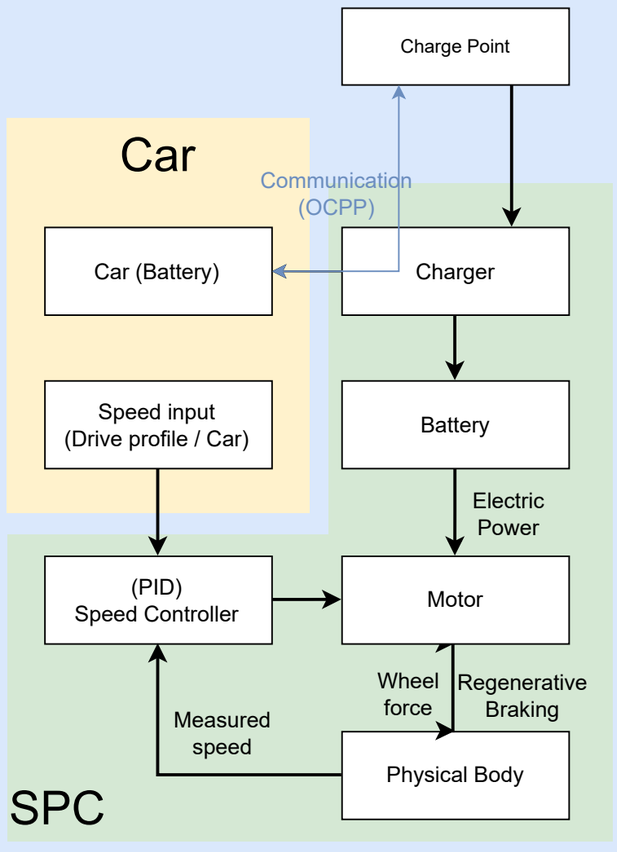
Self Propelled Caravan
System overview

Functional flow



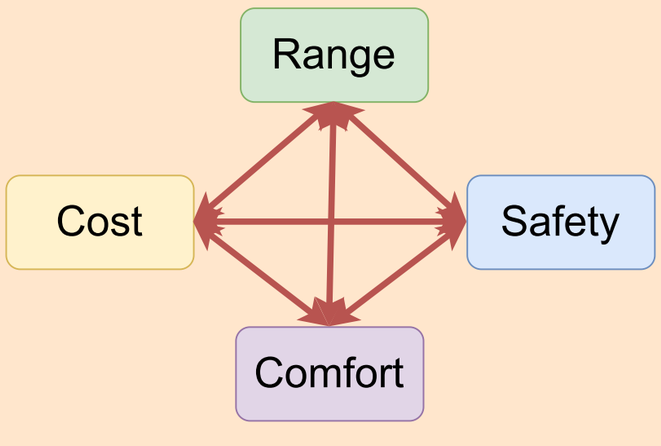
Visual aid: Aerodynamics of a caravan

https://www.youtube.com/watch?v=0wr2vht7J_8

Key parameters

* Range: The range should be calculated based on factors such as the size and capacity of the battery, the efficiency of the electric motors, and the aerodynamics of the design.
* Cost: This includes the cost of materials, labor, and components, as well as the cost of maintenance and battery replacement.
* Weight: The weight of the SPC affects the range and efficiency of the vehicle. This should be kept as low as possible to improve the range and handling of the caravan.
* Power and Torque: The power and torque of the electric motors affect the towing capacity and climbing ability of the caravan. This can be measured in horsepower or Newton-meters.
* Aerodynamics: The aerodynamics of the SPC affects the range and efficiency of the vehicle. This can be quantified using aerodynamic coefficient and drag area measurements.
* Safety: Safety can be quantified using measurements such as weight distribution, moment of inertia and center of gravity.
* Capacity: The amount of usable space inside the caravan should be large enough to accommodate the needs of the user.

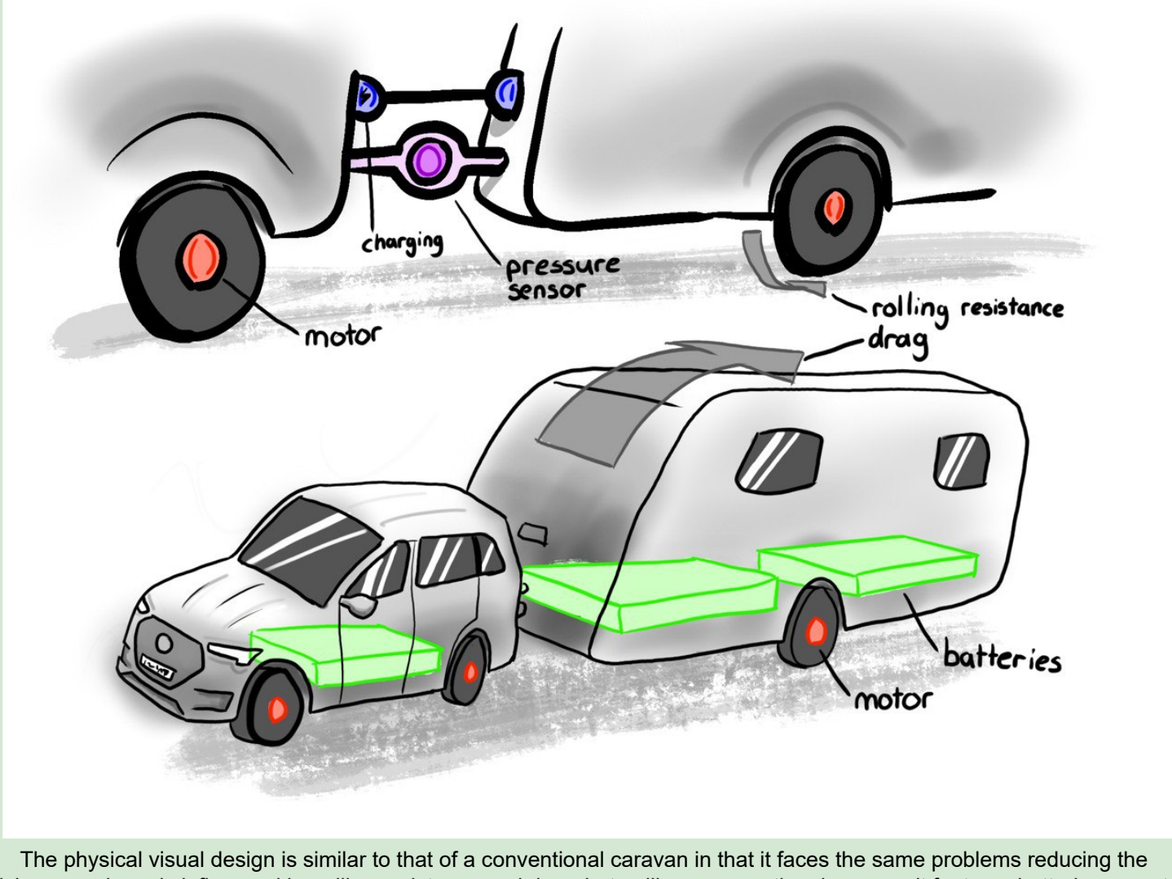
Key trade-offs



Design trade-offs

When designing an electric caravan, several trade-offs must be carefully considered to balance efficiency and comfort. A larger battery provides more range, but it also increases the cost, weight and moment of inertia, which can lead to dangerous situations. To minimize these trade-offs, designers can try to reduce the size and weight of the caravan, but this directly impacts the comfort and usability. Aerodynamics also plays a role, as a more aerodynamic design improves range and efficiency, but may impact the overall aesthetic of the caravan. Incorporating solar panels can extend range, but adds to cost and complexity. Power and torque of electric motors, transmission systems, and wheels also need to be considered. Weight distribution and stability are crucial for safety, and durability and maintenance must be taken into account to minimize cost of ownership.

Physical View



The physical visual design is similar to that of a conventional caravan in that it faces the same problems reducing the efficiency such as is influenced by rolling resistance and drag, but unlike a conventional caravan it features batteries, a motor, and a charging system that can be linked to the car so that both the car and the caravan can be charged at the same time

Definitions and abbreviations

* SPC = Self Propelled Caravan
* OCPP = Open Charge Point Protocol

Self Propelled Caravan
Summary

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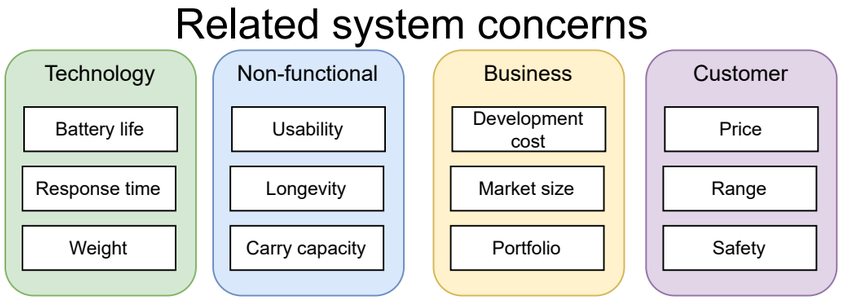
Introduction

Self-propelled caravans, also known as electric caravans, are an innovative technology that allows for greater flexibility and independence when traveling. These caravans are equipped with electric motors and batteries, which enable them to be independent from other vehicles and travel on their own power. This eliminates the range reduction caused by traditional caravans (about 40%), and allows for longer distances to be traveled without needing to stop and recharge. Additionally, electric caravans can be charged at campsites or RV parks, increasing their convenience and ease of use. This means that travelers can plan their journey with more confidence and peace of mind, knowing that they have the ability to recharge their caravan at various points along the way. Electric caravans are not only practical but also environmentally friendly, producing zero emissions and reducing dependence on fossil fuels. They are a great option for those who want to reduce their carbon footprint while enjoying the freedom of travelling in a self-sufficient way, making them a viable alternative for those who want to explore the world in a more sustainable way. With the development of the technology and infrastructure, it is expected that the number of electric caravans on the road will continue to grow in the coming years.

Top level view

The most important parts of the design are the exterior design, the battery, the motor, the charging circuit and the speed controller. The speed controller measures the relative speed between the car and the caravan, and adjusts the motor power accordingly. The battery influences the range, weight and cost, and can be recharged during regenerative braking using the electric motor. The motor power influences the power draw but also the torque and speed, both of which are necessary for safe driving.

Related system concerns



Functional view explanation

Our design of the self-propelled caravan (SPC) consist of a few important parts: the physical body, electric motor, speed controller, large battery, and charging system. The physical body of the SPC experiences negative exterior forces such as drag and rolling resistance, which can affect the energy efficiency of the vehicle. To improve energy efficiency, the SPC is designed to have a sleek and aerodynamic body, minimizing the drag and rolling resistance.

Furthermore, the SPC is also equipped with a pressure sensor in the towbar, which is used to determine its relative speed compared to the car. This input is then used by the speed controller to maintain a consistent speed while the SPC is being towed. This ensures a smooth and safe journey for both the car and the SPC, making the towing experience more comfortable and enjoyable.

Overall, the design of the SPC is a balance between maximizing energy efficiency, convenience, and comfort. With the integration of advanced technologies such as the charging circuit and pressure sensor, the SPC is designed to be a practical and efficient vehicle for travelers who value independence and sustainability.

The SPC is also equipped with a charging circuit that allows it to be plugged into a charging point, simultaneously charging both the car and the SPC. The charging circuit is designed to communicate with the charging point using the open charge point protocol (OCPP), similar to how an electric car would. This ensures that the SPC can be charged easily and efficiently at any charging point.

Physical view explanation

The physical design of the self-propelled caravan (SPC) is similar to that of a conventional caravan. From the outside, it looks almost the same, with a similar shape and size. However, the internal space of the SPC is slightly reduced to make room for the batteries and motor that power the vehicle. Despite this, the convenience and utility of the SPC remain unchanged. The SPC still offers the same level of comfort and functionality as a conventional caravan. One additional difference is the inclusion of a pressure sensor in the towing bar to regulate the caravan speed, and a charging system to provide power to the car during charging.

Known issues

Caravans are known for their poor aerodynamics which greatly reduces the efficiency of the vehicle. This requires the use of more powerful motors and larger batteries to extend the range, which in turn increases the cost and weight of the caravan.

Charging the car and caravan at different charge points would benefit the charging speed, but this may not always be possible due to physical limitations such as distance between charging ports. Charging the car and caravan at the same time through a single charge point is slower, but allows for easier integration with current charging infrastructure.

The use of larger batteries provides a longer range, but also increases the weight of the caravan, reducing its efficiency and increasing the overall cost. Batteries are the most expensive component of an electric vehicle.

Batteries do not perform well under low temperatures, which can limit the places customers can go without dealing with negative consequences such as battery deterioration or reduced charge capacity. This may be an issue for customers who want to travel to more remote locations.

Another current limitation is battery load balancing between the car and the SPC. This would ensure that both batteries deplete evenly, so the caravan does not need to be charged while the car's battery is still full. However, this requires a high power electrical and logical connection between both vehicles, which is not standardized or implemented in any car at the moment.

Key parameters & Requirements

* Range: The range of the car and caravan should be much longer than a conventional caravan, giving travelers the freedom to explore further and experience more on their journey.

* Safety: Safety is a key consideration in the design of the caravan. The caravan should not negatively impact the safety of the driver or other vehicles on the road. To achieve this, the caravan should be able to drive at standard highway speeds and have braking distances that do not exceed that of a normal car.

* Comfort and functionality: The caravan should offer the same amount of space and amenities as a conventional caravan, ensuring that travelers have everything they need for a comfortable journey.

* Cost: The caravan should be priced competitively and not exceed 100,000 EU, making it accessible to a wide range of customers.

References

https://doi.org/10.1017/S0001924000064642

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