Upgrade Of Jackal UGV Robot To A Jetson AGX Computer

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Introduction

We utilized a Jackal unmanned ground vehicle robot to learn about the different capabilities that the ROS software program enables such as:

- Machine Learning
- Autonomous Driving
- Computer Visualization

Upgraded the single onboard computer on the robot to optimize capabilities.

Additionally:

- We initiated the software programming for installation of a GPS system on the robot.
- Began process for visualization via laser scanner onboard the Jackal.

Figure 1: Jackal Unmanned Ground Vehicle (UGV) Robot from Clearpath Robotics

Equipment

1. Jetson TX2 Single Onboard Computer
2. Jetson AGX Single Onboard Computer
3. Clearpath™ Jackal UGV Robot
4. NovAtel GPS System
5. Velodyne Lidar Puck High-Res Sensor

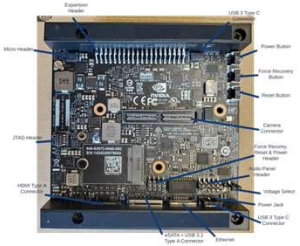


Figure 3: Jetson AGX Xavier single board computer is the upgraded computer implemented in the Jackal for optimization of the AI capabilities of the robot.

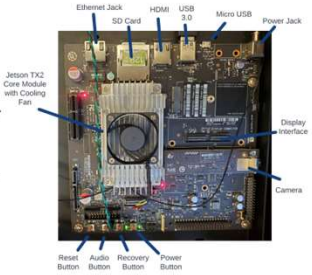


Figure 2: Jetson TX2 single onboard computer is the second computer installed in the Jackal. Most of the software learning that is required to operate the computer took place with this device.

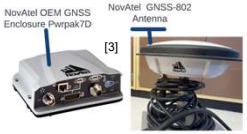


Figure 4: NovAtel GPS System consisting of a Global Navigation Satellite System or GNSS receiver (the antenna on the right) and an enclosure that delivers scalable GNSS with internal storage and inertial navigation system options (on the left).

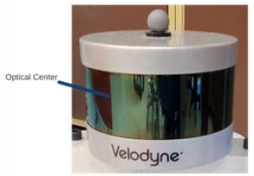


Figure 5: Velodyne Lidar Puck High-Res sensor is a 3D light detection and ranging sensor that uses lasers to ping off objects and return to the source of the laser.

Software

Downloading and installing software was necessary for communication with the Jackal. This mainly involved utilizing two operating systems (OS):

1. Linux Ubuntu 18.04 Operating System
2. Robot Operating System (ROS)
   - Melodic Distribution

[4]

Process

Learning Linux OS:

- To utilize the desktop in the lab it was necessary to learn how to Understand and use Shell Script, which is a coding language mainly utilized in the terminal window of the system.

1. Updating the desktop's OS to Ubuntu 18.04 which works optimally with the ROS Melodic distribution.
2. Understanding how to use the Command Line Interface (CLI) to facilitate operating ROS
3. Downloading and installing ROS into the OS to utilize and access it

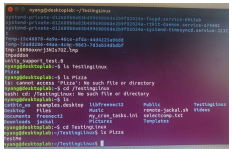


Figure 6: Learning to use the CLI terminal like creating directories in Ubuntu.

Learning ROS:

- To communicate with the Jackal, we would have to use the Robot Operating System which is mainly written in C++ and Python. It is also equipped with many compatible programs and utilities that enable functions for the robot such as mapping and visualization:

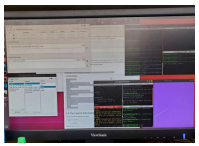


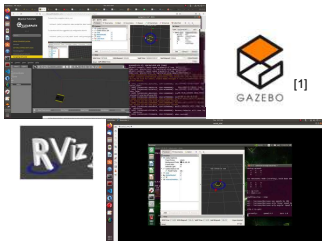
Figure 7: Learning to use ROS software with simulations.

1. Updated ROS to the Melodic distribution with guidance from Clearpath™ Robotics Jackal documentation
2. Installed and launched the Gazebo simulation program
3. Installed & launched the RVIZ visualization interface compatible with Gazebo

Driving the Jackal:

- To drive the Jackal, we followed steps to gradually progress in the way that we were seeing and enabling mobility on the robot.

1. Driving via a Bluetooth connection between the robot and a PS4 controller
2. Driving remotely via RVIZ using a USB connection to the PS4 controller
3. Driving remotely via RVIZ using the interactive markers and a Virtual Network Connection (VNC) to the Jackal
4. Driving remotely via RVIZ using the keyboard of the desktop and VNC to the Jackal



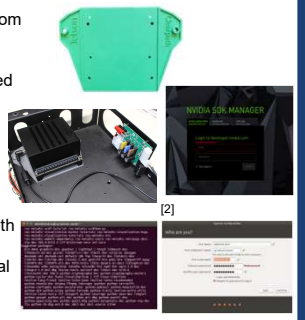
[1]

Figure 8: Using the visualization & simulation programs RVIZ and Gazebo, respectively.

Swapping the Jetson Computers:

- This process allowed us to increase the AI capabilities of the Jackal by switching the Jetson TX2 to the Jetson AGX Xavier:

1. Removed the Jetson TX2 computer from the chassis of the robot
2. Mounted the Jetson AGX Xavier computer on chassis using a 3D printed mounting bracket and powered it
3. Installed the software:
   - Downloaded latest version of Nvidia's SDK Manager
   - Wrote the OS to the Xavier and configured it for use with the Jackal
4. Connected PS4 controller via Bluetooth
5. Set up the host PC:
   - Installed ROS Melodic & the Jackal packages
   - Connected the Xavier to the host computer via a wireless network connection
   - Re-installed Gazebo, RVIZ, Velodyne, Gmapping, and GPS packages on PC



[2]

Figure 9: Steps in the installation of the Jetson AGX Xavier single onboard computer onto the Jackal.

Programming the Velodyne & Novatel Systems:

- Began process of installing and uploading drivers for the GPS system onboard the Jackal*
- Installed and updated software and drivers for the Lidar sensor*

* Both processes to be tested by future developer of the Jackal

Figure 10: Download of Lidar sensor updates (left) and installation of GPS system drivers (right).

Results & Future Work

Given a few more months we are confident we could validate the system.

- Further Applications:

1. Refer to introduction
2. Implementation of these systems in rovers (such as the Mars Curiosity) & other UGV's
3. 3D mapping

Acknowledgements

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- Thank you to my PI, Dr. Martin Barczyk, and the members of the Mechatronics Systems Control Lab
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Citations:

[1] Generation Robots. Gazebo Logo. [accessed 2022 Aug 8]. https://www.generationrobots.com/blog/en/robotic-simulation-scenarios-with-gazebo-and-ros/.

[2] Clearpath Robotics. 2015. Jetson AGX Installation. [accessed 2022 Aug 8]. https://www.clearpathrobotics.com/assets/guides/melodic/jackal/jetson_xavier.html.

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