Windshield Fogging Prevention by Means of Mean Radiant Temperature Sensor

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Abstract

To improve driving safety it is of outmost importance to guarantee that the windshield never starts fogging by means of an automatic and reliable procedure. To reach this goal and keeping always in mind comfort and fuel consumption, a fogging condition estimation algorithm has been developed. It requires a Mean Radiant Temperature (MRT) sensor and a humidity sensor. The MRT sensor is placed on the cabin compartment roof and points towards the dashboard and the windshield. Therefore it may be used to estimate windshield inner surface temperature. Combining this last piece of information with cabin relative humidity measured by the humidity sensor, the estimation algorithm forecasts fogging conditions so that the automatic thermal control system is able to take actions before fogging starts to appear. Centro Ricerche Fiat has already developed for Fiat Auto and patented a cabin thermal control that uses as feedback just MRT and blown air temperature one. This approach is not only safer, but it allows also cost savings with respect to state of the art sensor layout.

1 Introduction

One of the most important tasks that the air conditioning system has to perform on a vehicle is to assure perfect visibility by removing moisture condensed on the inner windshield surface. This is obtained by blowing warm air with an appropriate velocity and distribution through the defrost outlet. Usually, even if there is an automatic climate control unit, the driver is required to interact with it to start defog or defrost procedure by pressing a button and/or turning on the compressor.
This has two consequences on safety:

- The action takes place when moisture formation is already affecting driver visibility.
- The driver is required to perform an action that is not related to driving, thus affecting his/her level of attention.

Moreover, this may also have an impact on thermal comfort, since defrost/defog procedure usually sets airflow to maximum level and temperature blending to maximum heat. It may not be possible to assure both defogging procedure and thermal comfort, since the former is obviously a priority. But there are several other strategies that may benefit from reliable estimation of incipient fogging conditions. In particular, those that require control of the recirculation flap, such as air quality systems based on gas sensor, or energy saving strategies aimed at reducing thermal load on heater and evaporator.

Impact on fuel consumption is also worth to be mentioned. One of the devices that can help in defogging is turning on the compressor, provided that the external temperature is not too low (usually in the climate control unit there is a constraint regarding it). This results in condensation of the water vapour contained in the air to be treated by the heater, allowing to send drier air to the windshield, but it increases also fuel consumption: therefore, to know in advance that fogging condition is bound to appear may avoid the need for the compressor to be turned on.

From the above considerations, it is clear that to know when incipient fogging occurs can be very helpful for several reasons: safety, comfort and fuel consumption.

Generally speaking, there are two ways to get this piece of information: to detect it by means of sensors that are directly influenced by the condensation itself, or to estimate it by means of models or via sensors that measure physical quantities that influence the phenomenon. The different approaches are compared in [1]. If the approach requires additional sensors, in the analysis of the solution it is very important to evaluate if they can be useful also for other functions of the air conditioning system, or if the offer potential for additional functions (as an example, humidity control), so to perform the correct cost benefit evaluation.

Centro Ricerche FIAT has chosen a sensor set up that include a Mean Radiant Temperature sensor and a humidity sensor. This solution allows for incipient fogging condition detection and is perfectly integrated with other functions of the air conditioning system: thermal comfort and humidity control.