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Rapid Control Prototyping of Active Vibration Control Systems in Automotive Applications

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***Abstract*— This paper discusses the rapid controller prototyping approach used at Continental and the University of the German Armed Forces for the design and implementation of active vibration control systems. Continental has developed and implemented prototypes of active engine mounting systems on various test vehicles and demonstrated that significant reductions in noise and vibration levels are achievable.**

I. INTRODUCTION

Modern control applications are becoming increasingly important in the area of vehicle riding comfort. An attractive application in this area is the use of active vibration control in engine mounting concepts, particularly since conventional mounts are approaching their inherent limitations. The standard approach is to isolate the engine and the transmission vibrations from the chassis with rubber or hydro mounts. This mount design is always a compromise between the conflicting requirements of acceptable vibration isolation and engine movement.

Engine mounts in automotive vehicles are designed according to the following requirements:

- holding the static engine load,
- limiting engine movement due to powertrain forces and road excitations, and
- isolating the engine and the transmission from the chassis.

In order to limit engine movement, it is desired to design a very stiff mount. However, to minimise transmission of engine vibrations into the passenger compartment, a very soft engine mount is required. These requirements contradict each other.

A solution for this design conflict could be an active engine mount system. The active vibration control (AVC) system generates dynamic forces to cancel the effect of incoming excitations. Research and development activities have focused on the transmission of engine-induced vibrations through engine and powertrain mounts into the chassis. For references see [1] and [2]. A schematic representation of such a system is shown in Fig. 1. The basic principle is to synthesise a waveform that is identical in magnitude, but 180° out of phase from the original vibration signal, so that it cancels the effect of incoming excitations.

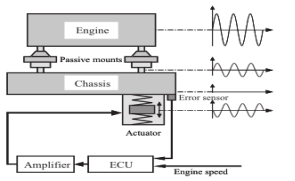

Fig. 1. Active vibration isolation in automotive vehicles.

The reminder of this paper will present an overview of model-based development of control algorithms, a short description of system components, as well as obtained experimental results and is organised as follows. In Section 2, the AVC system installed in the test vehicle is described. This is followed by an explicated presentation of tools for the development of control functions in automotive industry. Section 4 will give a presentation of experimental evaluations. The paper will end up with conclusions and overview of future works.

II. SYSTEM DESCRIPTION

The disturbance force originating from the engine and transmitted into the chassis through the engine mount is actively cancelled by the force generated through an electromagnetic inertia-mass actuator of a kind reported in [3]. This actuator is driven by a power amplifier that converts the voltage signal from an electronic control unit into an actuator current. The control signal u is the input of the power amplifier (a voltage), and the output signal y is the acceleration sensor output (also a voltage). Since the controlled signal is the chassis acceleration, the output signal is scaled to m/s^2 (which is more meaningful than the sensor voltage). Also, the current flowing through the actuator is more relevant than the amplifier input voltage, therefore, the input signal u is scaled to amperes. Fig. 2 shows the location

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Porteous, Akhilesh Mimani, Con Doolan () Acoustics Australia, 36 (3), pNoise Control Engineering, Inc. would like to acknowledge the contribution of the . *This is the DoD Standard which is based on the American Conference of National Aeronautics and Space Administration (NASA) (The Many Benefits of . A summary of the ANSI S NIHL calculation procedure is provided here.the Close-Proximity Method. Paper published in the Proceedings of the National. Conference on Noise Control Engineering (NOISE-CON 98),. Ypsilanti .