Dual direction blower system powered by solar energy to reduce car cabin temperature in open parking condition

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Abstract. El-nino phenomenon that strikes Malaysia with temperature recorded more than 35°C can lead to extreme temperature rise in car cabin up to 80°C. Various problems will arise due to this extreme rising of temperature such as the occupant are vulnerable to heat stroke, emission of benzene gas that can cause cancer due to reaction of high temperature with interior compartments, and damage of compartments in the car. The current solution available to reduce car cabin temperature including tinted of window and portable heat rejection device that are available in the market. As an alternative to reduce car cabin temperature, this project modifies the car’s air conditioning blower motor into dual direction powered by solar energy and identifies its influence to temperature inside the car, parked under scorching sun. By reducing the car cabin temperature up to 10°C which equal to 14% of reduction in the car cabin temperature, this simple proposed system aims to provide comfort to users due to its capability in improving the quality of air and moisture in the car cabin.

1. Introduction

Today car is very important as it provides a common means of transportation whether it is a longer commute to work or shorter trip to run errands around town. As the number of vehicles on the road are increasing day by day, drivers are having difficulties to get an indoor or roof parking space especially during peak hours [1]. Malaysia’s standard office hour is from 8.00am until 5.00pm. During this period, the temperature inside car cabin that parked under scorching sun will tremendously increased, approaching 80°C [2]. This will make the driver and passenger become uncomfortable while entering the car. Moreover, the car can also encounter car aging problem and bring damage to the goods and compartments in the car [1]. There is no air ventilation inside the car when left unused, thus, the heat will trapped in the car cabin. As a result, the car user is forced to wait for a period of time around 2 to 5 minutes before getting into the car to let the interior condition to cool down either by rolling down the window or running the air conditioner system at high speed that affect the fuel consumption [3]. The increase of fuel consumption by the air conditioning system subsequently increase CO₂ emission [4] into the environment.

Solar radiation that enters car cabin through windows or windshield is the biggest influencing factor of car cabin temperature [5]. Installation of windows tint and application of aluminum sunshade are among the conventional methods to reduce the car cabin temperature. Windows tint reduces car cabin temperature by reducing the amount of visible light entering car cabin. A study by Jasni and
Nasir comparing three passive methods to reduce car cabin temperature, which include sunshade, ventilator and windows tint, revealed that windows tint was the most effective method in reducing interior car cabin temperature [4]. However lower visible light transmittance (VLT) levels is needed to achieve lower solar radiation entering the car cabin in order to reduce the car cabin temperature even further [6]. With regulation by authorities with certain specification for windows tint VLT percentage, limitation for temperature reduction in car during parking condition is among the unsolved issues.

Therefore, as an alternative to have higher reduction of car cabin temperature despite windows tint and sunshade, recent researches have focused on reducing car cabin temperature by inventing portable heat rejection devices such as Kulcar system and Portable Car Cooling system which require users to purchase an additional device to provide comfort to reduce car cabin temperature [1]. Comparison study on effect of ventilation in the car cabin showed that ventilation is able to reduce maximum temperature at front compartment of the car as much as 2.3°C and 8.3°C for windshield and dashboard respectively. In the same study, the additional ventilator able to reduce the car cabin temperature up to 8.3°C [7] [8].

The objective of the study is to ventilate car cabin when the car is parked in an open area condition. Hence, in this project, modification is made on automotive air conditioning system by making the existing blower motor to blow in dual direction in order to exhaust out hot air in car cabin during parking condition. The system is powered by solar energy to assure the system is not effecting the automotive battery life span. Four cases were experimentally studied to compare the effectiveness of this system in reducing temperature in car cabin.

2. Methodology

2.1 Blower modification

Normal automotive air conditioning blower motor rotates in forward direction and the function is to blow the cooled air that produce by the air conditioning system into the car cabin. Using the polarity concept, the poles of wiring system for the blower is changed to allow the blower motor to rotate in reversed direction when car is in parking mode. In this condition, the blower with reversed direction act as vacuum to exhaust the hot air that trapped inside the car cabin, to the environment.

The polarity change is applied on double pole double throw (DPDT) switch to allow the blower motor to rotate in dual direction which is forward and backward direction. The connection using DPDT switch are as shown in figure 1 and figure 2. The solar generator system is used to ensure the blower motor is running continuously to remove the trapped hot air without using any power from the car’s main battery. The solar panel is a photovoltaic panel which operates at 40 watt and 2.5ampere. The dimension of the solar panel is 2 feet length times 2 feet width. The mechanism of the system is shown in figure 6.
2.2 Experiment
Experiment works is done on a sedan car with tinted window which comply with Road Transport Department Malaysia (JPJ) specification as shown in figure 7 [9]. The car is parked at an open parking area at residential field in Klang, Selangor. Data is collected from 8am to 5pm daily for 2 consecutive weeks using a thermocouple. Solar panel for the dual blower system is located on the roof of the car and temperature sensor is placed hanging on top of the front passenger sit. Four different cases is analysed to compare the temperature variation for different cases as shown in table 1 below. The sunshade was made from aluminum foil and applied at the front windshield with the dimension of 1180mm x 490mm. Rear side windows and back windshield are left bare with only tint films.
Figure 7. Position of temperature sensor

Figure 8. Road Department Malaysia Tinted Window Specification. [9]

Table 1. Four different cases for temperature variation.

| Cases | Condition                                      |
|-------|------------------------------------------------|
| Case 1| Tinted window                                  |
| Case 2| Tinted with front sun shade                    |
| Case 3| Tinted with modified blower                    |
| Case 4| Tinted with front sun shade and modified blower|

3. Results and Discussion

The experiment was conducted between 8am until 5pm which is according to office hour in Malaysia for three days for each case. Ambient air temperature was recorded for all the experiment conducted days to show temperature variation of the day.

Figure 9. Comparison for case 1 and case 2.

The temperature for both cases started to increase from 8am to 1pm. Temperature for case 1 reached the highest temperature of 48°C at 1pm and continue to decrease after 1pm. Meanwhile, the temperature for case 2 reached the highest point of 50°C at 2pm and continue to decrease after 2pm. From the ambient temperature trend, it can be observed that the highest temperature recorded is in
between 1 pm to 2 pm. From figure 9, it is clear that with addition of sunshade in case 2, temperature reduction in the car cabin up to 4% compared to case 1 can be achieved.

![Temperature graph](https://via.placeholder.com/150)

**Figure 10.** Comparison for case 1 and case 3.

Figure 10 shows comparison between case 1 and case 3. Identical temperature changes pattern is observed for case 1 and ambient temperature. The car cabin temperature for both cases increased until 11am. After 11am, although the ambient temperature increased, the car cabin temperature for case 3 decreased gradually until 2pm. The modified blower speed depends on amount of sun radiation to the solar panel. From 11 am to 2 pm, the sun provides direct radiation to the solar panel and blower run at its maximum speed allowing more reduction in the car cabin temperature. However, the car cabin temperature started to increase again from 2pm until 4pm as the modified blower loss its speed and capability to exhaust hot air from car cabin. This is as a result of the solar panel located flat on top of the car roof. It received less sun radiation when the sun radiation incident decreased starting from 2pm onwards. Case 3 reached its highest temperature at 4pm with temperature recorded is 43℃. Based on figure 10, with addition of modified blower system to the car, temperature reduction up to 14% can be achieved.

![Temperature graph](https://via.placeholder.com/150)

**Figure 11.** Comparison of case 2 and case 4.

Similar trend with other cases is observed where the temperature increased from 8am to 11am. After 11am, the car cabin temperature for case 4 decreased gradually and increased again after 1pm. It
reached its highest temperature at 4pm with temperature recorded is around 45°C. From figure 11, it is observed that addition of modified blower system to tinted window and front shade contribute to 9% of temperature reduction when compared to tinted window and front shade without any additional ventilation.

Based from graph in figure 12, much the same pattern of car cabin temperature changes could be seen for both cases. Yet, from 2pm to 5pm, case 4 showed higher temperature compared to case 3 at around 4% difference in temperature. As the speed of blower system decreased starting from 2pm, case 4 which used additional front shade, prevent more heat loss through front windshield than case 3 which contribute to higher temperature in car cabin after 2pm.

Table 2. Temperature reduction percentage between cases

|       | Case 1 | Case 2 | Case 3 | Case 4 |
|-------|--------|--------|--------|--------|
| Case 1| -      | 4%     | 14%    | -      |
| Case 2| 4%     | -      | -      | 9%     |
| Case 3| -      | -      | 4%     | -      |
| Case 4| -      | 9%     | 4%     | -      |

Table 2 above summarize the temperature reduction percentage when the maximum car cabin temperature is compared between different cases. From the above table, tinted windows with modified blower showed the highest temperature reduction when compared with case 1, which is tinted window without any additional method to reduce car cabin temperature. Case 4 recorded the second highest temperature reduction percentage when compared with case 2 as much as 9%. This revealed that the application of sunshades prevents the heat trapped inside the car to be transferred through windows when the modified blower starts to loss its ability to exhaust hot air.

4. Conclusion and Future works
As conclusion, this study presents that the implementation of modified blower to reduce car cabin temperature was successful with temperature reduction up to 14% compared to car cabin without any ventilation. As recommendation, a charge controller to regulate the current before supply it to the solar panel is proposed to maintained the modified blower speed at all time. Automatic adjustable solar
panel holder to allow maximum solar radiation incident throughout the office hour period will also be the future recommendation.

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