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Intelligent energy management control of vehicle air conditioning system coupled with engine

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HIGHLIGHTS

► AC interacts: vehicle, environment, driver components, and the interrelationships between them.
► Intelligent AC algorithm which uses three integrated fuzzes controllers to improve fuel consumption.
► Intelligent AC controller is a more efficiently since it integrated with the engine operation.

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ABSTRACT

Vehicle Air Conditioning (AC) systems consist of an engine powered compressor activated by an electrical clutch. The AC system imposes an extra load to the vehicle's engine increasing the vehicle fuel consumption and emissions. Energy management control of the vehicle air conditioning is a nonlinear dynamic system, influenced by uncertain disturbances. In addition, the vehicle energy management control system interacts with different complex systems, such as engine, air conditioning system, environment, and driver, to deliver fuel consumption improvements. In this paper, we describe the energy management control of vehicle AC system coupled with vehicle engine through an intelligent control design. The Intelligent Energy Management Control (IEMC) system presented in this paper includes an intelligent algorithm which uses five exterior units and three integrated fuzzy controllers to produce desirable internal temperature and air quality, improved fuel consumption, low emission, and smooth driving. The three fuzzy controllers include: (i) a fuzzy cruise controller to adapt vehicle cruise speed via prediction of the road ahead using a Look-Ahead system, (ii) a fuzzy air conditioning controller to produce desirable temperature and air quality inside vehicle cabin room via a road information system, and (iii) a fuzzy engine controller to generate the required engine torque to move the vehicle smoothly on the road. We optimised the integrated operation of the air conditioning and the engine under various driving patterns and performed three simulations. Results show that the proposed IEMC system developed based on Fuzzy Air Conditioning Controller with Look-Ahead (FAC-LA) method is a more efficient controller for vehicle air conditioning system than the previously developed Coordinated Energy Management Systems (CEMS).

1. Introduction

A classical Air Conditioning (AC) system consists of an engine powered compressor activated by an electrical clutch. AC imposes an extra load onto a vehicle's engine by increasing its fuel consumption, which leads to greater emissions. To the best of our knowledge, there has been no comprehensive study to quantify the effect of vehicle air conditioning system coupled with engine, under various operating and driving conditions. Therefore, this study investigates what operating conditions contribute to a greater fuel consumption accounting for the air conditioning system. Lambert et al. [1] reported that the mechanical compressor can increase fuel consumption by up to 12–17 percent for subcompact to mid-size cars. Also they showed that optimising the energy consumption of the AC system of a vehicle, would help improve the overall energy efficiency of the vehicle.

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