



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS**

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SHORT ABSTRACT

Time-frequency based signal processing is a popular technique for output only operational modal analysis (OMA). These techniques are mostly based on either Hilbert transform (HT) or wavelet transform (WT) besides other time-frequency tools which are less popular among the researcher and engineers. Different Hilbert transform based techniques are empirical mode decomposition (EMD) or Hilbert-Huang transform (HHT), ensemble empirical mode decomposition (EEMD), analytic mode decomposition (AMD) and multi-variate mode decomposition (MEMD). The major drawback of these tools is their lack of strong mathematical background in the light of modal vibration and their susceptibility to generate spurious modes. Moreover, these techniques have a prerequisite for free vibration response for modal identification which is either directly obtained or digitally processed using other techniques available in the literature. The motive of the current study is to investigate the improvements of HHT based algorithm for their use on forced response directly. The improved algorithm should have the ability to minimize the generation of spurious mode and to differentiate between the modal and the forcing frequencies. To address the issue, an adaptive filtering technique is proposed prior to apply HHT based identification techniques. This is followed by a phase comparison which separates out input frequencies present in the response. It compares two decomposed responses belonging to the same mode extracted from two different sensors.

With the successful implementation of improvised HHT for OMA using forced vibration response, the study continued to investigate further for more accurate and efficient time-frequency analysis. It is observed that wavelet based pre-filtering works efficiently which makes the EMD operation redundant. Hence, a combined WT-HT based algorithm is further developed that can avoid the spurious mode generation. The problem is more complex in presence of contiguous modal or forcing frequencies which are clubbed over different regions in the scalogram. To address these issues, two major modifications are proposed in this study - i) use recently developed synchrosqueezed transform that offers better resolution with the same number of scales and ii) use machine learning algorithm to bypass ad-hoc intermittency which is practically difficult to implement in forced response based OMA. The synchrosqueezed transform used in this study offers better energy spectrum in a workable precision. It is followed by k-means clustering based unsupervised learning to avoid intermittency and to achieve automated identification of energy segregation. Together these two modifications offer a high fidelity identification algorithm for forced response based OMA. The qualities of the results are impressive as the estimation errors are consistently well within the allowable limits for all practical purposes.