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DEVELOPMENT OF AN ADAPTIVE CONTROLLED GAS-SPRING-DAMPER FOR PASSENGER CARS

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ABSTRACT

This paper presents recent work concerning the development of a Gas-Spring Damper Unit (GSD). A GSD is composed of several air springs working against each other and connected by a restrictor. The restrictor is a high flow piezoelectric valve. The valve is manufactured in-house by piezo ceramic injection moulding. The GSD, as a vehicle suspension, has to isolate the body from the high frequency vibrations caused by the uneven road surface. It also needs to guarantee proper contact between tire and road for driving safety. For the high volume market of small and medium sized cars the GSD ought to be presented as a cost effective adaptive damping system.

Our GSD comprises two air chambers of different size working against each other. The GSD payload results from its geometry, the damping additionally from valve setting. The final GSD force is the difference between the forces of both Gas-Springs. Compressing the GSD means compressing the larger Gas-Spring and expanding the smaller one. This causes an increase of the force of the larger Gas-Spring, while the force of the smaller Gas-Spring decreases. An air flow between the chambers reduces the potential energy and creates a damped system. Hence, the modulation of the air flow controls the damper rate of the GSD.

The base for the valve is a structured Piezo ceramics using the 3,1-Piezo effect. In a hybrid structure with steel, the small displacement of the Piezo results to an angular displacement of a solid ring. The amplification factor of the integrated movement amplification system is above 15. There are multiple holes on the ring. Their cumulated surface equals the valve crossing section which depends on the displacement. Integrated pressure sensors at the valve are used as input for the local controller. In this paper, the results of a prototype are presented. The prototype was designed to generate a maximum flow area at limited stress. To achieve this goal, we optimized the complete valve on a finite element model. Based on the experimental results, the valve optimization and final design is presented.

A test bed with integrated GSD is shown in this paper. Our test bed comprises a mounting plate, a linear induction motor and a sliding bed arranged one upon the other and interconnected by linear bearing. The GSD is connected to the mounting plate and to the sliding bed. On this test bed, we evaluated the performance of our control strategies for the GSD. The GSD will be redesigned for wireless power supply and communication. Due to the cost effectiveness the construction will be manufactured as an injection moulding Piezo structure.