JetBot: An Autonomous Vehicle for Minicity

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https://github.com/subhashchandra001/ou-ai-sp24

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1. Introduction

The culmination of our final project endeavors to harness the power of machine learning and computer vision to empower a JetBot in navigating a MiniCity course. Situated amidst this simulated urban environment lies a gas station flanked by two distinct lanes, with a dotted white line demarcating their boundary.

Our approach centered on the construction of a comprehensive and diverse dataset, laying the foundation for our exploration. To identify the optimal architecture for this task, we conducted a thorough evaluation of several pre-built models available in PyTorch. Our analysis includes the renowned ResNet18 model, alongside the MobileNet and GoogleNet models.

2. Software Setup

- Download Pre-built Image: Obtain the JetBot SD card image corresponding to your Jetson Nano model from the provided table.
- Flash Image onto SD Card: Use Etcher to flash the downloaded image onto the SD card inserted into your desktop machine.
- Boot Jetson Nano: Insert the flashed SD card into your Jetson Nano, connect peripherals, and power it on.
- Connect to WiFi: Log in to the Jetson Nano using the provided credentials, then connect to a WiFi network via the command line.
- Access JetBot Interface: Once connected to WiFi, shut down the JetBot, unplug peripherals, power it via a USB battery pack, and access the JetBot interface from your laptop's web browser.
- Sign In and Begin: Sign in to the JetBot interface using the provided password, enabling seamless control and interaction.

3. Data Collection and Training

Data Collection:

- Connect to JetBot via http://<jetbot_ip_address>:8888.
- Sign in with default password.
- Navigate to ~/Notebooks/road_following/ and open data_collection.ipynb to collect image regression dataset.

Neural Network Training:

- Option 1 - Train on Jetson Nano:
  - Connect to JetBot via http://<jetbot_ip_address>:8888.
  - Sign in and navigate to ~/Notebooks/road_following/.
  - Open train_model.ipynb and follow instructions.
- Option 2 - Train on Other GPU Machine:
  - Connect to GPU machine with PyTorch and Jupyter Lab.
  - Upload road following avoidance training notebook.
  - Open train_model.ipynb and proceed with training.

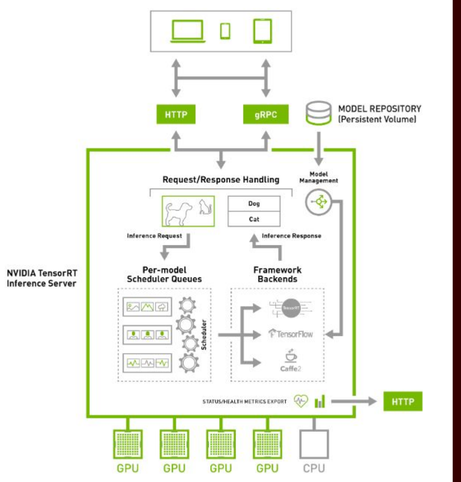
Model Optimization on Jetson Nano:

- Connect to JetBot via https://<jetbot_ip_address>:8888.
- Sign in and navigate to ~/Notebooks/road_following/.
- Open live_demo_build_trt.ipynb and optimize model with TensorRT.

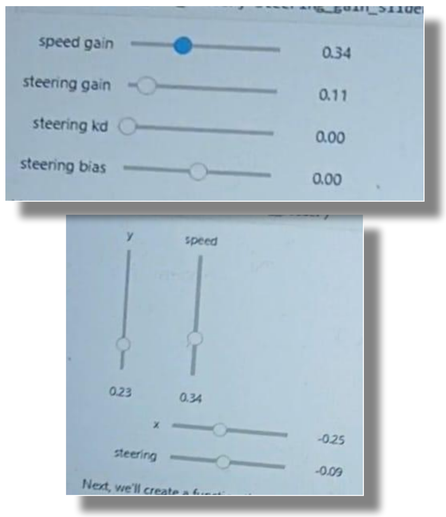
Live Demo on JetBot:

- Connect to JetBot via http://<jetbot_ip_address>:8888.
- Sign in and navigate to ~/Notebooks/road_following/.
- Open live_demo_trt.ipynb to run the optimized model and demonstrate live performance.

3.TensorRT Model



5. Livo Demo



6. Future Work

- Expand training data to include more diverse scenarios and environments
  - Varied lighting conditions (low light, glare, shadows)
  - Different road surfaces (gravel, dirt, uneven terrain)
  - Obstacles and dynamic objects (pedestrians, animals, moving vehicles)
- Enhance perception capabilities
  - Integrate additional sensors (LIDAR, radar) for better object detection and mapping
  - Improve object classification and tracking algorithms
- Develop advanced navigation and control strategies
  - Implement path planning and obstacle avoidance algorithms
  - Explore reinforcement learning techniques for autonomous navigation
- Conduct extensive real-world testing and validation
  - Test on actual roads and highways with varying traffic conditions
  - Evaluate performance in different weather conditions (rain, snow, fog)
  - Assess safety and robustness in edge cases and failure modes
- Collaborate with industry partners and research institutions
  - Leverage expertise and resources from automotive and technology companies
  - Participate in autonomous vehicle competitions and challenges
- Explore ethical considerations and societal impacts
  - Develop guidelines and frameworks for safe and responsible AI systems
  - Study the potential effects on transportation, urban planning, and society