Summer Internship Project

On

Driverless Small Scale Vehicle Based on Open Source Donkey Car Platform

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Certificate

This is to certify that the dissertation titled "***Driverless Small Scale Vehicle Based on Open Source Donkey Car Platform***" submitted by ***Mr. Sarthak J Shetty [1RV15ME095]*** in partial fulfillment of the requirements for the award of degree of ***Bachelor of Engineering*** in ***Mechanical Engineering*** of **R.V College of Engineering, Bangalore,** is a bonafide of the work carried out by him under my guidance and supervision during the stipulated internship period.

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Autonomous Vehicles

What are Autonomous Vehicles?

- An autonomous car (also known as a driverless car, auto, self-driving car, robotic car) is a vehicle that is capable of sensing its environment and navigating without human input.

- Many such vehicles are being developed, but as of May 2017 automated cars permitted on public roads are not yet fully autonomous.

- They all require a human driver at the wheel who is ready at a moment's notice to take control of the vehicle.

How do Autonomous Vehicles work?

- Autonomous cars use a variety of techniques to detect their surroundings, such as radar, laser light, GPS, odometry, and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage.

- Autonomous cars have control systems that are capable of analyzing sensory data to distinguish between different cars on the road, which is very useful in planning a path to the desired destination.

Advantages of Autonomous Vehicles:

- Among the potential benefits of autonomous cars is a significant reduction in traffic collisions; the resulting injuries; and related costs, including a lower need for insurance

- Autonomous cars are also predicted to offer major increases in traffic flow; enhanced mobility for children, the elderly, disabled and poor people; the relief of travellers from driving and navigation chores; lower fuel consumption; significantly reduced needs for parking space in cities; a reduction in crime; and the facilitation of different business models for mobility as a service, especially those involved in the sharing economy.

Donkey Car Platform

Donkey is minimalist and modular self-driving library written in Python. It is developed for hobbyists with a focus on allowing fast experimentation and easy community contributions.

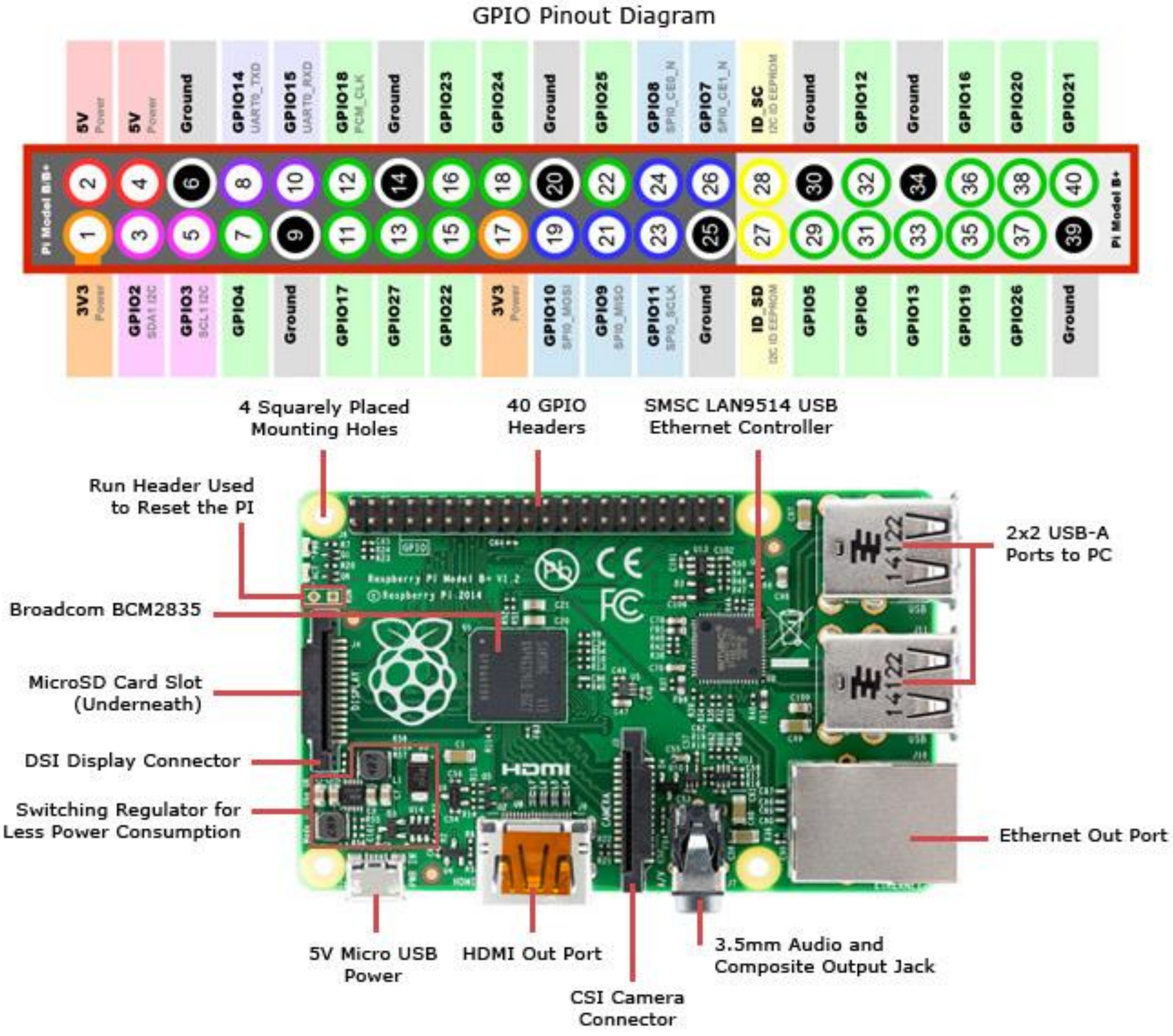
FEATURES:

- Data logging of image, steering angle, & throttle outputs.
- Wi-Fi car controls (a virtual joystick).
- Community contributed driving data and autopilots.
- Hardware CAD designs for optional upgrades.

GOALS OF THE DONKEY PLATFORM:

- Make an RC car drive its self.
- Compete in self driving races like DIY Robocars
- Use existing autopilots to drive your car.
- Use community datasets to create, improve and test autopilots that other people can use.

Instructions to implement the Donkey platform:



Step 0: Set Up the Pi:

- The Adafruit Motor HAT is inserted on the GPIO Pins as shown in the diagram above, in such a way that the HDMI slot on the Pi aligns with the slot provided on the HAT.

- There are four cables emerging from the motors below the chassis of the bot. These cables are inserted to the slots labelled M1 and M2 respectively for Left and Right Motors.

- The HAT has to be separately powered using a LiPo. The power has to be in the range of 5-12V to prevent damage to the hat.

- The HAT has to be inserted while the Raspberry Pi is disconnected from the power source, in order to avoid shorting of the board.

Step 1: Get Raspberry Pi Running

1. Download zipped disk image. https://s3.amazonaws.com/donkey_resources/donkey.img.zip (2.5GB). This disk image includes all the installed libraries (Tensor Flow, OpenCV, Pi Camera) and the folder structure to start saving images and models. See the FAQ for instructions to install the required packages manually.

2. Unzip the disk image (8GB).

3. Insert your sd card into your computer.

4. Use a disk creator utility to create a disk image.
   a. Ubuntu - Startup Disk Creator
   b. Windows
   c. Mac

5. Eject SD card from your computer and put it in the Raspberry Pi.

6. Plug your raspberry to a monitor, keyboard and mouse
7. Turn on your Raspberry Pi by plugging in the battery.

8. Run “git pull origin master” to ensure you have the latest changes

9. Connect to Wi-Fi.

Step 2: Start a Pilot Server

A Donkey vehicle uses a separately hosted web server to route communications and perform autopilot calculations. To begin driving your vehicle from your phone you need to first start a donkey control server on your laptop or an remote server.

Use Virtual Environment (Tested on Ubuntu Linux):

1. git clone http://github.com/wroscoe/donkey.git
2. virtualenv -p python3 donkey_env
3. source donkey_env/bin/activate
4. pip install -e donkey[server]
5. cd donkey
6. python scripts/setup.py
7. python scripts/serve.py

Now you can go to localhost:8887 in your browser to view the web interface.

Drive the vehicle

Connect to the Pi via SSH:

You can't have the Raspberry Pi attached to the monitor while you drive so first we must connect to the Pi remotely via ssh. The we'll simply start the drive loop and the Pi will start requesting directions from the server. Here are the steps.

1. Find your Raspberry Pi IP address. Assuming your Raspberry Pi is connected to the same local network as your computer, you can find the ip address of your Pi by running this command on your computer.

   ```
   Python scripts/find_car.py
   ```

2. SSH into your Raspberry Pi using:

   ```
   ssh pi@<your raspberry pi ip address>
   ```

<u>Activate the virtual environment:</u>

1. `cd donkey`

2. `source env/bin/activate`

<u>Start the Vehicle:</u>

1. Connect your car to the server.

   ```
   python scripts/drive.py --remote http://<your server ip>:8887
   ```

2. Turn on the power to your car. You should first see the ESC blink red, then hear a beep indicating that the ESC has been calibrated.

<u>Collect training data:</u>

1. Go to **localhost:8887** in your web browser.

2. Go to the vehicles tab and select "mycar".

3. To start driving your car using the virtual joystick.

Train an autopilot

- Run the code virtualenv –p python3 donkey_env and then source dpnkey_env/bin/activate. Following that run this code, with the sessions name from the mydonkey

  ```
  python scripts/train.py --sessions <your session name(s)> --name <name your autopilot>
  ```

- If training exits quickly with the message “Killed” on a large training data set, try increasing the amount of memory allocated to Docker.

- Now when you refresh your control screen you’ll see the autopilot in your pilot dropdown.

- Select your pilot.

- Increase your throttle to see how the pilot steers

Scope for Further Development:

- The default vehicle setup uses a web server hosted on the Pi to control the car. A model can be developed wherein the server can be hosted on the car instead of a remote server such as a laptop.

- The Donkey architecture is modular. Vehicles are now initialized by adding “parts” to the vehicle similarly to the way you add layers to Keras models. This makes it easier to add new sensors, autopilots and actuators.

- Computer vision autopilots are a “part” that can be added to vehicles to replace or supplement the Keras Behavioural Cloning autopilots.

- Modular approach to the development of the vehicle will aid in the debugging and development of the vehicular platform.

- The Git Repository has several bugs which have to be debugged and tested over and over again so that most of the errors can be worked out through trial and error.

- A video of the working DonkeyCar can be found here.