A new Receptance Coupling Substructure Analysis methodology to improve Chatter Free cutting conditions prediction

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Abstract

The cutting process stability depends on machine tool dynamics that is strongly influenced by the tool. Receptance Coupling Substructure Analysis (RCSA) can be used to estimate the tool tip dynamic compliance and consequently the chatter free cutting conditions when the machine is equipped with a tool that has not been previously tested. This methodology can be particularly useful on real shop-floors where a lot of different tool-tool holder configurations are generally used. RCSA typically combines experimental dynamic compliance measurements performed on a machine equipped with a selected tool and the Finite Element (FE) models of both the already tested tool and the new ones. This paper presents a new Receptance Coupling Substructure Analysis (RCSA) approach that overcomes the drawbacks in the estimation of the receptances that contain rotational and moment contributes. This indeed often limits the accuracy of the RCSA techniques presented in other scientific works. The proposed formulation allows to better estimate both the matrices of receptances of the spindle-tool holder assembly and the tool-tool holder connection stiffness. Those quantities are used, together with the FE model of the new tool, to predict the unknown tool tip dynamic compliance. Some useful guidelines to implement the proposed RCSA are also defined: they allow to manage the procedure accuracy considering the experimental methodology typically used to measure dynamic compliances. The proposed innovative RCSA is experimentally tested and validated.