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Evaluation of the Advantages of Electric Vehicles over Conventional Vehicles

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Abstract
The environmental circumstances and the shortage of petrol stress the importance of developing the electric vehicle industry. This paper is a survey focusing on whether the advantages of electric vehicles outweigh the disadvantages and possible future aspects and research and development. The paper discusses the perceived advantages over aspects such as the impact on the environment, automatic driving technologies and finally battery of electric vehicles. To be specific, the first part will cite formulas and calculate using statistical data to compare the GHG emission directly. The second part will introduce automatic driving technologies. This part will introduce the advantages and limitations of software and hardware. The final part will be about batteries, which presents the battery management technologies and current problems the batteries of electric vehicles are facing. This paper gives a comprehensive evaluation and analysis of electric vehicles and states the main advantages, limitations and future research and development prospects on several newly explored aspects, which are not currently mature enough.

Keywords
Electric vehicles; Conventional vehicles; GHG emissions; Automatic driving; Batteries

Introduction

Nowadays, environmental pollution has attracted global attention. With the development of modern technologies, global warming, which is caused by the emission of greenhouse gases, is becoming a serious problem. In 1950, the global emission of carbon dioxide was about 6 million tons. By 2020, this data increased by about 6 times to 34 billion tons. Therefore, many departments and institutions are seeking methods for reducing carbon dioxide emissions. The electric vehicle is one of them and this industry is currently developing rapidly. The first electric vehicle in the world was invented in 1834 by T. Davenport. Due to the restrictions on the technology of charging the batteries and the rapid development of internal combustion engines, conventional vehicles monopolized the vehicle market for decades. Until the 1990s, as protecting the environment was becoming a global focus, the research and manufacture of electric vehicles have redeveloped as they are not producing any greenhouse gases while driving. An entrepreneur called Elon Musk founded Tesla and started the manufacture of electric vehicles, and many firms in China joined the competition. In addition, many

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vehicle companies producing conventional vehicles have attempted to produce electric ones. With the growth of battery charging technologies and supportive policies of the government, the electric vehicle industry is more competitive than before and its prospect is well expected.

This paper aims to evaluate the advantages of electric vehicles over conventional vehicles and reach a conclusion on which one is better. The paper will be divided into seven sections. The first part is the introduction, which aims to illustrate the importance, general background and inevitability of electric vehicle production. The next section will be a literature review, this section will show my research on this topic and evaluate the reliability of the resources. In the third part, I will state my opinions and explain them and explain the counterarguments as well. They will be explained in the following aspects: impact on the environment, automatic driving technologies and batteries. The last two sections are conclusions and reviews. In the conclusion, the final opinion is presented and all the arguments will be summarized. Eventually, I will review and judge myself.

Literature Review

The purpose of this paper is to evaluate the perceived advantages of electric vehicles over conventional vehicles, such as reduced greenhouse gas emissions, more technologies applied and mileage improvement, and suggest some possible prospects of electric vehicles. Therefore, I will discuss both advantages and disadvantages of electric vehicles over aspects such as impacts on the environment, advantages and limitations of automatic driving technologies and current limitations of batteries and possible solutions to them.

The literature review is divided into the following two sections: impact on the environment and advantages and limitations of technologies, which review papers illustrating the GHG emissions and some problems the technologies of electric vehicles are currently facing.

Impact on the Environment

Papers about the impact of electric vehicles on the environment indicate that electric vehicles do not necessarily produce less GHG emissions than conventional vehicles. Different papers have suggested different equations to calculate specific data of GHG emissions using a different model. For example, H. Hao et al. (2017) calculate the carbon emission of conventional and electric vehicles during manufacturing and usage processes, which is introduced in my discussion part. It uses data about the electricity consumption rate of electric vehicles and the energy required to generate electricity to acquire the equation which calculates the carbon dioxide during driving. For the manufacturing stage, this paper utilizes data about battery capacity, carbon dioxide emission per unit capacity and greenhouse gas emission of except batteries. For conventional vehicles, this paper models the GHG emission as the product of GHG emission intensity, the density of gasoline, and the LHV of gasoline. Another research compares the GHG emissions as well but combines the manufacturing and usage processes in one equation.

According to Wu et al. (2017), the authors utilized the WTW method. For conventional vehicles, the GHG emission is modelled as the sum of “well-to-tank” (WTT) and “tank-to-well” (WTW) coefficients. For electric vehicles, the paper uses the sum of “well-to-produce” (WTP) and “produce-to-wheel” (PTW), the two steps are then separated further into electricity generation and combustion and electrical transmission and non-exhaust phase. The results of calculations from both studies reveal that the GHG emission of electric vehicles is not necessarily lower than that of conventional vehicles as the process of generating electricity is considered to burn coal.

In addition, studies are focusing on exploring new methods of electricity generation utilizing renewable sources such as solar power, wind energy, geothermal energy, tidal energy and so on. According to Ahmadi et al. (2018), the principle of solar power is to convert solar energy into electrical energy. To be specific, concentrated solar power uses lenses and mirrors to collect and focus the solar radiation on a small area. The energy collected is transmitted to thermodynamic cycles to generate electricity. The entire device is protected by poor heat conductors to prevent energy loss.

Advantages and Limitations of Technologies

This section is divided into two parts: automatic driving technologies and battery management technologies. They will be covering paper works cited in the discussion part and others that are not cited and mentioned. The papers reveal that both technologies will require high techniques of coding and sensors to gain extremely accurate data. To be specific, automatic driving are mainly based on wave sensors and battery management will be focusing on temperature sensors and current and voltage sensors.

Automatic Driving Technologies

The research by Ahangar et al. (2021) introduces different hardware such as sensors and communications of autonomous vehicles. The article compares the advantages and limitations of various types of hardware such as ultrasonic sensors, RADAR, LiDAR, cameras and GNSS and GPS (global navigation satellite system and global Positioning System). For example, ultrasonic sensors and LiDAR can endure extreme weather conditions, radar can detect obstacles, recognize pedestrians and vehicles and cameras can capture clear images of objects. It is also mentioned that the malfunctioning of that hardware can cause dangerous accidents. Therefore, enhancements or improvements are necessary.

Battery Management Technologies

The battery management system is the system that monitors the current, voltage, and temperature to make sure that the electric vehicle operates normally.

The study of Lelie et al. (2018) reviews the principles, requirements and difficulties of acquisition of the data of temperature, current and voltage. The precision of the data will be required to be within the third decimal place because one piece of inaccurate data can cause wrong estimation and evaluation of the current status of the battery, then the driver cannot analyze when to recharge correctly, which may cause trouble if the vehicle is out of electricity. In addition, if the temperature is not controlled well, too high or too low temperature will cause the battery to break down or malfunction. This will be a test for the designer of the battery management system.

Matthe R. et al. (2011) introduced a method to manage the batteries. The purpose of this method is to control the temperature of the battery. If the temperature is too low, the mileage of the electric vehicle will be reduced. When the temperature is low, the BMS heats the circuits, the heating appliances can heat the cooling liquid and pump the heat back to the battery to maintain the temperature. When the temperature is high, the thermal energy is taken out from the battery via cooling liquid and dissipated by cooling panels. If the temperature is too high, there are risks of burning down the battery, it is necessary to decrease the temperature at an extremely rapid rate.

It is readily apparent that algorithms such as machine learning are considered to help the data collection be more accurate and faster. Yang et al. (2018) illustrated the RF-based classification method and three steps model-based diagnosis algorithm to detect and analyze the electrolyte leakage and ESC fault. In the pre-trained RF classifier, the RMSE indicator is used to confirm the leakage condition. Several cases showed the effectiveness of the proposed method in monitoring ECS battery cells. Zhao et al. (2017) focused on developing a novel fault diagnosis approach for EV batteries using a 3σ multi-level screening strategy (3σ-MSS) and machine learning algorithm. The 3σ-MSS was utilized to identify the abnormal changes in battery terminal voltages while the machine learning algorithm was applied to execute the diagnosis process using the big data statistical regulation. Hong et al. (2019) developed a novel LSTM algorithm for battery fault diagnosis by taking the battery performance concerning weather and driver's behavior in EV operation into consideration. All hyperparameters of LSTM were pre-optimized offline using a dual-model-cooperation prediction technique. The prognosis stability and feasibility of the method were examined using real-time data under various voltage fluctuations. The results showcased the successful execution of the proposed method in battery protection and safety toward the identification of advent battery faults.

Discussion

Impact on the Environment (Comparison of Greenhouse Gases Emissions)

One of the purposes of manufacturing and researching electric vehicles is to reduce carbon dioxide emissions because the principle of electric vehicles does not require the combustion of gasoline or other forms of petrol. However, this question needs to be viewed from a broader perspective. The process of generating electricity and manufacturing or extracting the raw materials of electric vehicles will release carbon dioxide. In China, the greenhouse gas emission (GHG) accounted for approximately 5% of the total greenhouse gas emission in 2014 (Hao et al., 2015).

Conventional Vehicles

According to Hawkins et al. (2013), the aggregated GHG emission of conventional vehicles during the manufacturing process is approximately 6.5 $t\ CO_{2,e.}$ On the basis of H. Hao et al. (2017), the carbon emission intensity is calculated by an equation:

$$GHG_{gv}=GHG_g \times FCR \times \rho \times q_{L,g}$$

Where GHG_g is the life-cycle GHG emission intensity of conventional vehicles, FCR stands for the fuel consumption rate, ρ represents the density of gasoline, and $q_{L,g}$ is the low heat value (LHV) of gasoline.

The life-cycle GHG emission intensity of conventional vehicles in China is approximately 98.9 $g\ CO_{2,e}/MJ$ according to Ou et al. ,2011. The density of gasoline is 0.732 kg/L and the LHV is 43,070 kJ/kg (National Bureau of Statistics of PRC, 2015). By referencing the standard of passenger vehicles in China, the fuel consumption rate in 2020 is presumed to be $6L/100km$ and $5.5L/100km$ in 2025. We can deduce that it is $5.75L/100km$ in 2022. The result of the calculation is that the carbon emission of conventional vehicles is $179.288g/km$.

Electric Vehicles

According to H. Hao et al.(2017), the GHG emission during the manufacturing of electric vehicles is calculated by the following equation:

$$GHG_{m,EV}=BC \times GHG_{m,b}+GHG_{m,other}$$

Where $GHG_{m,EV}$ is the GHG emission in the manufacturing stage $GHG_{m,b}$ stands for GHG emission of unit battery capacity, $GHG_{m,\ other}$ represents the GHG emissions of BEVs except batteries and BC is the battery capacity.

Assume that the GHG emission of unit battery capacity ($GHG_{m,b}$) is 0.10 $t\ CO_{2,e}/kWh$ according to Amarakoon et al. (2013). By referring to data in Hawkins et al. (2013), the GHG emissions of BEVs except for batteries ($GHG_{m,\ other}$) is 8 $t\ CO_{2,e.}$ For example, the battery capacity (BC) of Tesla Model X is $100kWh$ (*Wikipedia*). After calculations, the GHG emission of manufacturing a Tesla Model X is 18 $t\ CO_{2,e.}$ During the usage process, the equation of GHG emission is the following: (H. Hao et al., 2017)

$$\mathrm{GHG}_{EV} = \frac{ECR}{\eta_c \times (1-\eta_t)} \times \alpha_t \times \lambda_{sc} \times q_{L,sc} \times GHG_C$$

Where ECR is the electricity consumption rate, η_c represents charging efficiency, η_t stands for average line loss factor, α_t is national thermal power share, λ_{sc} is net coal consumption rate, $q_{L,\ sc}$ is the LHV of standard coal and GHG_C stands for the life-cycle GHG emissions intensity of coal.

Taking Tesla Model X as an example, its electricity consumption rate (ECR) is between 15.6 kWh/100km and 30.6kWh/100km. (EV Database) The charging efficiency of batteries installed in electric vehicles is considered to be 90% according to Yuan et al. (2015) and Van

Vliet et al. (2011). The average line loss factor in 2014 was 6.34% (Chinese Electricity Council, 2015), and it is aimed to decrease linearly to 5% by 2025. We can deduce that the line loss factor in 2022 is 5.365%. The national thermal power share was 75.4% in 2014, which is expected to decline linearly to 60% in 2030 (Wu et al., 2012). We can infer that the national thermal power share is 67.7% in 2022. The net coal consumption rate was 318 g/kWh in 2014, which is assumed to decline to 300 *g/kWh* in 2030 (China Electric Power Yearbook Editorial Board, 2014). We can propose that the net coal consumption rate is 309 *g/kWh* in 2022. The LHV of standard coal is 29,307 *kJ/kg* in China. The life-cycle GHG emissions intensity of coal is approximately 104.5 $g\ CO_{2,e}/MJ$, according to Ou et al.(2011). The result of the calculation is 173.76*g/km* on average.

The results of calculations reveal that there is not a big difference in the amount of GHG emissions if the process of generating electricity is taken into consideration. In addition, the manufacturing process of electric vehicles makes more contributions to greenhouse gas emissions than conventional vehicles. Exploration of renewable energy sources to generate electricity can have the effect of reducing GHG emissions. Therefore, the advantage of electric vehicles over conventional vehicles is that electric vehicles can have more developing and researching potential on topics such as ways of generating electricity using other forms of renewable energy.

Automatic Driving Technology

The technology of automatic driving is that the driver only needs to aid or does not need to operate at all. It is usually applied to electric vehicles. The vehicle automatically detects the surroundings and calculates the model of the path the vehicle travels, using the technologies of radar, optical radar, GPS, and computer vision (CV). The complete automatic driving technology is not yet universally commercial. The majority of the vehicles with it are models or display systems. Some reliable technologies will be released into production streamlines and become reality gradually.

The technology aims to enhance road safety and reduce traffic congestion in present downtown areas as the current traffic system is becoming more and more disordered and inefficient. (Kaiwartya, O. et al., 2016). To achieve this objective, the technology of sensors is applied. Autonomous vehicles are installed with various sensors which enable the vehicles to make their own decisions by detecting the surroundings and passing on the instructions on the mobility of vehicles (Zhao et al., 2018).

To be specific, the sensors capture signals of various types of waves, then they are converted from analogue data to digital ones. The in-built computer calculates the distance between the vehicle, then a decision is made about the further movement of the car. The sensors include ultrasonic sensors, RADAR (radio detection and ranging), LiDAR (light detection and ranging) and cameras, etc. The fundamental operating principles are the same, but they have different functions. For ultrasonic sensors, a sound wave is generated by a magneto-resistive membrane and the echo is detected. The distance is calculated by the product of the time of flight (TOF) of the emitted wave. The functioning of this type of sensor is not affected by the material itself and weather conditions. It can operate normally even in dusty environments (Ahangar et al., 2021). RADAR, is designed to scan the surroundings and sense the presence and locations of vehicles or obstacles.

The RADAR has higher penetrability and the capability of measuring the accurate short-range targets in any direction and therefore calculating the relative velocity using the principle of the Doppler effect. Moreover, radars have anti-blocking and anti-pollution abilities which allow them to operate normally under rain, snow, fog and low-light conditions. Radars on electric vehicles are applied in forward cross-traffic alert (FCTA), lane change assistance (LCA), blind-spot detection (BSD), rear cross-traffic alert (RCTA), etc.(Ahangar et al., 2021). For LIDAR, laser light is emitted with the aid of a micro-mirror in order to obtain the vertical projection of the object. The entire process is repeated until a complete image appears. LIDAR can be used for positioning, detecting obstacles, and environmental reconstruction (Wang, et al., 2020). A roadside Lidar has proven to reduce vehicle-to-pedestrian crashes. Moreover, Lidar produces more accurate measurements than radar does (Ahangar et al., 2021). For cameras, they utilize image sensors, applying two technologies which are a charge-coupled device (CCD) and a complementary metaloxide-semiconductor (CMOS) (Rosique, et al., 2019). A camera is able to collect and record accurate data on the texture, color distribution and contour of the surroundings (Wang, et al., 2020).

The technologies applied to autonomous vehicles face certain limitations and challenges. For ultrasonic sensors, they are limited to single directions and the detection range is narrow (Zong, W et al., 2018). Therefore, it is necessary to install multiple sensors to obtain a comprehensive view. However, they will influence each other and create extreme ranging errors. (Kim, H et al., 2001). Radars might face problems such as reduced field-of-view, causing the waves to reflect from incorrect angles, leading to obtaining less precise measuring and resulting in more false alarms (Alluhaibi, O. et al., 2017). For LIDAR, its performance is catastrophic under extreme weather conditions such as fog, snow and rain. (Rasshofer, R. et al., 2011). Moreover, the detection accuracy depends on the light reflectiveness of the object (Wallace, A.M. et al., 2020). For cameras, the angle of photographing might be limited so that multiple cameras will be installed to monitor the surroundings better. (Swief, A. et al., 2018, Baftiu, I. et al., 2016 and Delavarian, M. et al., 2020). This will require the camera to process huge amounts of data, causing the system to be overwhelming (Wang, Z et al., 2020).

The sensor technology enables the vehicle to obtain detailed and accurate information about the surroundings, other vehicles, pedestrians, buildings and obstacles. The technologies do not have the limit of human physical extreme and the operations done by computers are probably more accurate than those done by human drivers. Therefore, the automatic driving technology can help reduce traffic accidents, reorganize and manage the flow of vehicles on roads and hence eliminate traffic congestion, reduce the workload of navigation and driver, etc. However, the flaws and limits of the technologies will cause the data collected by the sensors or other forms of technologies to be inaccurate. More accidents might be created. There are also ethical and legal controversies such as who should take the responsibility when two autonomous vehicles crash.

It is readily apparent that algorithms such as machine learning and deep learning can enhance the technology of automatic driving. It is unlike normal algorithms. The operation of normal algorithms is calculating a result using the input data, while the principle of machine learning is that the input is the data and the expected result, and the computer then outputs an algorithm model. Through machine learning, the computer can form a calculating model on its own and form its judge gradually. The final step is for the computers or the microprocessors to predict the obstacles, weather, speed of other vehicles and pedestrians and so on. In this way, artificial intelligence is formed to some extent. In other words, machine learning automates automation itself. This technology will enable the automatic technology to operate better and lessen the burden on the coders. Deep learning is a method of a completely different principle from machine learning. To be specific, deep learning makes comparisons of the perceived resulting data via weighing calculations and the actual results and then finds the difference. By this difference, the weighing is adjusted and the comparison is done again. This process is operated repeatedly until the difference is the smallest. When the amount of calculations and calculation results reach a certain level, the computer has already saved a set of weighing at each point. This is the result of deep learning, as the evidence for further new content. In automatic driving aspects, these two technologies can be combined, one models the routes for electric vehicles and one ensures that the route is as accurate as possible, which ultimately ensures the safety of passengers and eliminates the problems of traffic congestion to the greatest extent.

Battery Technology

Currently, the battery of an electric vehicle can support the vehicle to travel around 300 miles and 400 miles, which is about 482 kilometers to 644 kilometers. In other words, an electric vehicle can travel for about four to six hours by maximum speed limits, which is far fewer than a full-fuel-loaded conventional vehicle. The following is current research on possible improvements on the battery to improve the mileage of electric vehicles.

A battery management system (BMS) is the system for managing the batteries. It is often equipped with the function of measuring the electromotive force to keep the current and temperature to be in a reasonable range so that the heat loss of the battery during operations is minimized. Therefore, the efficiency is improved.

1) Temperature acquisition

It is a very difficult task to obtain accurate data on temperature. Firstly, the location of installation of temperature sensors plays an important role since the acquisition of peripheral temperatures such as those of the containers and fuses can sometimes be crucial (Marcus Lelie et al., 2018). Secondly, the number of sensors is limited, the ratio of the number of the temperature sensors to the number of voltage sensors is controlled approximately between 2:3 to 2:12 (Marcus Lelie et al., 2018).

2) Voltage acquisition

Classical battery management systems for lithium-ion batteries are often installed with at least one voltage acquisition equipment per series circuit connected in batteries. Rates of detection are usually controlled below kilohertz as the battery time constants are usually large. A high data acquisition rate will be necessary if oversampling can help or if there are large pulse currents in the application. Currently, available BMS high-tech chips usually have an accuracy of 1mV. According to Marcus Lelie et al.(2018), it is concluded that better voltage accuracy can improve the state of charge (SOC) estimation and only one voltage data is not sufficient to estimate SOC.

3) Current acquisition

This is a method combined with voltage acquisition to determine the SOC by coulomb counting. This method combines the current flowing into and out of the battery. After calibrating the coulomb counter to a defined state, the coulomb detector is ready for further detection alone. However, it is risky to rely completely on this method because there are errors in temperature, drift and offset (Marcus Lelie et al., 2018). In addition, the current sensors have to equip with a great range starting from milliampere up to 1000 ampere. Moreover, the sensor should be designed for counteracting EMI noise and operate extremely precisely (Marien J. et al., 2013).

4) Management methods

According to Matthe, R. et al. (2011), the BMS apply a method called battery liquid cooling. The purpose of this method is to control the temperature of the battery. If the temperature is too low, the mileage of the electric vehicle will be reduced. When the temperature is low, the BMS switches the liquid cooling to heating circuits, the heating appliances can heat the cooling liquid and pump the heat back to the battery to maintain the temperature. When the temperature is high, the thermal energy is taken out from the battery via cooling liquid and dissipated by cooling panels. If the temperature is too high, there are risks of burning down the battery, it is necessary to decrease the temperature at an extremely rapid rate. The BMS will control the cooling liquid to switch to air-conditioning circuits to cool the liquid. In addition, there is another method for controlling the temperature called "in-built heat exchanger design" (Parrish R. et al., 2011). This method constructs a system that allows the cooling liquid to get in contact with every battery. In comparison with other methods, it enables the battery to heat or cool the cooling liquid more comprehensively.

Current Problems of Batteries

According to statistics provided by askci, the number of chargers for electric vehicles reached 1.092 million chargers by November 2021, of which 450 thousand of them are d.c. and 646 thousand of them are a.c. The top ten cities and provinces installed are Guangdong Province, Shanghai, Bejing, Jiangsu Province, Zhejiang Province, Shandong Province, Hubei Province, Anhui Province, Henan Province, and Fujian Province. The chargers are distributed among the parking lots of shopping malls and along the routes of highways. However, there is still a huge gap between the number of chargers for electric vehicles and petrol stations for conventional vehicles.

The mileage of current battery technology is not sufficient for traveling over long distances. In addition, there are supportive policies for purchasing electric vehicles such as direct subsidies which reduce the prices and giving the license plate directly to solve the problem of traveling in metropolises such as Bejing, Shanghai, Guangzhou, and Shenzhen. In these cities, a license from other provinces or cities is not allowed to drive on overheads during legal working days in order to tackle traffic congestion. Therefore, the market for electric vehicles in China continues to grow. Hence the construction of more chargers for electric vehicles is of growing importance. In addition, the government may provide more vacancies for domestic charging, so that the car owners would not have to run for recharging the electric vehicles.

Moreover, a battery of an electric vehicle has limited time for use. The capacity will ultimately use up and the battery might malfunction after times and times of recharging. The electric vehicle is different from conventional vehicles as conventional vehicles have a system of internal combustion machine to convert the energy in fuel to kinetic energy, which helps preserve the value of conventional vehicles over time. However, the electric vehicles might face severe problems of depreciation. If there are newly invented batteries that can support the electric vehicles to drive over long distances such as 1000 kilometers, the current electric vehicles with mileage of 400 kilometers will of outdated and the value of electric vehicles cannot be preserved as there is no mechanical design in electrical vehicles as it is in conventional vehicles. In addition, there should be methods for recycling abandoned electric vehicle batteries as the chemicals inside the batteries may leak and damage the environment.

Conclusion

The researches and developments of conventional vehicles are much more abundant than that of electric vehicles as electric vehicles are just becoming popular in order to solve the problem of petrol shortage and environmental protection precautions during recent 20 years. In addition, the coding skills in the past are not able to support the installation of hardware such as sensors on vehicles, radar on conventional vehicles can provide information for car parking but far from controlling vehicles. Therefore, the research on electric vehicles has far more aspects and futuristic space than conventional vehicles.

For the GHG emission of electric vehicles part, it has been proved that electric vehicles do not necessarily produce fewer GHG emissions than conventional vehicles, since the majority of electricity generation processes depend on the combustion of coal. Future research can focus on the improvements of sources of producing electricity, such as solar power, wind energy, energy cell and so on to minimize the GHG emission of generating electricity. The government can subsidize scientific institutions to encourage or support those researches and invest in education to train human resources for the next generation.

In the autonomic driving technology aspect, researchers have shown that automatic driving technology can help reduce traffic accidents, improve the efficiency of traffic and reduce traffic congestion to some extent. Future research can focus on enhancing the algorithm and the precision of the sensors to improve the accuracy and rate of data collection.

In the battery technology aspect, the system can monitor the status of the batteries accurately so that the remaining battery capacity and hence the mileage of the vehicle can be accurately evaluated. In addition, the system provides methods for preserving the capacity of batteries under special temperature conditions.

In my opinion, the design of electric vehicles on the battery fitter should be uniform so that the changing of batteries is more convenient. The battery that is changed should be recycled and the chemicals inside it should be managed by special measures. The shell of the batteries can be used to manufacture new batteries.

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