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VIRTUAL PROTOTYPING OF A CAR DIRECTION INDICATOR SWITCH USING HAPTIC FEEDBACK

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ABSTRACT

The present work describes the whole procedure of virtually prototyping a direction indicator switch for a car. Although turn switches are mechanisms with simple geometry, designing the "feel" of the driver when operating one is quite a challenge. To use the CAD drawings or conventional CAE simulation and then to convert these results into "user feelings" mentally, needs a very skilful designer as well as very detailed specifications from the ergonomic designer. This could be nicely replaced with the experience to switch with a virtual device reproducing the force feedback that would characterize the real counterpart with a high degree of precision. In this context, the challenge is to establish a method to design a virtual switch which would work on a desired operating force profile.

To achieve this objective the following steps had to be followed:

- Developing a haptic system that would be capable of replicating the force profile of a real switch.
- Defining a desired force profile, and determine the corresponding cam mechanism geometry. After the theoretical synthesis of the cam mechanism, the MBS simulation could be then applied if cam profile modifications and adjustments are needed from technological reasons.
- Then, the new geometry should be tested on the virtual prototype simulated by the dedicated haptic device for final assessment from the point of view of the end-user.

Developing a haptic system able to replicate a certain, measured force profile implies a complex process. The first stage is to design and build a mechatronic system able to provide the same feeling as the real switch. For the purpose of the proposed research, a 1 dof system was adopted including a MAXON motor with controller EPOS (Fig. 1). The system's general architecture and design mimics the real switch device in order to facilitate the assessment of the virtual prototype in the same conditions as the real system. Controller design and details are given in the paper.

For the haptic rendering purpose, a detailed CAD model was developed for the switch. This

was further imported in a Multi Body Simulation in order to define a MBS model of the system able to deliver a theoretic force profile. In the next stage this model was validated experimentally and calibrated accordingly, in order to get it as close as possible to the behavior of the real system. The experimental validation and calibration was performed using a physical model that was subject to measurements, to determine the real force profile.

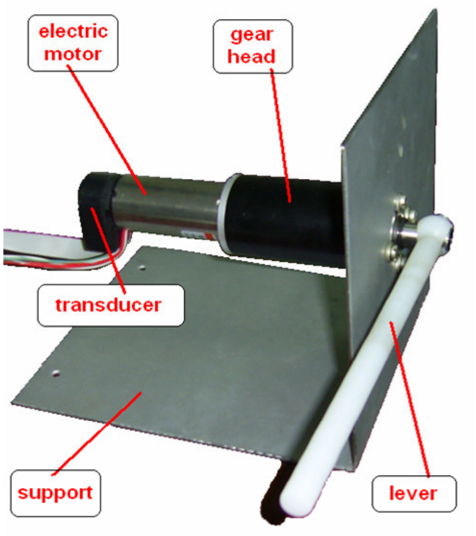

Fig. 1. Haptic system

A C++ computer program was could read the force profile and supply the motor with the adequate current, in order to get the required reaction torque on the shaft. Alternatively, the reaction torque could be the result of the MBS simulation, in case a cam profile is given, allowing thus to assess it directly before the physical model is executed.

In order to accelerate the design process, a dynamic synthesis of the cam mechanism was developed which makes possible to determine the cam geometry starting from an imposed force profile that was previously validated on the haptic device.

This new approach of designing a direction indicator switch enables the designer to also design the “feel” of the switch, and directly manufacture a good model, skipping the usual iterative process to get to the desired force profile, which sometimes means also taking some compromises. The project is also an example of combining CAD, CAE, Mechatronics and also Haptics, providing the design of an extra tool, the control over the “feeling”.

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