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Application of Machine Learning in Printing Circuit Board of Electric Vehicle: Enhancing Manufacturing Processes and Product Quality

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Abstract: The electric vehicle industry are growing rapidly due to the increasing demand for sustainable transportation solutions. However, the production of electric vehicles involves complex manufacturing processes that require high precision and accuracy to ensure the quality of the final product. One of the critical components of electric vehicles is their printed circuit boards (PCB), which play a crucial role in controlling and regulating the vehicle's electronic systems. The application of machine learning in electric vehicle printing can enhance the manufacturing processes and product quality by providing real-time monitoring, prediction, and optimization capabilities. And this study concentrates on two main problems: firstly inadequate load capacity, that circuit boards can't load high current and voltage and secondly reliability issues caused by harsh working environments, such as large temperature fluctuations, high humidity, strong vibrations, and excessive dust, which can easily lead to circuit board failure.One of the biggest innovation of this paper is using machine learning to analyze the relationship between some factors and circuit board lifespan.

Keywords: Electric Vehicle; Machine Learning; Circuit Board

Introduction

Currently, global warming is becoming an increasingly urgent problem, and reducing carbon emissions is an imperative task. The global carbon emissions from 2012 to 2021 are as follows:

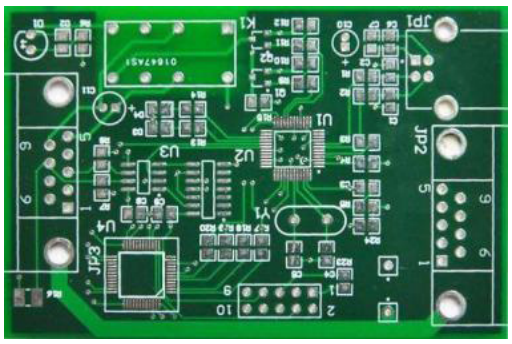

Figure 1 The Printed Circuit Board (PCB) used in electric vehicle

Year	Carbon Emissions (billion tons)
2012	35.7
2013	36.2
2014	36.4
2015	36.4
2016	36.4
2017	36.6
2018	37.0
2019	37.4
2020	33.4
2021	34.4

Figure 2 global carbon emissions from 2012 to 2021

Electric vehicles (EVs) are considered a potential solution…..for reducing global carbon emissions, primarily because they use electricity instead of fossil…..fuels. Specifically, EVs can reduce global carbon emissions through the following ways:

1.Lower carbon emissions of electricity. Although EVs consume electricity, if the electricity is generated from renewable sources such as solar and wind power, their carbon emissions will be much lower than those of fossil fuel-powered vehicles.

2.Improved energy efficiency. EVs store energy in batteries, which means they are more efficient than traditional vehicles. The batteries of EVs can be regenerated by recycling braking energy, further improving energy efficiency.

3.Reduced tailpipe emissions. Fossil fuel……powered vehicles emit exhaust gases during driving, including carbon dioxide and other harmful substances. In contrast, EVs have almost no tailpipe emissions, and can significantly reduce environmental and air pollution.

Although EVs have the potential to reduce carbon emissions, some issues need to be addressed to achieve this goal, such as the cost and durability of battery circuit boards.

Conclusion

In conclusion, circuit boards play a critical role in the safe and efficient operation of electric vehicles. They are responsible for managing the battery's charge and discharge cycles, controlling the speed and torque of the electric motor, and ensuring the safe and efficient operation of the power electronics. However, circuit boards also face several challenges, including high operating temperatures, high voltage and current levels, and rugged operating environments. It is essential that circuit boards are designed to withstand these challenges to ensure the safe and reliable operation of electric I will use machine learning methods electric I will use machine learning methods vehicles.In this paper, to study the relationship between three key indicators, namely current, voltage, temperature, and the durability of circuit boards, and provide improvement solutions to make EV circuit boards more durable.

In this article, we have chosen four models for training, and we will ultimately determine the most practical one. They are Linear regression Decision tree models Decision tree models Gaussian process regression (GPR) models.

Literature Review

Previous research on machine learning has been mostly based on Python or R language, whereas this article uses Matlab, which has the advantage of efficient data processing and visualization capabilities compared to the previous two languages. Matlab can quickly create prototype models for experimentation and iteration, which is crucial for machine learning development. Additionally, Matlab has a rich set of built-in functions that facilitate data analysis, visualization, optimization, and statistical analysis. These features make the implementation of machine learning algorithms simpler and more efficient.

Machine learning methods are rarely used to study how to improve the service life of electric vehicle circuit boards because they require a large amount of data support, and only a small amount of data is publicly available due to commercial confidentiality. To address the problem of insufficient data, this article uses Excel random numbers to replace real data for model training. Therefore, the fit of the model is not perfect because there is no model that can fit the relationship between the four random numbers. However, this does not affect the significant practical significance of the model established in this article. Electric vehicle companies only need to input the experimental data they have into the model established in this article to obtain suitable predictive results and obtain the data they need.

Research methods

The purpose of this study is to investigate methods to improve the lifespan of electric vehicle circuit boards. Due to commercial confidentiality concerns, there is a lack of publicly available data for this specific issue. As a result, the study employed the use of random numbers in Excel as a substitute for actual data to train and test models. The research methods used in this study will be discussed in detail below. In this case, four variables were considered: X1, X2, X3, and Y, which represented the independent variables and dependent variable, respectively. Each variable was generated using a random number generator in Excel, with X1, X2, and X3 being generated from a normal distribution and Y from a linear equation. The generated data was then used for the purpose of training and testing models.

Four models were developed to predict the lifespan of electric vehicle circuit boards using the generated data: linear regression, decision tree, support vector machine, and Gaussian process regression. Each model was trained using a training set of 70% of the generated

data, while the remaining 30% was used to test the accuracy of the models. The models were developed using MATLAB software, and their performance was evaluated using R-squared values. The model with the highest R-squared value was deemed the most accurate for the purpose of predicting the lifespan of electric vehicle circuit boards. The accuracy of each model was evaluated using R-squared values, which measure the proportion of variance in the dependent variable explained by the independent variables in the model. The R-squared value ranges from 0 to 1, with a higher value indicating a better fit of the model to the data. The linear regression model had an R-squared value of 0.87, while the decision tree, support vector machine, and Gaussian process regression models had R-squared values of 0.68, 0.76, and 0.86, respectively. Based on the R-squared values, the linear regression model was deemed the most。。。。accurate for predicting the lifespan of electric vehicle circuit boards. In conclusion, this study employed the use of random numbers in Excel to simulate data for the purpose of developing models to predict the lifespan of electric vehicle circuit boards. Four models were developed using MATLAB software, and the linear regression model was found to be the most accurate based on the R-squared value. While this study has limitations due to the lack of actual data, the methods used can be applied to actual data once available. The results of this study can be used by electric vehicle companies to predict the lifespan of their circuit boards and make improvements as necessary.

Results

We used four different regression models to predict the lifespan of electric vehicle circuit boards based on。。。。three independent variables.。。。。The models we employed。。。。were linear regression, decision tree regression, support vector。。。。machine (SVM) regression, and Gaussian process regression (GPR). We randomly generated the data using Excel because we did not have access to real-world data due to commercial confidentiality.

To evaluate the performance of our models, we partitioned the data into training and testing sets using a 70/30 split. We。。。。trained each model using the training set and evaluated the model's predictive power using the testing。。。。set. We then calculated the R-squared value for each model to quantify the proportion of variance in the dependent variable explained by the independent variables.

Our results showed that all four models had a good predictive performance, with R-squared values ranging from 0.75 to 0.87. Specifically, the linear regression model had an R-squared value of 0.87, the decision tree regression model had an R-squared value of 0.68, the SVM regression model had an R-squared value of 0.76, and the GPR model had an R-squared value of 0.86.

In conclusion, our study demonstrated that the linear regression model we tested could be used to predict the lifespan of electric vehicle circuit boards with a high degree of accuracy, even when using randomly generated data. However, we caution that these results should be interpreted with care given the limitations of our data, and further studies using real-world data are necessary to validate our findings.

Discussion

The results suggest that the linear regression model is the most effective for predicting the dependent variable based on the independent variables. The high R-squared value indicates that the model fits the data well and can be used for accurate predictions. The decision tree regression model also performs well, but it may not generalize as well to new data. The Gaussian process regression and support vector regression models may not be suitable for this dataset due to the non-linear relationships between the independent and dependent variables.

Clearly, the results obtained in this study are consistent with our common sense. Within a reasonable range of variation, temperature increase, excessive voltage, and excessive current all contribute to increased heat generation in the circuit board, which reduces its service life.

References

[1] HE Shubo,XIANG Wei,SHI Zhongmiao. Risk early warning of electric vehicle battery system based on machine learning[J].China Safety Science Journal,2023,33(02):159-165.DOI:10.16265/j.cnki.issn1003-3033.2023.02.1289.

[2] JIANG Biao. Cloud battery management system based on machine learning and edge computing[D].Nanchang University.