Eco-Driving Strategy

In this chapter will introduce the technologies and functions nowadays related to the thesis. First of all, the section 2.1 shows currently existing traffic simulation methods. In Section 2.2, the fuel-efficient methods at the present time are provided and compared, especially the coasting function.

Traffic Simulation

Some factor like traffic condition has a great influence on control strategy of the vehicle. In this thesis, we will try to figure out an eco-driving strategy that aim to a better way to reduction of fuel consumption. The characteristic of this strategy is to create a preview decision by using traffic-simulation. It is because of two aspects. One is the Reality: the designed curve is quite different from the reality, so we need to simulate the traffic and get a better description of fuel consumption. And an another is from economical: simulate the actual road condition instead of real running, it will reduce many costs.In other words, the complexity of traffic flow and the difficulty of experimenting with worldwide traffic in real-life make computer simulation a critical tool in traffic analysis. In the meantime, traffic simulation models are used to monitor data for traffic planning. Through analysis, traffic scenarios can have more variations and can effectively dominate the simulation time.Generally speaking, there are three types of traffic simulation models, which are microscopic, mesoscopic and macroscopic. The microscopic and macroscopic traffic simulations are explained below. This thesis uses the microscopic traffic flow model and describes it in detail.

Macroscopic Traffic Simulation

A Macroscopic traffic flow model is a mathematical traffic model that establishes the relationship between traffic flow characteristics like density, flow, mean speed of a traffic stream, etc. Usually deal with a wide range of issues, regardless of individual driving behaviour. These models are typically implemented by integrating diverse microscopic traffic flow models and converting the single-entity level characteristics to comparable system level characteristics. [Di Francesco, M.; Rosini, M.D. (2015). "Rigorous Derivation of Nonlinear Scalar Conservation Laws from Follow-the-Leader Type Models via Many Particle Limit". Archive for Rational Mechanics and Analysis. 217 (3): 831–871]The aim of macroscopic models is to describe the most important property, that is dynamics of the traffic flow. According to various experiments, several macroscopic traffic flow models is simple enough for the real-time simulation of large traffic networks, while being sufficiently integrity to actually describe the main total traffic flow variables and their dynamics. In general, this model can determine average travel time, average fuel consumption, and emissions associated with traffic flow.The macroscopic traffic model is not very demanding for calculations. In addition, computing demand does not increase with increasing traffic density, i.e., does not depend on the number of vehicles in the network. Meanwhile, this model is less sensitive to small disturbances in the input.

In General, the macroscopic traffic model is applied to short-term forecasting in a network-wide coordinated traffic management and suitable for the development of dynamic traffic management and control systems designed to optimize transportation systems and can be available for estimate and predict average traffic flow operations.

Microscopic Traffic Simulation

In contrast to macroscopic models, microscopic traffic flow models simulate individual vehicle units, therefore the models focus on the dynamic variables represent microscopic properties like the position and velocity of single vehicles.The microscopic simulation describes the system entities and their interactions with high levels of detail. A microscopic model makes effort to analyse the flow of traffic by modelling the influence respectively between individual unit such as driver-driver and driver-road. Microscopic traffic simulation has proven to be a useful tool to achieve these analyses. This is not only due to its capability to capture the full dynamics of time related traffic steam, but also being able of dealing with behavioural models accounting for drivers' reactions when facing different traffic phenomenon.

Software VISSIM is part of the PTV Vision and provides microscopic simulation methods for evaluating and resolving various transportation issues. The main functions of VISSIM include vehicle-following, lane-changing and pedestrian-movement as defined by the model. Vehicle-following models are a form of stimulus-response model, where the response is the reaction of the driver (follower) to the movement of the vehicle immediately preceding him (the leader) in the traffic flow. As the traffic flow to be displayed and expressed becomes complex enough, the influences of planning concepts based on purely aggregated values are difficult to analyse and understand. In this case, the only option that can draw reliable conclusions about traffic quality is to express street traffic for certain traffic plan measures through a visual representation. With the help of Vissim and other microscopic simulation software, you can determine how drivers and pedestrians interact with each other in the entire transportation network based on their stereotyped athletic behaviour. In addition, visualization of each traffic light and speed bump as well as conflict zones provides an overview of the traffic flow. Vissim is also able to refine the level of detail of the map as close to reality as possible so that the connected models are displayed with the most realistic definition.[https://www.ptvgroup.com/en/solutions/areas-of-application/microscopic-traffic-simulation/]During the simulation, multiple assessments are available for online and offline analysis. Another special feature is the animation visualization in 2D or 3D, which have the opportunity to instantly understand the simulated traffic conditions and fills in gaps between technical expertise and non-technical audiences. Microscopic traffic simulation has proven to be a useful tool to achieve these analyses. This is not only due to its capability to capture the full dynamics of time related traffic steam, but also being able of dealing with behavioural models accounting for drivers' reactions when facing different traffic phenomenon.

Fuel-Efficient Methodes

Automobiles need energy in the fuel to overcome various losses (air resistance, tire drag, etc.) encountered during driving process, as well as powering vehicle systems such as ignition or auxiliary system. Various strategies can be adopted at present to reduce the loss of the energy conversion between the chemical energy in the fuel and the kinetic energy of the vehicle. And driver behaviour can also greatly affect fuel economy; manoeuvres such as rapid acceleration and heavy braking will cost a lot of energy.Fuel efficiency depends on many parameters of the vehicle, including its engine parameters, fuel performance, weight, aerodynamic drag and rolling resistance. In recent decades, great achievements have been made in all areas of vehicle design. The fuel efficiency of the vehicle can also be improved through careful maintenance and driving habits. ["Simple tips and tricks to increase fuel efficiency of your car | CarSangrah". CarSangrah. 2018-06-07.

Hybrid Electric Vehicles Hybrid vehicles use two or more power sources for propulsion. In many designs, a small internal combustion engine is combined with an electric motor in series or in parallel. In this way, the kinetic energy lost by heat during braking is instead re-captured as electrical energy to improve fuel efficiency. When the vehicle is stopped, the engine will automatically shut down. When the brake pedal is depressed, the engine will start again to prevent wasting energy when idling. ["How Hybrid Work". U.S. Department of Energy. Archived from the original on 2015-07-08. Retrieved 2014-01-16.]Available hybrid vehicles can be classified depending on the power level and the function of the motor into the following categories. The hybrid vehicle's configuration with the smallest electric propulsion unit is called micro hybrid. It is basically an integration of starters and alternators in traditional ICE vehicles. T The main function of the motor is for start and stop, therefore, energy saving is mainly through optimizing the start and stop processes of the motor. In city driving where there are frequent starts and stops, the energy saving may reach about 5% to 10%. The cost of a micro hybrid is only few percent higher than that of conventional vehicle, since the motor is small and the structure is simple. Another alternative model, sometimes referred to as a mild hybrid system, is to use only the motor as a power booster and regenerative braking, without the need for "all-electric" operation. In this case, the motor and storage device can be relatively small but there is less chance of maintaining the engine in an inefficient operating area and reducing the ability to regain braking energy.

The most advanced and complex designs are defined as full hybrids. Generally speaking, there is a motor, generator and engine that employs series-parallel or complex hybrid structure. The power flow between engine, motor, generator and the battery is flexible by means of a power split device such as a planetary gear to achieve optimum drive performance with maximum energy efficiency and minimum emissions. Propulsion can be implemented by motor only (for start and stop), engine only (for cruising when the engine is in the optimal operating range), or a combination of motor and engine (for sudden acceleration when the required propulsion power is less than the engine optimum power region. Thus, the engine will drive the generator to charge the battery so the engine will deliver more power than required propulsion power to reach the optimum operating range). The Full hybrid vehicles can be further subdivided into Synergy Hybrid and Power Hybrid. Synergy Hybrid compromises the drive performance, energy efficiency and emissions reduction.

The Power Hybrid is designed to have better driving performance, so the engine will not shrink in size and the vehicle will have better driving performance through the combination of the motor compared with a traditional vehicle. [Hybrid Electric Vehicle Drivetrain]And in this thesis, will apply the mild hybrid electric vehicles and go through different system architectures for Mild Hybrid Electric Vehicles. For a single-motor hybrid system, depending on the position of the motor relative to the conventional power system, the single-motor hybrid scheme can be divided into five categories, named P0, P1, P2, P3, and P4.P0 means the entire electric system is installed in front of the engine. P1 and P2 have a great similarity. The only difference is that there is no clutch between the motor and the engine, and the auxiliary function of the motor cannot be cut off. The structure of P1 is that the motor is directly connected with the engine, and when the engine rotates, the motor follows. Hence the P1 mode doesn't have a pure electric driving mode. P2 is currently the most widely used mode of hybrid vehicles on the market. Two clutches and an electric motor are inserted between the engine and the gearbox to achieve hybrid driving. Vehicles in P2 mode can be driven in pure electric mode. The P3 mode moves the motor at the end of the gearbox.