UNIVERSITI TEKNOLOGI MARA

KINEMATIC ANALYSIS ON CONCURRENT BRAKE ACTUATOR DESIGN FOR DYNAMICALLY MODELLED MOTORCYCLE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The simultaneous application of front and rear brake are required to obtain a better braking performance on the motorcycle. The proper amount of braking force on both wheels is needed to optimize the braking performance and stability of the motorcycle. The braking effectiveness can be maximized by keeping the ideal nonlinear brake force distribution during braking. The objective of this work is to develop a new concurrent brake actuator (CBA) with nonlinear force distribution to improve the braking capability and stability control on the motorcycle system. The analysis of the CBA conceptual design was carried out to identify the best actuation mechanism. The integration of Design Failure Mode and Effect Analysis (DFMEA) and SOLIDWORKS Motion Analysis have been utilized in this analysis. The optimal brake force distribution was obtained based on the Altair HyperStudy framework and become a design target for CBA. The CBA model was developed based on the concept of the passive compliant actuator to exhibit the required design target. Then, the kinematic analysis of the CBA model was carried out using the multibody dynamic (MBD) platform offered by Altair MotionView. The validation of the experiment results possessed an excellent correlation with the CBA performance. It also found that the simulation results had correctly predicted the overall force distribution produced by the CBA. However, spring stiffness and mass of the CBA main body are identified as the significant factors that influenced the CBA performance. Therefore, the optimization analysis was carried out to obtained the optimum configuration of CBA. Design exploration analysis offered by the Altair HyperStudy-MotionView framework has been used in this study. The range of spring stiffness was set between 9.00 N/mm to 20 N/mm. The range of mass for the CBA main body is 0.2 kg up to 0.3 kg. Global Response Surface Method (GRSM) was used to identify the optimum configuration. Based on this analysis, the spring stiffness of 15.30 N/mm with the mass of the CBA main body is 0.255 kg has been selected for CBA configuration. The optimum CBA configuration possessed the best correlation compared to other spring stiffness conditions. The prediction obtained by this optimum configuration had correctly predicted as the design target. Therefore, a new CBA has been successfully developed to distribute nonlinear brake force with CBA main body mass is 0.255 kg and spring stiffness of 15.30 N/mm. Thus, the braking performance of the motorcycle can be enhanced with this final configuration of the CBA. Therefore, the riders of motorcycles will receive the safety benefit from this CBA design regardless of their skill level and riding experiences.

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