STUDIES IN IDENTIFICATION AND MODIFICATION OF DYNAMIC MECHANICAL SYSTEMS

THESIS SUBMITTED TO THE INDIAN INSTITUTE OF TECHNOLOGY, DELHI,
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BY

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TO

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ABSTRACT

The present studies deal with System Identification for extracting a physical model of a linear dynamic multi degree of freedom (MDOF) mechanical system, directly from its multipoint harmonic mobility data. The studies also include the development of System Modification techniques for which the parameters of the extracted models provide the input data base. The dynamic behaviour of systems predicted from their identified models and of modified systems predicted from the modified-identified models has been extensively studied.

The application of System Identification technique has been demonstrated by identifying the parameters of equations of motion of two d.o.f. 'Vibration Absorber' system and an eight d.o.f. lumped linear representation of a machine tool like continuous system - an F-structure, from the analytically generated mobility data base.

The mobility data base has also been polluted with controlled measurement errors to study the effect of Bias and Random errors on System Identification and Modification. The model identified from exact mobility data base (I-Model), the one identified from polluted mobility data base (DT-Model), and the Exact Model (exact analytical formulation) are used to predict the dynamic behaviour of the unmodified and modified MDOF systems.

The changes occurring in the mass, stiffness, and damping matrices of the equations of motion of a MDOF system due to

the physical mass, stiffness and damping modifications on the system have been identified. The modification procedures to incorporate the corresponding changes in the parameter-matrices have been developed. The procedures also include the possibility of attaching a tuned absorber to the system. Several System Modification studies by modifying the mass, stiffness and damping matrices of the directly identified physical models have been undertaken to explore the feasibility of employing the identified model data base and evaluate their utility for System Modification purposes.

The dynamic behaviour of the modified systems has been evaluated in terms of those drive point and relative responses which affect the performance of the system. For a mechanical system like that of a machine tool it is also important to study the influence of modifications on its stability or chatter behaviour. Accordingly the studies also include the evaluation of the resulting negative real part of receptance which influences the dynamic stability of a machine tool.

The developed System Identification and Modification software implementable on a digital computer has been observed to be an effective tool in the hands of a dynamicist for improved MDOF system design or modification without resorting to time consuming and expensive hit and trial experimental dynamic testing-modification cycle. The conclusions in greater detail and some suggestions for further work have been included in the last chapter.

CERTIFICATE

This is to certify that the Thesis entitled "Studies in Identification and Modification of Dynamic Mechanical Systems" being submitted by Mr. Tejinder K. Kundra to the Indian Institute of Technology, Delhi, for the award of the Degree of 'Doctor of Philosophy' in Mechanical Engineering, is a record of bonafide research work carried out by him. He has worked under my guidance and supervision and has fulfilled the requirements for the submission of this Thesis, which has reached the requisite standard.

The results contained in this Thesis have not been submitted in part or in full, to any other University or Institute for the award of any degree or diploma.

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