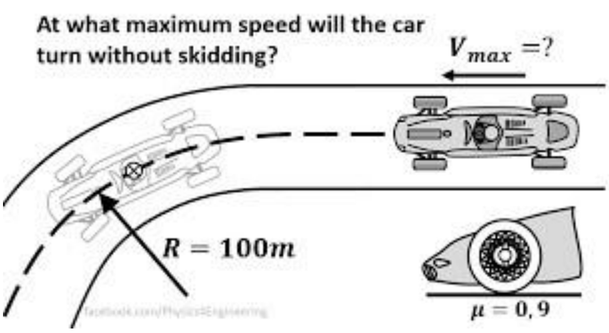
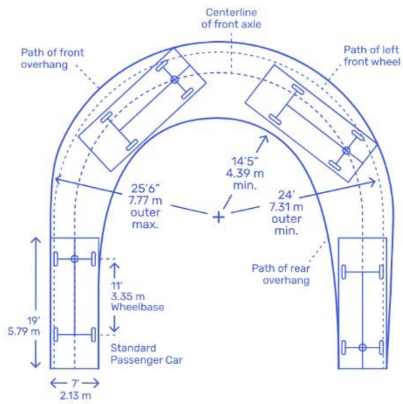
Tasks for CAV development:

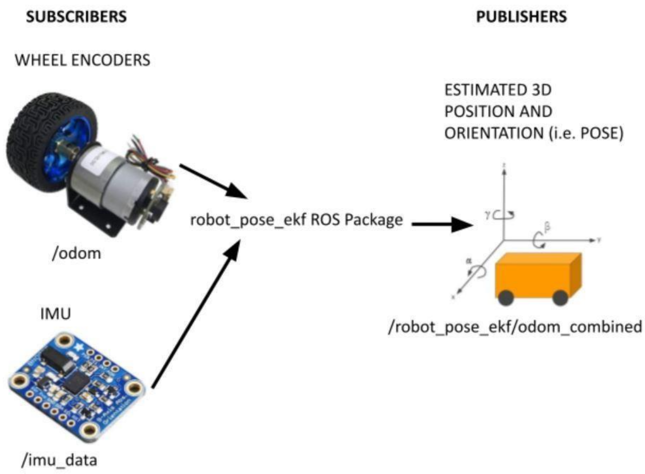
Vehicle dynamics and control

1. **Limitations with respect to motion and its ability to control its positioning.** During operation, limitations on the CAV performance should be imposed to ensure safe travel within the bounds of the road. This includes corning speeds to limit potential under/oversteer and provisions for ensuring safe stopping distances.

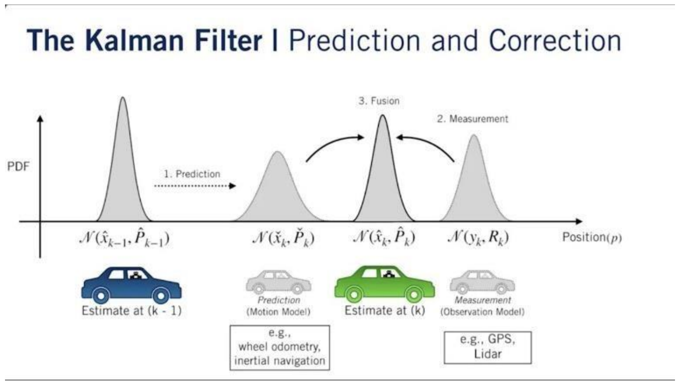




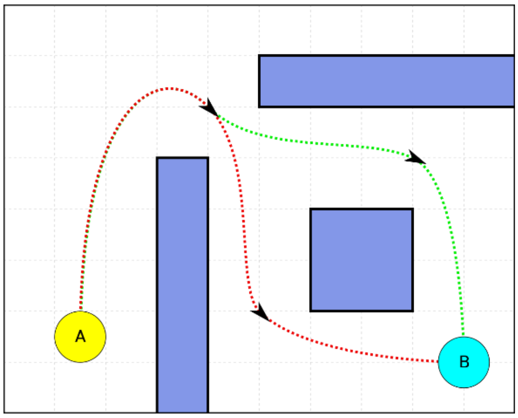
2. **Integration of motion based IMUs which will feed back real time positional data.** These sensors enable the car to understand its position relative to the surroundings and predict future states based on current dynamics. The integration of detailed maps, GPS data, and sensory inputs will enhance its navigation capabilities, leading to more efficient and safer travel routes.



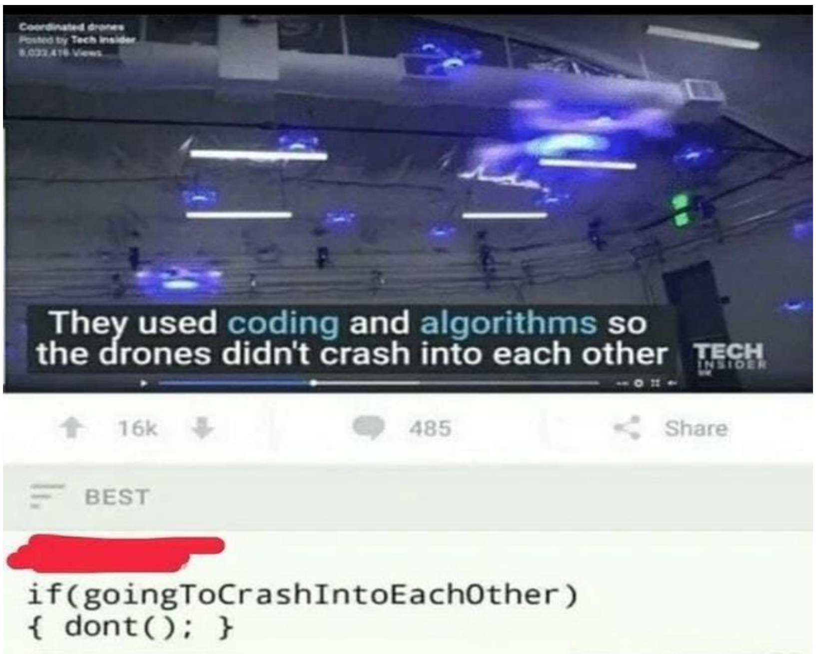
3. **The dynamic behaviour of the vehicle should be modelled to provide real physical impacts of the vehicle on the environment spatially.** Sensor data collected through multiple avenues should be used to construct a sense of understanding of the cars state. The data collected will be normalised as to predict the location, direction, and motion of the car through the environment.



4. **Creating reliable modelling coupled with state space awareness.** This will give the vehicle a sense of localisation and its ability to navigate through the world. Allowing the car project and predict its state is vital for pathfinding and navigation exercises.



5. **The feedback of environmental conditions.** Though the use of the sensors and optics must be incorporated as to allow the car to perceive obstacles. This will provide real world implementations of varying road conditions into the cars dynamics for collision avoidance and traversing the roadways.

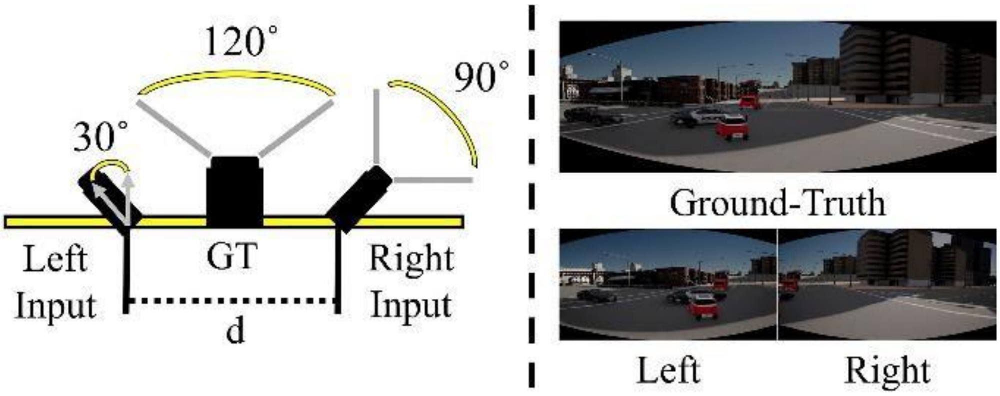


Object Object-Lane Detection and Environment Building-Sampling

1. **Select and train an object detection model such as YOLO, SSD, or Faster R-CNN suitable for real-time applications.** This step requires setting up a pipeline that captures data from all on-board cameras, processes this data through the object detection model, and translates the results into actionable information. The system must efficiently differentiate between static and moving objects to make informed decisions.

2. **Collect and annotate dataset with images from the vehicle's perspective, including various objects like cars, pedestrians, and traffic signs-lights.** The CNN based computer vision model will require tuning and training to suit the needs of this project. There are multiple available online traffic and road related data sets which can provide the volumes and quality of training data what will be required for the training of the CNN model for object, lane and on road features.

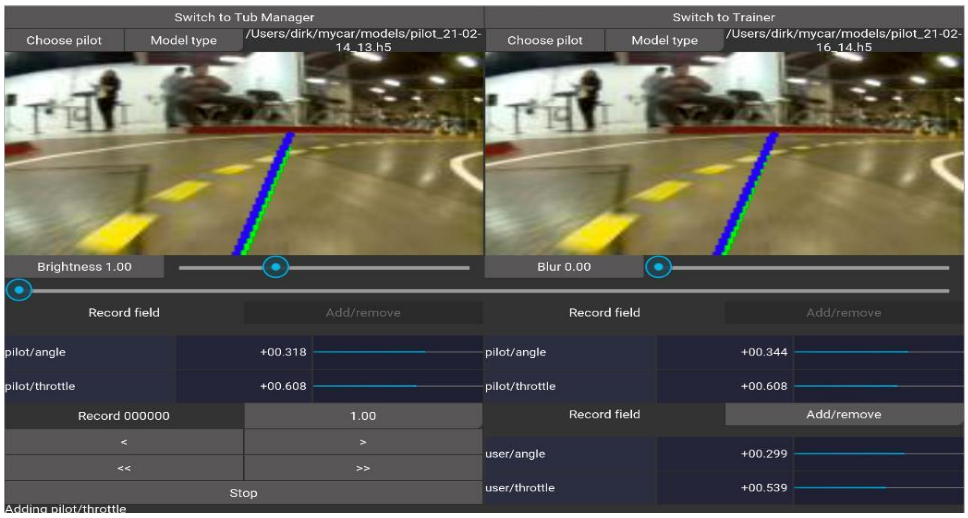
3. **Integrate the trained model into the CAVs system to process the multi camera feed in real-time and identify objects around the vehicle.** Optical sensors are by far becoming the most prevalent means of autonomous navigation. The use of multiple cameras which are calibrated to create panoramic views by stitching frames together will allow for the car to have a larger undistorted view of its environment.



4. **Implement post-processing steps to filter and prioritize detected objects.** This process is based on their relevance and threat level to the CAV. Not all detected objects pose the same level of threat to the vehicle's/road users' safety. The system should classify objects based on their potential impact on the vehicle's trajectory and implement decision-making protocols to address immediate threats.

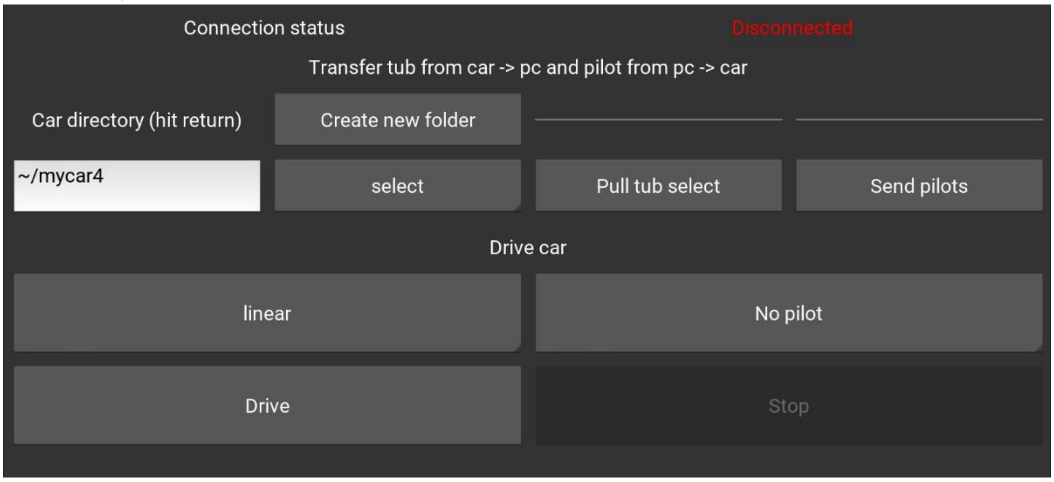
Integration, Simulated Environment, and dashboard

1. **Dashboard and GUI.** The car will require user access and verification of its processes and perception for debugging and tuning. This creates a requirement for a convenient way to 'peak under the hood' of the CAVs operation. This emphasizes the necessity for a secure, user-friendly interface that allows developers and testers to access internal system metrics, logs, and operational statuses. By providing this level of access, teams can identify and rectify issues more efficiently, leading to a more robust and reliable CAV system.

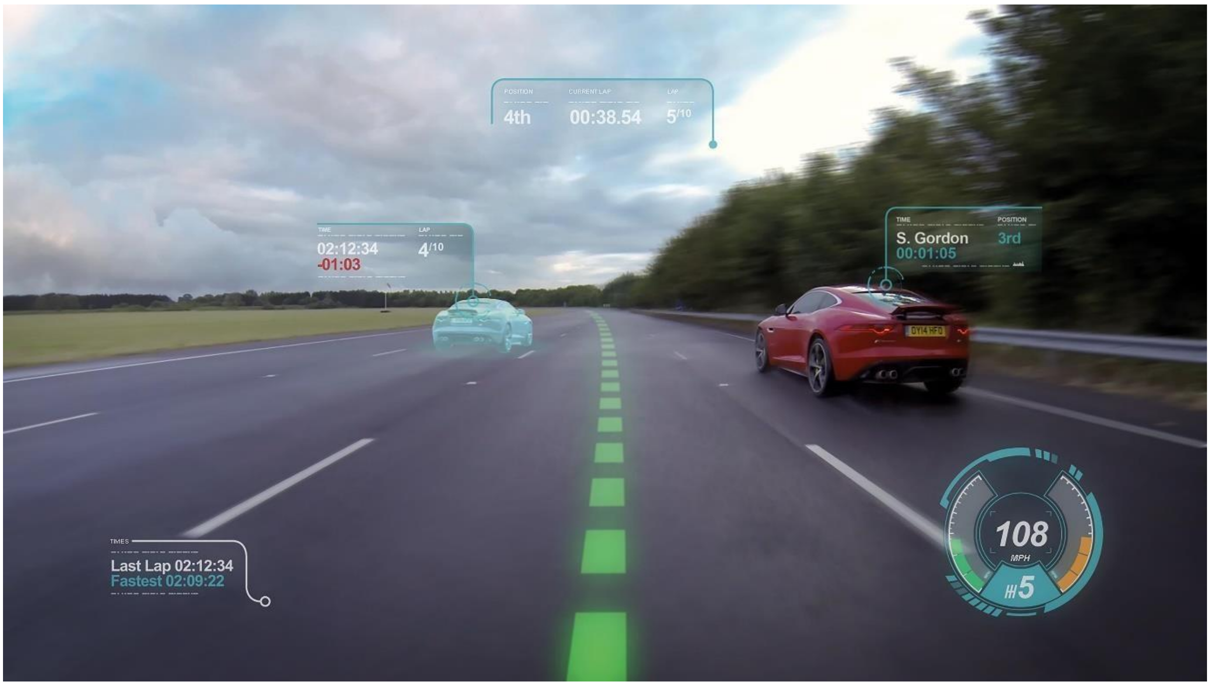


2. **The dashboard should include the development of real time car parameters such as speed, location, projected path, and perception.** A comprehensive dashboard provides critical information, aiding in user observation, immediate decision-making, and long-term strategy planning. This includes visualizing the vehicle's current state, upcoming manoeuvres, and sensor interpretations, thereby increasing the transparency and understanding in the CAV's operational capabilities.

3. **The GUI should be able to take requests from the user as to override/intervene during the car's operation.** While autonomy is the goal, human intervention should still be possible in critical situations. The GUI should offer an intuitive and immediate way for users to take control of the vehicle or modify its behaviour, ensuring safety and compliance to simulated road conditions.



4. **The car will require a simulated environment in which to operate**. This will involve the development of a real world or simulated environment for the car to be tested and trained as to improve and tune the cars performance. This could be done through simulation software that mimics real-world scenarios, allowing for the testing of the CAV's responses to various situations without the risks associated with physical testing.



Lastly, the combination of each process into a final usable platform. The car should integrate pathway planning, object detection and real time dynamic control in the form of a turnkey solution. This final step involves synthesizing all components into a cohesive system, ensuring they work in harmony to deliver a seamless autonomous driving experience. This integration is crucial for transitioning from prototype to completed product.