Proof-of-Concept Design: Autonomous Mobile Robot (AMR) with Accurate Indoor Positioning and Navigation

Precise positioning data is essential for localization and mapping, allowing autonomous robots to operate safely and to create accurate representations of their surroundings. This information is crucial for collision avoidance, as robots can dynamically adjust their trajectory based on their precise position. Accurate positioning also ensures reliable task execution, enabling robots to perform tasks, such as item picking or delivery, with precision. Modern robot position technology uses multiple sensors to achieve higher accuracy.

To address this requirement, Arrow and eInfochips have used in their AMR prototype an Analog Devices' Time of Flight (ToF) sensor (ADTF3175 module), AMR leveraging the NVIDIA Orin Kit, and IMUs (ADIS16470 IMU). eInfochips revised Sensor Fusion algorithms that fuse data from wheel encoders and IMU to enhance AMR localization and adapted ToF sensor data for occpancy map generation. These algorithms are compatible with both RTAB-Map and NVIDIA navigation stacks, enabling customers to expedite the time-to-market for their AMR products.

This proof-of-concept AMR can be used as a starting point for mobile robot design for use in laboratories, industry, warehousing and logistics, transportation, shopping, and entertainment applications.

Proof-of-Concept Design: Autonomous Mobile Robot (AMR)

In Partnership with:

ANALOG DEVICES
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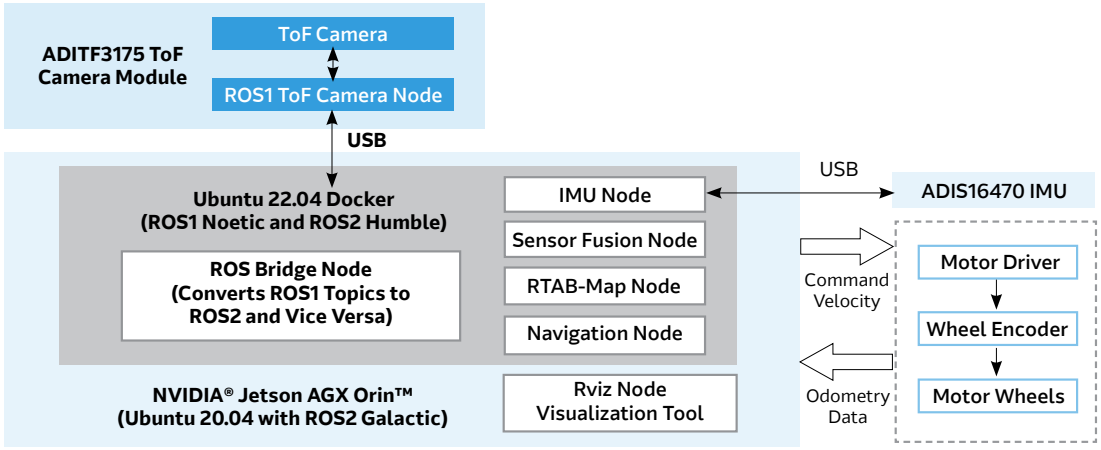
Enable Accurate Indoor Positioning and Navigation with ToF and IMU Sensors

- ToF sensors can be used to measure the distances between the sensor and surrounding objects or landmarks. By creating a map of these distances, it is possible to determine the position of a user or device within the indoor space.
- IMUs consist of accelerometers, gyroscopes, and magnetometers that measure the device's linear acceleration, rotational rate, and magnetic field, respectively. By integrating the data from these sensors, the device's position, velocity, and orientation can be estimated over time.
- **When combined, ToF and IMU technologies can complement each other to improve the accuracy and robustness of indoor navigation systems. ToF provides accurate distance measurements to anchor points or landmarks, while IMUs help track the device's movement and estimate its position and orientation relative to the surroundings.**

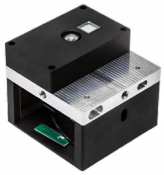
The AMR navigation system, illustrated in the diagram below, employs sensor integration of Time of Flight (ToF) and Inertial Measurement Unit (IMU) technologies. The software stack is built on the Robot Operating System (ROS2) framework.

The core processing unit is NVIDIA's AGX Orin kit, which runs all the ROS2 Humble nodes through docker and controls the AMR's motion. External sensors, namely EVAL-ADTF3175D-NXZ and ADIS16470, are connected to the AGX Orin. The EVAL-ADTF3175D-NXZ incorporates an I.MX8 embedded board that includes sensor drivers and ROS node packages. It establishes a USB connection with the AGX Orin and publishes all topics in ROS1 format.



AMR Navigation System Diagram

ADTF3175 Time of Flight Evaluation Kit



EVAL-ADTF3175

Features

- **Resolution:** 1024 × 1024 ToF sensor
- **Illumination:** FOI 81° x 81° - 940 nm VCSEL
- **Field of view (FOV):** 75° x 75°
- **Operating range:** 0.4 to 4 m @ 15% reflectance (native)
- **Depth Noise:** <15 mm
- **Accuracy:** ±3 mm depth error

ADIS16470 Inertial Measurement Unit (IMU)

ADIS16470/PCBZ
ADIS16470

Features

- Triaxial, digital gyroscope, ±2000°/sec dynamic range
- Triaxial, digital accelerometer dynamic range: ±40 g
- Factory calibrated sensitivity, bias, and axial alignment
- Programmable operation and control

NVIDIA® Jetson AGX Orin™ Development Kit

Features

- Up to 275 TOPS and 8X performance boost with high-speed sensor support
- Features NVIDIA Ampere Architecture GPU, 12-core Arm® Cortex®-A78AE CPU, and next-gen accelerators
- High-speed I/O, 204.8 GB/s memory bandwidth, and 32 GB of DRAM for concurrent AI pipelines

Online
www.github.com/ArrowElectronics/Robotics_AMR/wiki

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