Development of an electric 8 seats tourist vehicle with high safety and high-grade climbing capability

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(一)Introduction

In recent years, because of the rise of domestic tourism and environmental awareness, the number of visitors continues to rise year after year. Most of the national forest resorts and amusement parks are turning into purchasing electric vehicles to replace conventional gas/diesel vehicles in order to pursuit green energy principle. However, those resorts and parks are mostly located in mountainous areas of Taiwan, where may probably have steep slopes. Most of such electric vehicles carry 8 to 11 passengers. Due to the larger number of passengers and heavier loads, the power required varies greatly. Therefore, their powertrains, body structures and chassis systems are more difficult to design. Usually, most electric vehicles used in resorts are designed to drive on the flat ground. When such vehicles travel on the hillside, the powertrains and brake systems may overload and even fail. In addition, a large number of low-priced electric vehicles imported from China make the domestic industry no longer able to carry out the corresponding research and development. Facing with such a competitive situation, if Taiwan does not have key technologies in vehicle design and analysis, the industry may lose the competition even it has good manufacturing capability.

(二)Design Concept

This project is focused on the development of a tourist electric vehicle with high-grade capability and high security. It is especially designed to improve the safety of electric vehicles running in the mountainous area with steep slopes of Taiwan tourist attractions. The project is divided into three part: high-performance drive module, lightweight body structure and indigenous chassis system. The vehicle has a new body structure design. This includes topology analysis, lightweight analysis, structural stress analysis, full-load brake analysis and vehicle dynamic collision analysis. The indigenous chassis system development contains steering and suspension systems designs. It also includes chassis system parameters setup and performance testing. For climbing demand, the power system analysis is performed. Combining with other key technologies developed by the team before, a complete electric vehicle system is produced. The vehicle designed in this project has been actually manufactured. Various system integration tests have been done in this vehicle. Evaluations of the performance of the electric vehicle have also been made. All the vehicle data collected from various running tests will be used for further improvements of the high-grade and high security tourist electric vehicle.

(三)Technical Development

This project covers three main modules: the high-performance driving module, the lightweight body structure module, and the customized chassis system module.

1.The key technologies supporting the lightweight body structure module include: (1) lightweight body structure design and analysis, (2) rigid body structure analysis, (3) stress analysis of body structure under full loading, and (4) body structural crash analysis and fatigue life simulation.

2. The chassis of this electric vehicle is mainly made of steel pipe structure. The making of this vehicle allows the establishment of key technology related to the design and analysis of lightweight body structure. Therefore, the manufacturing cost and weight can be effectively reduced through this technology. Through this project, independent design and analysis capability to build lightweight body structure can be developed among personnel.

The key technologies required in the customized chassis system module include: (1) the calibration technology for actual vehicle, (2) Chassis K&C Analytical Technology, (3) dynamic simulation analysis, (4) techniques for vehicle dynamic energy measurement and performance evaluation, and (5) technique for steering system performance analysis.

The chassis of this electric vehicle consists of an independent MacPherson type front suspension system, a trailing arm rear suspension system, and a steering system integrated with a hydraulically assisted gear rack pairing. Based on the actual needs on terrain and conditions, the development of current chassis system focuses on low-level chassis, straight-running stability, steering sensitivity, steering reversal, passenger comfort and so on. Through this process, the design methodology, the analysis approach, the calibration of parameters, the evaluation of vehicle performance, the standard of experimental procedure, and the testing facility have been established. Not only does this project train personnel to master the aforementioned key technology, but also promote the establishment of chassis system design capability.

3. The key technologies associated to the high-performance power-driven module include: (1) the design of a low-cost automatic transmission mechanism, (2) the technology to design and to match for power module optimization, (3) the automatic shift strategy, and (4) the control technology for Vehicle Control Unit (VCU).

In order to solve the problem faced related to insufficient torque output during hill-climbing maneuvers, this electric car is equipped with a two-shift clutchless manual transmission system with high torque output, a modular automatic transmission control system, and a high-performance induction motor with a large operating range. The use of a full vehicle controller and novel safety mechanisms for the brake locking and releasing on ramp parking, stall parking, shift strategy, etc. increases the overall vehicle load capacity (and maneuverability. The innovative design and technology mentioned above serve to ensure high security for the vehicle users.

(四)Technology Competitiveness

This research team has actually mastered the key technology for a full vehicle development as well as the capabilities for its design, analysis, and manufacturing process. The electric car developed has the following features:

1. The use of two-level gearbox suitable for both high and low speed maneuvers, generally without gear-shifting within a 30% road gradient.
2. The use of electrically power assisted steering system providing an excellent driving control.
3. The use of vacuum assisted brake system ensuring more efficient braking.

4. The use of kinetic energy recovery system paired with an electromagnetic brake generating electromagnetic braking force and performing energy recovery.
5. The use of suitable suspension system providing high passenger comfort.
6. The use of full vehicle controllers and mechanisms to ensure high safety.

(五)R&D Result

Figure 1shows the development process associated to the design and manufacturing of current electric vehicle. Upon its completion, this electric car has to undergo several testing and tuning stages to ensure optimized performance. Figure 2 is the photo of the completed product.

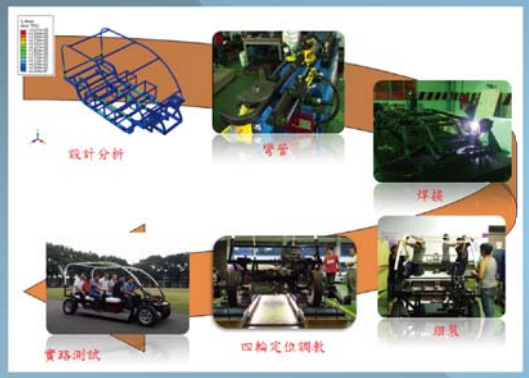

Figure 1. The development process for current electric vehicle.

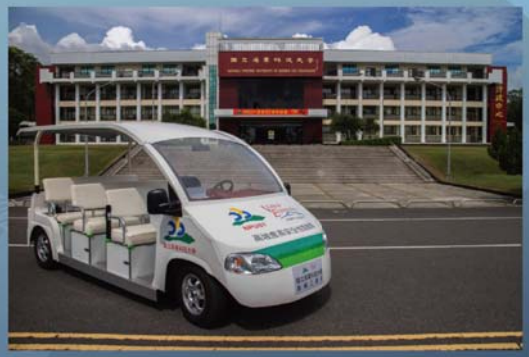

Figure 2. The picture of current electric vehicle.

(六)Acknowledgement

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