

Individual Report

INTRODUCTION

The main idea of the roof design is to build an umbrella shaping structure with an umbrella membrane, a central pin and about 60 rails connect the central pin to the 60 points of the roof edge. The umbrella membrane is controlled by servo DC motors on each rail. The electrical part of the project is to provide power for servo DC motors and design a control system for the motors.

SPECIFICATION

NEED ASSESSMENT

1. It is often rainy in South Africa, so that the maintenance of electronic modules should be considered. Using Block-based design so that each Block can be easily replaced once broken, also each part should cover by waterproof material. Chips and coils in each Block should be cover by waterproof coating such as P2i¹. In addition, coils should not be exposed to the air directly.
2. The position of the central pin is special at the midair so the space to place electronic modules is limited. It is not possible to place huge modules like transformer inside. Also, it is not safe to use too many coils for power supply. Using battery as a entrepot is good because it can be disconnected to the power source once fully charged. In addition, it will not take many wires to charge the battery so that it is easy to maintain or replace.
3. The loads are DC motor, so that the industrial electricity (3 phase 380V AC 50Hz) need to be convert to DC. Because of the using of battery, the problem need to change into charging battery by industrial electricity. It is necessary to build a power supply system to convert the 380V AC power into high voltage DC power which Tesla Motors², the electric vehicle company, have already doing for years. The power supply system's conceptual design is shown in the next section of this report.
4. The number of loads (servo DC motor) is huge so the power matching should be decided carefully. Each battery has its own output limitation, so when the number of loads is exactly confirmed by the mechanical engineers, the number of batteries will be calculated to make sure each battery will not exceed the limitation output.
5. The speed of each motor should be adjustable by controlling the voltage supply. The motors to be applied to the roof control are DC motors, so that the speed can be controlled by voltage supply. And the control system's conceptual design is shown in the next section.
6. Energy efficiency, the system should not waste energy when not activated. The connection between loads and the battery should be designed to disconnect after the roof open or close.
7. Solar power can be used to reduce the industrial electric energy usage.
8. There should be sensor to automatize whole system. Once a membrane carrying module arrive at the spot it should be, sensor on the module can recognise the spot and activate mechanic structure to fix to the spot. Also, the power connection between the module and the battery should be disconnected to reduce the wasting.
9. Emergency situation should be considered. A backup battery which can support a few times roof switching is needed.

CONCEPTUAL DESIGN

The main idea of the electrical part design is to separate the whole circuit system into two parts, power supply system (using industrial electricity and solar power to charge the battery) and control system (using the battery voltage to drive the motor and adjust motor speed by changing the output voltage of the battery), by adding batteries into the central pin as a entrepot. This design can easily reduce the difficulty of the maintenance and fault finding in terms of it separates a complex system into two concise system – battery charging and DC circuit, in another word, the system is similar to a remote-controlled toy car. For the battery choosing, considering about the weight, energy capacity and price, 2170 battery, which is also used by Tesla and Samsung, is one of the appropriate choice.

POWER SUPPLY SYSTEM

The power converting flow is showed in the below picture, and the exact parameter will be calculated after more detail of civil and mechanic part come out.

CONTROL SYSTEM

Batteries module contains pairs of main battery and backup battery. Membrane carrying module contains servo DC motor and sensor. Speed control module contains circuits which can adjust voltage connect the battery and motors. Sensor in the membrane carrying module can give signal to switch off the power when the module arrives at assigned spot. Some detailed systems such as the motor reverse circuit are not showed in the diagram.

REFERENCES

1. <https://www.p2i.com/>
2. <https://www.tesla.com/>

