Creating a Virtual Tyre Temperature Sensor

POPULAR SCIENCE SUMMARY

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This thesis develops a virtual sensor using recurrent neural networks (RNN) to predict tyre temperature in electric vehicles. The study evaluates the accuracy of the virtual sensor in estimating the tyre temperature within ±2 °C using on-board vehicle signals, showing promising results with approximately 90% accuracy achieved by the final model.

Imagine you're pushing a toy car on a smooth, hard floor; it glides easily, right? Now, try doing the same on a carpet. It's harder, isn't it? That's because the carpet creates more rolling resistance. Now scale that up to an electric vehicle on the open road. Many factors can increase the vehicle's rolling resistance, and one critical factor is the temperature of the tyres. The hotter the tyres, the lower the rolling resistance, and vice versa.

The catch? Currently, we estimate tyre temperatures based on standards developed in labs, not under the varying conditions that cars experience in real-life driving scenarios. But what if we could predict tyre temperatures in real time as conditions change? That's where this research steps in.

The study aimed to build a virtual sensor for predicting tyre temperature in electric vehicles while they are being driven. But not just any sensor – a sensor powered by recurrent neural networks (RNN), a type of artificial intelligence (AI) that learns patterns over time, much like our human brains do.

Two different types of RNN were tried: Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU). These are sophisticated AI models designed to remember past information and use it to predict future outcomes. They're great at learning patterns over time, which makes them ideal for predicting something like tyre temperature, which changes based on a variety of factors during a drive.

These two models, LSTM and GRU, were put through their paces. They were trained and evaluated to see if they could meet the challenge of predicting tyre temperature within a range of ±2 °C using only data available from the vehicle itself, like speed, brake pedal position, accelerator pedal position, and road inclination.

After thorough testing and reiteration, the LSTM model came out slightly on top, managing to predict tyre temperature within the target range about 90% of the time, which is pretty impressive considering the complexity of the task!

The most significant contributing factors to the model's performance were vehicle speed, ambient temperature, brake pedal position, accelerator pedal position, and road inclination. These are like the star players of the team, the ones who carry the game and ensure the win. Without these inputs, the accuracy of the tyre temperature predictions would be considerable worse.

In conclusion, this study marks a significant step forward in the integration of AI and automotive technology, by developing a virtual sensor for predicting tyre temperatures in electric vehicles. Although the sensor's performance fell short of the ideal, the study highlighted the potential to improve this technology. The addition of data like weather and road surface information in future research could refine the sensor's accuracy. Thus, paving the way for smarter and more efficient EVs.