform and Sensors

Our Autonomy Research Testbed (ART) vehicle, shown in Fig. 1a, called WALL-E is equipped with a Jetson AGX Xavier for on-board computing, and on-board sensors include a 4D LiDAR, a IMU, and a two cameras for a stereo camera setup.

(a) ART-Oak



(b) PowerTrain Diagram

Figure 1

1.1 Vehicle Powering System

The vehicle powertrain system includes a 7.4V battery, a brushless motor (charge throttle), a servo (charge steering), and an Arduino board (as an intermediate control step between ROS2 topic and servo and motor). The Fig. 1b explains the powertrain system workflow for ART-WALL-E.

1.2 Nvidia Jetson AGX Xavier

We use a Nvidia Jetson AGX Xavier, as shown in Fig. 2a, that consists of a CPU having 8 cores and 16 GB RAM at 2.2 GHz. The Jetson runs Ubuntu 20.04 and storage is 1TB. It also hosts a Volta GPU with 512 Cuda cores and 16 GB of global memory.

1.3 Unitree 4D LiDAR L1

The Unitree 4d LiDAR L1 sensor, as shown in Fig. 2b, is a low cost and compact LiDAR sensor that is capable of omnidirectional ultra-wide angle scanning which can be used to perform obstacle avoidance, navigation, and slam for robotics applications. Some technical spefications include: (1) 360°x 90°; (2) measuring radius: 30m at 90% reflectivity; (3) Effective frequency: 21600 points/s; (4) Near blind spot 0.05m.

(a) Jetson AGX Xavier

(b) Unitree Lidar 4D L1

Figure 2

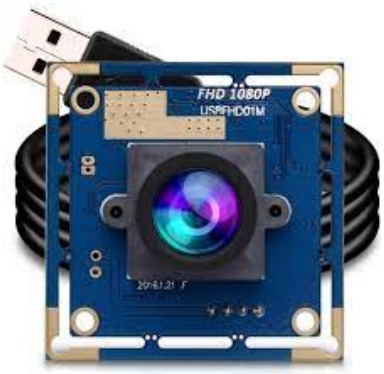
1.4 Flir Back Fly S x2

We use two FLIR Blackfly S camera sensors, as shown in Fig. 3a, paired with two Arducam C-Mount lenses, one offering a 5mm focal length and the other a 16mm focal length. The camera has a maximum frame rate of 55 FPS. The camera is 3.2 megapixels, and the outputted images have a resolution of 2048 x 1536.

1.5 ELP USB Camera

We use a ELP Megapixel USB Camera with 2.1mm lens, as shown in Fig. 3b. The camera has a high frame rate MJPEG 120fps@640(H) x 480(V), 60fps@1280(H) x 720(V), 30fps@1920(H) x 1080(V). It has a 2 megapixel high pixel technology for sharp image and accurate color reproduction and a 2.1mm HD wide angle lens for wide view range.

(a) Flir Back Fly S



(b) ELP USB Camera

Figure 3

1.6 Wheeltec IMU

The WHEELTEC N100 IMU Module, as shown in Fig. 4, is a versatile, high-precision attitude sensor tailored for ROS robots, offering dynamic angle accuracy of 0.1° RMS and a high output frequency of up to 400Hz. It supports robust data exchange with a Type-C USB interface and is designed for durability, withstanding 10,000 plug cycles. With pitch/roll accuracy of 0.05° RMS statically and 0.1° RMS dynamically, and heading accuracy assisted by magnetometers at 0.5° RMS, it's ideal for precise navigation tasks.

Figure 4: Wheeltec N-100 IMU