

Development of an Automatic Windshield Defogging System

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ABSTRACT

The development of an automatic defogging system using an accurate windshield humidity sensor and the existing HVAC hardware is described herein. Improved cabin temperature control and forward visibility for the driver was achieved using a sophisticated automatic defogging strategy integrated into the Automatic Temperature Control microprocessor. Laboratory tests were conducted under various weather conditions and test modes using a climate wind tunnel and field tests were conducted in North America. The automatic defogging system worked well in all cases.

INTRODUCTION

The fogging of the car's windshield obstructs the forward visibility of both the driver and the front passenger and is widely considered by many as a major motoring safety hazard while driving or changing lanes. In addition, "excessive windshield fogging" tops J D ' Power Initial Quality Study (IQS) indicating that the problem is not only a safety hazard but is also a major consumer concern. Windshield-fogging-related consumer complaints are attributed more however to the consumers' unfamiliarity with defogging systems than to the actual performance of the systems themselves. In fact surveys have shown that a vast majority of motorists either never use their cars' defogging systems or use them inappropriately.

It stands to reason then that if the automated defogging system is properly operated before the driver attempts manual control both the driver's safety and the passenger's comfort would be further promoted.



Figure 1. Problems caused by windshield fogging

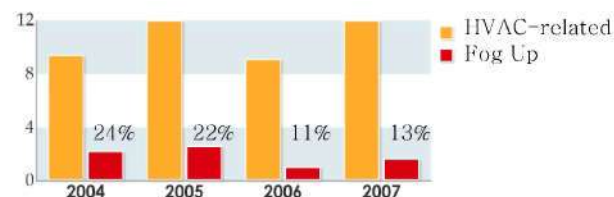


Figure 2. JD Power IQS : Fog up a lot

This document illustrates the development background of an automatic defogging system that was integrated in Hyundai Genesis, based on the hardware and defogging performance test results.

AUTO DEFOG SYSTEM DESIGN

The FATC (Fully Automatic Temperature Control) HVAC system in most vehicles on the road today was designed to maintain the interior temperature at the user-selected

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level and is incapable of providing an effective solution to defogging the windshield. For this reason, the driver constantly manually adjusts the HVAC system to defog the windshield. As a solution, an automatic defogging system can be devised and implemented if the HVAC functions are properly operated by integrating a sensor that detects fogging into the conventional FATC HVAC controller and embedding a defogging control logic in the FATC controller's microprocessor.

The key feature of this automated system is its ability to simultaneously maintain a pleasant in-cabin atmosphere and provide an unobstructed forward visibility for the driver. Even if a defogging system were capable of detecting fog buildup in advance and automatically start to defog the windshield, all would be for naught if the system were incapable of providing similar levels of interior-temperature comfort as the conventional, non-automated defogging HVAC systems can perform. This means that the development of an actuator that would independently open and close the defrost door without sacrificing the HVAC system functionalities was needed, as well as the detail tuning of outdoor conditions (specific dehumidification factor algorithms) in connection with door opening level.

Fig. 3 shows the change that was made to the conventional HVAC unit. This was the result of the efforts to minimize the structural changes to the HVAC and to achieve the independent control of the defrost door. As shown in the figure, the defrost door shaft was separated from the existing operational structure of a cam operated mode door actuator. The separate actuator was added to the door shaft in order to enable the automatic defogging system to independently control the defrost door.

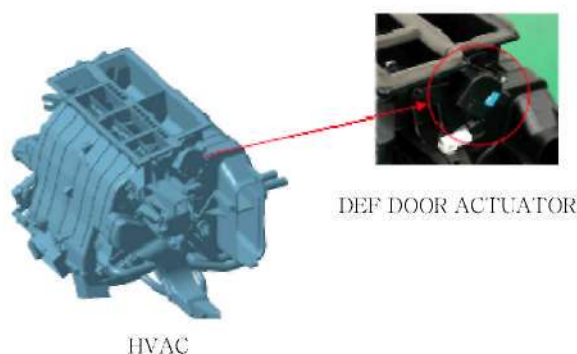


Figure 3. Separate defrost door actuator

The basic concept and mechanism of the automatic defogging system presented herein are shown in Fig. 4. The system is made up of a sensor that measures the surface humidity of the windshield, a controller that analyzes the obtained data to determine the presence of fog on the windshield and an actuator that activates the HVAC defrost door (Fig. 5).

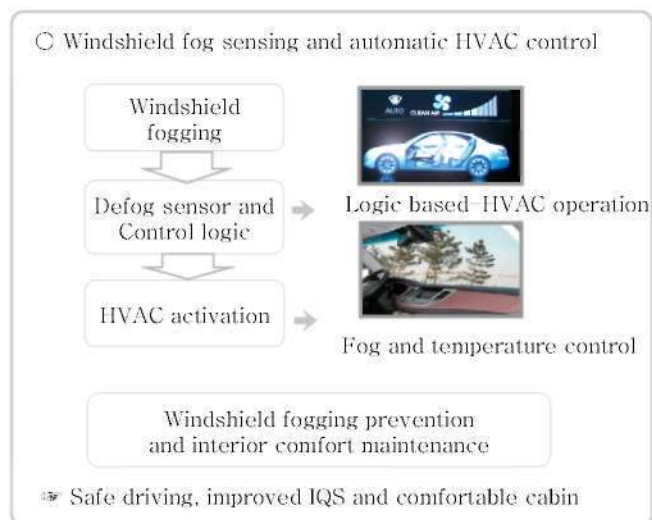


Figure 4. Auto defog system concept.

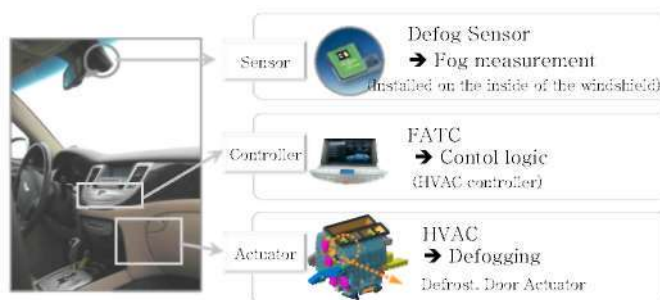


Figure 5. System composition

DEFOG SENSOR

The standard method of measuring windshield condensation involves taking humidity and temperature readings from the air near the windshield to derive the dew point on the windshield surface. In contrast, the presented system utilizes a sensor that takes direct readings of the windshield surface condensation and calculates the relative humidity based on the lead electrode capacitance change. This sensor detects windshield fogging much quicker and features a PID control algorithm that adjusts the measurement basis points for accurate sensing when sudden changes in humidity occur.

As interior-air stream, air discharge direction, temperature, passengers, and various other elements affect windshield condensation, different readings may result, depending on the position of the sensor. This requires the configuration of the sensor position and a baseline windshield condensation level that will trigger the HVAC. The defog sensor in the developed system was positioned behind the rearview mirror, on the cabin side of the windshield, considering the driver's view, solar radiation, and interior aesthetics (see Fig. 6).