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An Effective Control of Auto Defog System to Keep Automobile Windshield Glass Clear

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Abstract: This paper describes the development and validation of an automatic defogging system control. This system consists of an auto defog sensor, an independent actuated defrost door flap toward windshield glass and a control head. The sensor signal is calibrated within 2%RH tolerance according to the windshield glass temperature. A fog probability (FP) value is suggested to indicate the likelihood of fogging for more sophisticated actions. Anti-fog control strategies are established on some practical requirements to be applied in actual vehicles.

Keywords: Auto defog system, Windshield Fogging, Auto defog sensor, Fog probability, Quick fog, Control.

1. INTRODUCTION

Defogging is one of the most important functions in heating, ventilation and air conditioning (HVAC) system and control. Unfortunately, however, most normal users do not know how to remove the windshield fog. Moreover, in many of passenger cars, the sealing of vehicle body has been remarkably improved in order to enhance the incoming noise reduction and the fuel efficiency. However, under this sealing, the ventilation of the air gets worse so that the fog may happen with relative ease.

The purpose of the paper is to develop and validate the auto defog system and control to cope with the quick fog situation.

Fig. 1 The comparision between without and with automatic defogging

2. AUTO DEFOG SYSTEM

The auto defog system enhances windshield visibility by alleviating the occurrence of window fogging. By monitoring the interior humidity, the defog system predicts misting conditions, and takes preventive actions before or as mist is visible. This system consists of an auto defog sensor, an independent actuated defrost door flap toward a windshield glass and a control head as illustrated in Fig. 2. This system allows drivers to keep their eyes on the road through the clear window and improves the overall comfort for passengers by a moderate humidity level. It was considered as key technologies to predict misting conditions before mist is visible and to be compatible with overall comfort during auto defogging.

3. AUTO DEFOG SENSOR

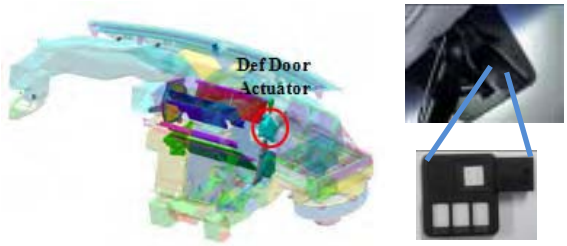

Fig. 2 Auto defog sysem (Sensor and HVAC)

The purpose of the auto defog sensor is the detection and measurement of the invisible fog condition or relative humidity as fog probability. So a tolerance has to be under almost 2%RH in the range from 70% to 100% relative humidity (RH) where fog starts. The sensor is of the capacitive type and is compensated and calibrated according to its windshield glass temperature to improve its accuracy.

4. SIGNAL PROCESS

A fog probability (FP) value is suggested to indicate the likelihood of fogging. The indication numbers will be divided by only 30 steps in the critical range 70%~100%RH. From the viewpoint of defogging control, it is more useful to expand FP value to 256 steps for more sophisticated actions. FP 0 means the minimal probability of fogging just below 70%RH, while FP 255 implies that water-film is fully developed or water drops in windshield glass. FP is affected by the humidity above a certain level, ambient and vehicle speed. The fog probability can be modeled as.

$$FP = K_1(H_r - H_{th}) + K_2 T_{amb} + K_3 V + K_4 , \quad (1)$$

where H_r , H_{th} , T_{amb} and V are the relative humidity, the threshold, the ambient temperature and the vehicle speed, respectively. Also, K_i 's are the coefficients.

This model with variable gains describes the nonlinear probability shape of the fog occurrence according to the change of humidity as shown in Fig. 3.

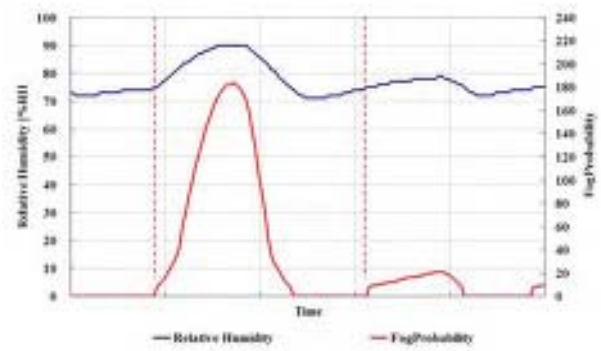

Fig. 3 Fog probability vs relative humidity.

5. CONTROL STRATEGIES

Our control strategies are established on the following practical requirements and field issues.

- reduce power or fuel consumption
- increase / decrease proportionately in the continuous control variables
- reduce passenger's discomfort and incompatibility
- reduce a HVAC noise

As the fog probability increases, an intake mode is put in fresh mode and, then, an air distribution is added to windshield by defrost door opening. At the middle fog probability, air conditioning is turned on, especially, changed from high evaporator target temperature to low in a variable compressor as fog probability and a blower fan speed is increased gradually. At a high level of fog probability, full defrost air distribution mode is chosen. Overall anti-fog control strategies are illustrated in Fig. 4

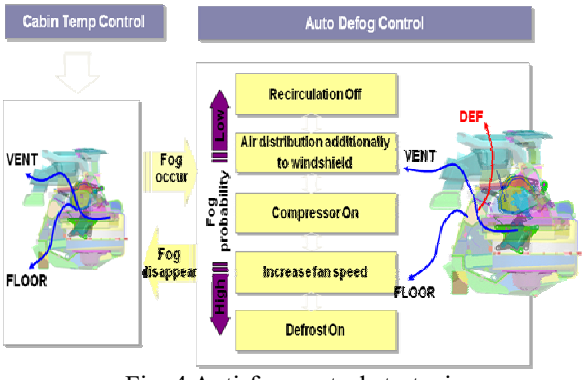

Fig. 4 Anti-fog control strategies

A major problem in excessive windshield fogging comes from the flash and quick fogging. It makes a fog issue even worse because the instance of fogging cannot be detected immediately.

A quick fog is often experienced in case of the wet air bleeding directly from the HVAC duct, heat exchanger or outside moist air to the windshield glass. So we modeled the condensing water amount as the function of air conditioner on/off time, fog probability, and etc. If the remaining water level is predicted over a certain threshold, the air distribution to windshield will be blocked for some moist purging time.

6. TEST RESULT AND CONCLUSION

The proposed auto defog system and control method proved the good anti-fog performance as shown in Fig.5 .

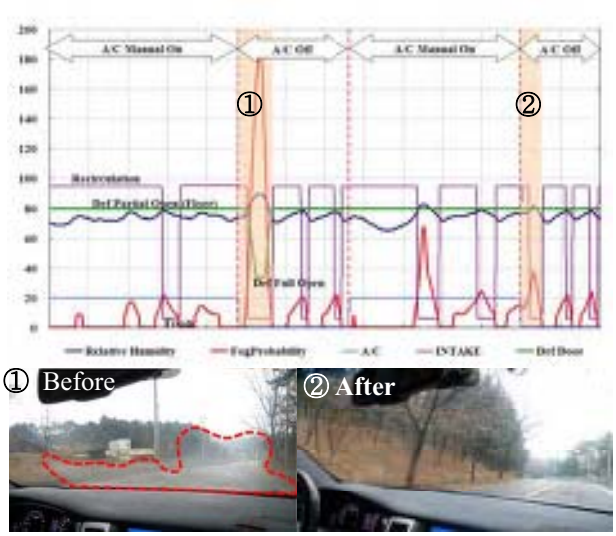

Fig. 5 The comparision between before and after anti-quick fog control

This study has proposed an auto defog system which has the auto defog sensor, the independent actuated defrost door and the control head. We defined the unique requirement of auto defog sensor and the fog probability model was presented to define anti-fog actions more accurately. In addition, the auto defog control was developed and validated through the field tests including the worst case – the quick fog situation.

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