Multidisciplinary development of new door and seat concepts as part of an ergonomic ingress/egress support system

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Mechatronic systems continuously gain in importance in today's automobiles. They give the possibility to meet the customers' wishes for more comfort and safety. Despite the advantages already achieved mechatronic systems still provide potential for further improvement. Therefore five institutes of the Technische Universitaet Muenchen in collaboration with BMW work on a multidisciplinary project which is part of the cooperation CAR@TUM. Based on the example of an ergonomic ingress/egress support system the scope of this project is the improvement of mechatronic systems and their development processes.
One of the major goals within the project is to assure an ergonomic design. This concerns improving the comfort of ingress and egress as well as the development of a door operating concept. Furthermore it is to create a model in order to measure arising discomfort for static postures and dynamical movements. This shall serve the other team-members as input to identify functions for technical realisation: e.g. object detection and anthropometry, intention recognition, seat adjustments.
Sensors are used to detect an approaching car driver. With this anthropometric data the driver's seat shall be preadjusted prior to/during ingress. Hereby it is possible to support the passenger during the seating movement, as well as to provide an approximate seat position setup.
Additionally, sensors provide ambience information being a prerequisite to avoid collisions between door and obstacles.
Especially in parking situations it is desirable to have doors allowing multiple opening paths. This renders the possibility to choose the way of opening the door situation-dependently based on ambience information gathered. Thus collateral obstacles can be avoided and discomfort during ingress/egress can be reduced. To ensure usability the system's degree-of-freedom can be reduced by means of actuators. Alternatively specific kinematic structures can be preselected by using actuated locking mechanisms or mechanical transmissions.
The proposed door mechanism and its actuation are evaluated via user studies using a high-fidelity Virtual Reality System with force feedback. Using this system, a virtual car door control algorithm can be emulated and tested along with the necessary sensors and actuators. The capacity of the Virtual Reality System can be fully utilized to study the effects one component has on the other and to optimize the haptic effects that the door will provide.
Based on the experiences with the presented system a further intention is the design of a generic development process and associated methods/tools to support development of mechatronic products. Therefore a mechatronic product- and process-modeling is designed which integrates component and function specific views and allows a domain-integrating, transparent representation of the process. This also involves setting up associated stages of maturity. Furthermore domain overlapping interdependencies among functions and system elements have to be comprehended and represented in a comprehensible way.