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A Comprehensive Survey on Performance and Energy Analysis of Electric Vehicle Control Systems

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Abstract: *Electric vehicles have the potential to substitute for conventional vehicles and to contribute to the sustainable development of the transportation sector worldwide, e.g. reduction of greenhouse gas and particle emissions. Hybrid electric vehicles consist of a combustion and an electric motor[11]. In practice, the effect of selecting appropriate electric motor is observable on all the main indices of vehicle performance such as maximum speed, gradeability, pollutant emission, fuel consumption, etc. However, investigating the performance of electric motors as electric traction systems in hybrid electric vehicles has not been emphasized in literature. DC charging and ac charging vary by the location at which ac current is converted to dc current. For typical dc charging, the current is converted at the off-board charger, which is separate from the vehicle. For ac charging, the current is converted inside the vehicle, by means of an on-board charger. The location of the ac to dc conversion equipment, or converter, shapes the complexity of the equipment design[11-12] A comprehensive and systematic solution to the safety of electric vehicles are also studied, which can effectively control the charging safety of electric vehicle and eliminate the potential danger. All the above points have guiding significance for the popularization of electric vehicle.*

Key Words: *Electric vehicles, energy consumption, motor , Battery Management System*

1. INTRODUCTION:

With the increasing awareness and adoption of eco-friendly vehicle technologies such as hybrid electric vehicles (HEVs); most if not all major worldwide vehicle manufacturers have released an eco-friendly vehicle or have announced a future release (e.g. concept demonstrator vehicles). Such vehicles can meet current legislative emissions standards (with comparatively lower CO_2 tailpipe emissions compared to conventional combustion engine vehicle equivalents), yet performance in the real world is often far worse than quoted test figures (e.g. fuel economy). In order to maintain and grow customer acceptance of such vehicle technologies it is important that real world usage is considered during the design and development processes[12].

The energy consumption and power needs of electric vehicles are evaluated on roller test benches according to test procedures defined by legal standards and by vehicle manufacturers. These test procedures are mainly defined by driving cycles and include tolerances to compensate for the human error during these tests. These tolerances may seem to make the tests easier but they can have a big effect on the appropriate dimensioning of the components, and also on the performance of the vehicle[11].

2. LITERATURE REVIEW:

[1] As the primary energy storage component in electric vehicles, the reliability of lithium-ion batteries is of paramount importance. Identifying high-risk vehicles is crucial to ensure the safety of electric vehicles and their users. Traditional fault diagnosis methods predominantly depend on the real-time collection of battery status parameters by the onboard

Battery Management System (BMS) to facilitate diagnostics and trigger alert notifications. these approaches suffer from inherent latency issues and have limited ability in predicting potential risks.

To overcome these limitations, this paper introduces an innovative fault diagnosis approach, which entails modeling of various abnormal battery behaviors, followed by the creation of precise mathematical expressions to quantitatively represent each of these risk behaviors

this study employs advanced machine learning algorithms, such as Logistic Regression algorithm, to calculate customized risk factors for real vehicles and optimize the parameters of a multi-feature input model. Validation results confirm the feasibility and robustness of the proposed fault diagnosis method

[2] This paper proposes an Extended Hazard Nonlinear and Time-Dependent (EHNTD) strategy based on the Lifelines Python library. The degradation of EV batteries is often nonlinear and affected by time-varying factors, such as changes in temperature, charging/discharging cycles, and state of charge. Traditional Cox-PH and AFT models may struggle to account for these complex dynamics. An Electric Vehicle Motor Controller (EVMC) is an essential component in electric vehicles (EVs) that manages the power flow between the vehicle's battery and electric motor. The failure modes of EVMC are categorized as linear and nonlinear. Lifelines Python library supports non parametric, semi-parametric, and parametric prediction approaches for EV motor controllers .proposed EHNTD-AFT approach is the best-fit approach for EV motor controller reliability prediction. The EHNTD reliability prediction technique demonstrates superior accuracy for EVMC, achieving a C-index of 0.95 and outperforming other intelligent methods for nonlinear hazard data.

[3] Conventional EV wireless power transfer (WPT) solutions require designing different circuits for various input voltages and using different compensation circuits for different transmission distance classes which hinders the widespread adoption of the WPT technology. To address these two issues, this paper proposes an EV WPT system based on series-parallel inverters. The proposed system offers adaptability to different grid voltages and Z classes without requiring changes to the resonant circuit or the addition of DC/DC converters. And it eliminates the need for a resonant inductor on the GA side, making it a cost-effective solution. Finally, a 3-kW prototype is constructed to demonstrate the feasibility of this proposed system and the maximum overall efficiency achieved is 92%.

[4] The in-wheel motor-bearing(IWMB) system is a critical component of the in-wheel motor(IWM) driving electric vehicle(EV). Studying the deformation issues of the IWMB system under service conditions is of significant importance for enhancing of the reliability and durability of IWM drive systems and vehicles. Based on an analysis of the coupling relationships among various physical field loads involved, a comprehensive dynamic analysis model of the IWMB system is established, considering the coupling effects of electromagnetic, thermal, mechanical, and flow fields .The main factors of deformation and the main influence of temperature on deformation are analyzed. This study can provide a theoretical basis for improving the reliability of the IWMB system.

[5] This paper presents a solar photovoltaic-integrated, sensorless permanent magnet synchronous motor (PMSM) drive for a 3-wheeler electric vehicle (EV). It also delves into vehicle design, modeling, and energy calculations based on Indian Driving Cycle (IDC). Based on rooftop size, a solar photovoltaic (PV) array is selected and connected to DC link through a boost converter to achieve maximum power using a modified perturbation and observation (P&O) algorithm. characteristics of multiple filters with adaptive nature, which makes it effective over a wide range of speed. In addition to this, a modified quadrature phase-locked loop (QPLL) is used for rotor position and speed estimation, featuring an adaptive gain based loop filter to enhance dynamic performance. A comparative performance of presented sensorless technique and dynamics of battery-solar system are discussed and validated with test results.

[6] The aggregation and control of massive electric vehicles (EVs) are crucial for grid frequency regulation (FR). challenges such as disordered charging, high computational and communication burdens need to be addressed. Markov-based EVA state space model is designed, integrating the user's willingness to-pay(WTP) index and hybrid state. It estimates the EVA's FR capacity(FRC)with lower communication burden and reduces computational burden by simplifying control dimensions. MPC-based switching control method and a SOC-based probabilistic response control exhibit advantages in FR, considering factors such as user willingness and battery degradation. The proposed prediction compensation mechanism effectively reduces FR errors resulting from parameter inaccuracies and resolves the issue of asynchronous control cycles.

[7] Inverter-fed electrical machines used in electric vehicle applications are increasingly prone to experiencing partial discharge (PD), particularly in 800V powertrains. accurate determination of the thermal aging enhancement factor remains a challenging issue. In this paper, PDIV variations are measured under three accelerated aging temperature levels with more than 10 aging sub-cycles. The data are then used to deduce the changing rate of PDIV at generic temperature conditions and finally, the thermal aging enhancement factor. PD risk assessment using the proposed factors suggests to prevent the PD risk by adopting a lower winding temperature or employing the dv/dt filter.

[8] In this study, a mid-size passenger vehicle, having 80 kW fuel cell stack supported by a 1.97 kWh battery pack, is modeled with Matlab. The vehicle is simulated on Worldwide Harmonized Light Vehicle Test Procedure (WLTP) Class 3 driving cycle and fuel consumption and range values are 2.15 L/100 km as gasoline equivalent and 859.2 km, respectively. The average efficiency of the internal permanent magnet synchronous motor providing vehicle propulsion is 93.4% throughout the cycle. The overall efficiency of the vehicle is found to be 56.2%. The future scope of this study, which addresses the performance and energy analysis of FCEVs, includes Advanced optimization of FC and battery Systems, high-performance batteries.

[9] This study proposes a simplified integration system of bidirectional on-board chargers (OBC) and wireless power transfer (WPT) charging systems for electric vehicles. magnetic coupler design method enables the secondary coil to be shared in both OBC and WPT modes. To validate the proposed integrated OBC and WPT charging system, a prototype with a 3.3-kW OBC and WPT system is configured and verified through experiments. This letter proposed a simplified integration system of bidirectional OBC and WPT charging systems that share the switch bridges and magnetic coupler coils. The performance of the proposed charging system was evaluated under the charging and discharging conditions.

[10] Electric vehicles are developing rapidly, and a large amount of electric vehicle charging during the same period will have an impact on the normal operation of the power grid. Therefore, studying the time of use pricing strategy for electric vehicle charging piles is of great significance. a genetic algorithm for the time of use electricity price of electric vehicle charging piles was proposed; Finally, a time of use electricity price model for electric vehicle charging piles was established. Through simulation analysis, it can be concluded that the model established . Using genetic algorithm ensures the smooth operation of the power grid load, reduces the charging costs of users, and achieves a win-win situation for both users and charging stations.

3. CONCLUSIONS

In this study, various systems have been studied and found for suitable modifications to existing electric vehicles. Using genetic algorithm ensures the smooth operation of the power grid load, reduces the charging costs of users. Markov-based EVA state space model is designed, integrating the user's willingness to-pay(WTP) index and hybrid state. Lifelines Python library supports non parametric, semi-parametric, and parametric prediction approaches for EV motor controllers. Solar photovoltaic-integrated, sensorless permanent magnet synchronous motor (PMSM) drive for a 3-wheeler electric vehicle (EV) delves into vehicle design, modeling, and energy calculations based on Indian Driving Cycle (IDC). Some of these studies suggest possibility of employing advanced machine learning algorithms, such as Logistic Regression algorithm, to calculate customized risk factors for real vehicles and optimize the parameters of a multi-feature input model. Validation results confirm the feasibility and robustness of the proposed fault diagnosis method. In conclusion, several modifications to existing electric vehicles have been proposed and found suitable for practical implementation in the near future.

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