Computer vision technique for blind identification of modal frequency of structures from video measurements.

Vishal Allada and T . Jothi Saravanan

School of Infrastructure
Indian Institute of Technology Bhubaneshwar
Odisha, India.

The 8th International Electronic Conference on Sensors and Applications

(Student Session)

CONTENTS

Objective:

To extract the modal frequencies of the structure from structure's video, by estimating the time history data of the structure, using computer vision techniques like complex steerable pyramids, and separating the modal frequencies using principal component analysis (PCA) and analytical mode decomposition (AMD).

Methododlogy:

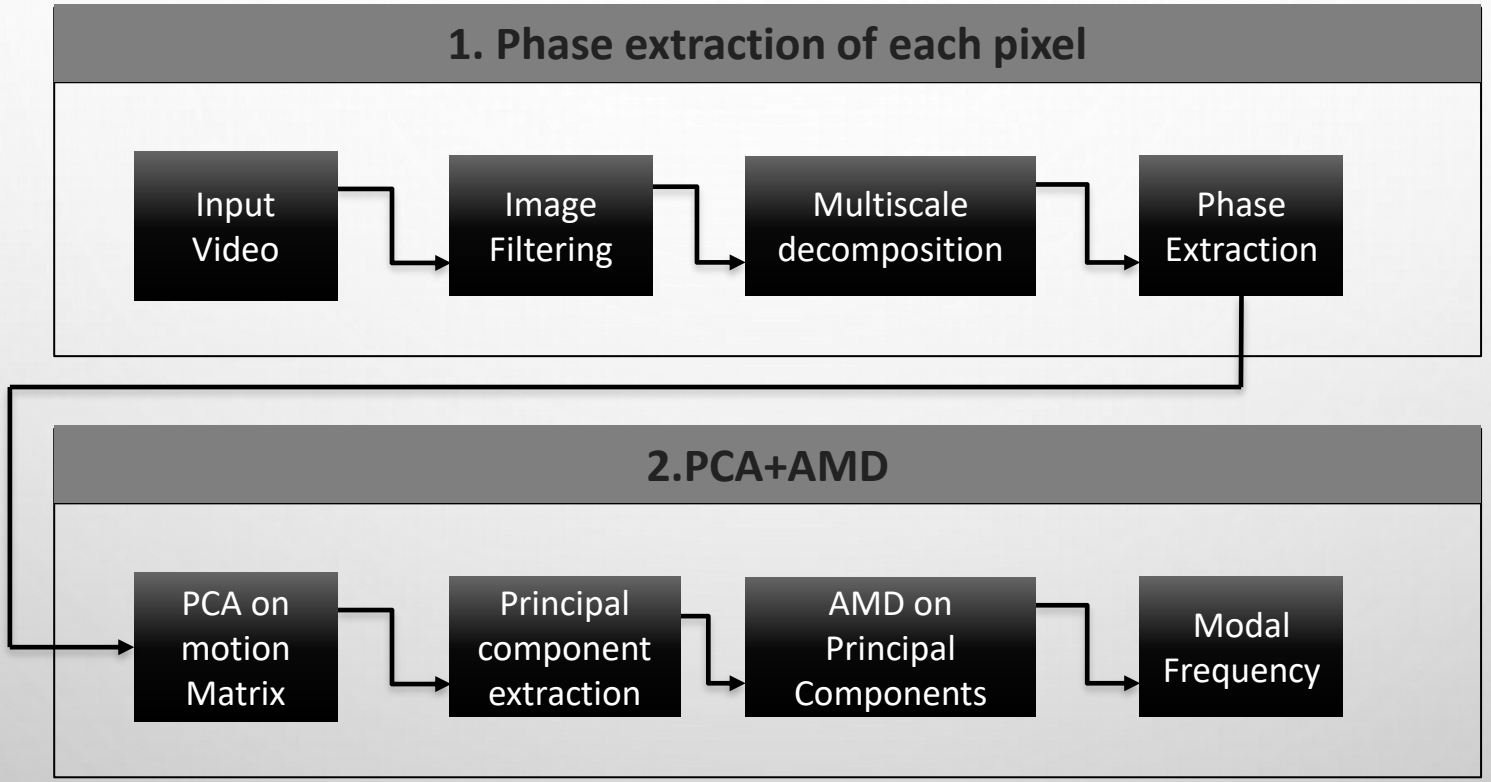


Figure 1- Flowchart of proposed method

Validation:

The proposed method is validated on a 10 DOF numerical model

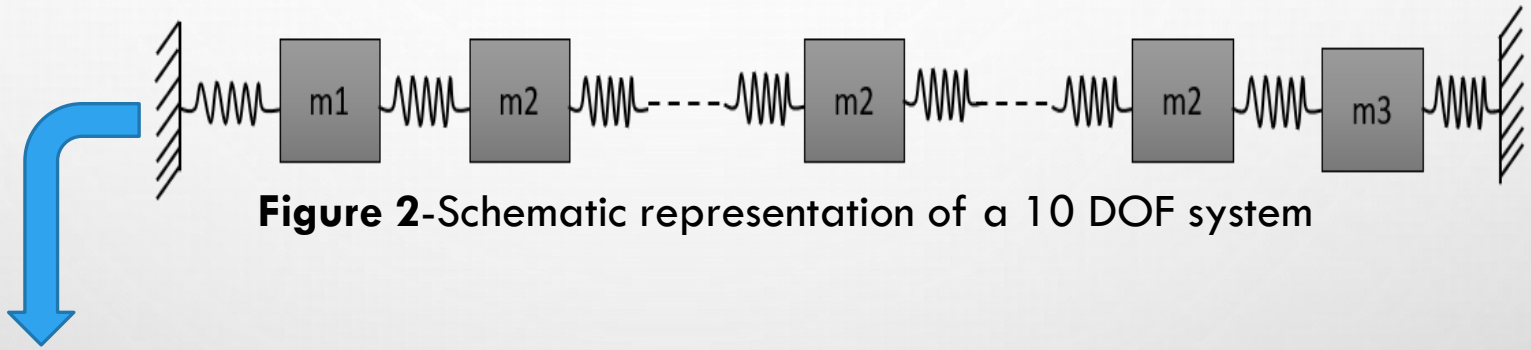


Figure 2-Schematic representation of a 10 DOF system

New10 channel output with 4 modes dominant is generated by Newmark Beta Algorithm → PCA for dimension reduction → AMD for signal decomposition

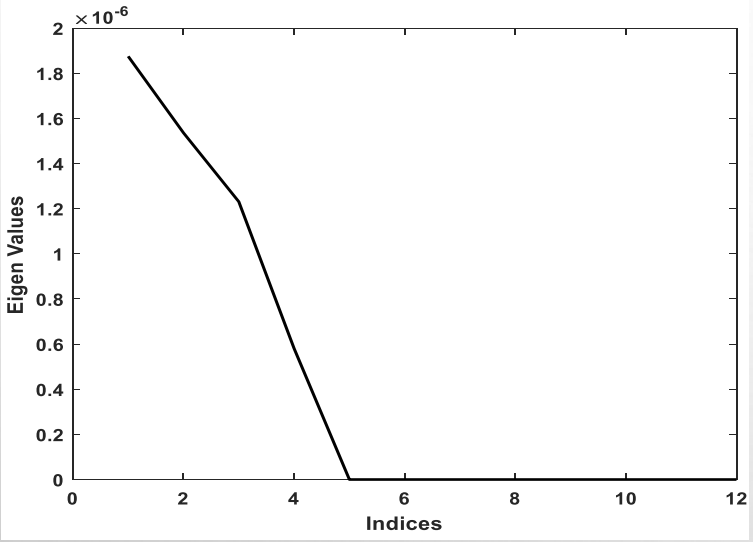
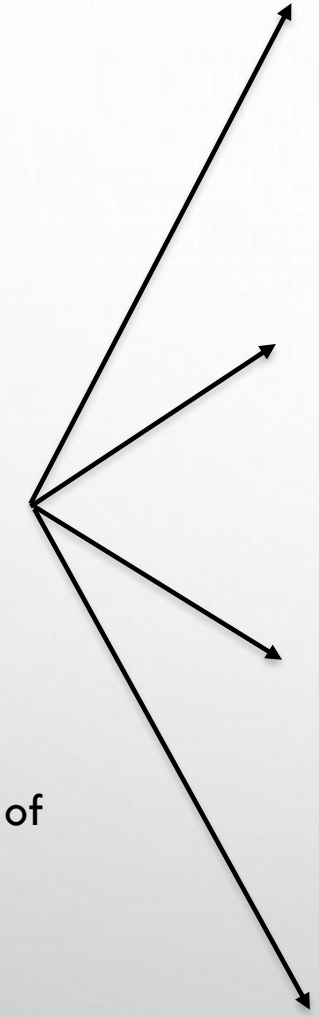
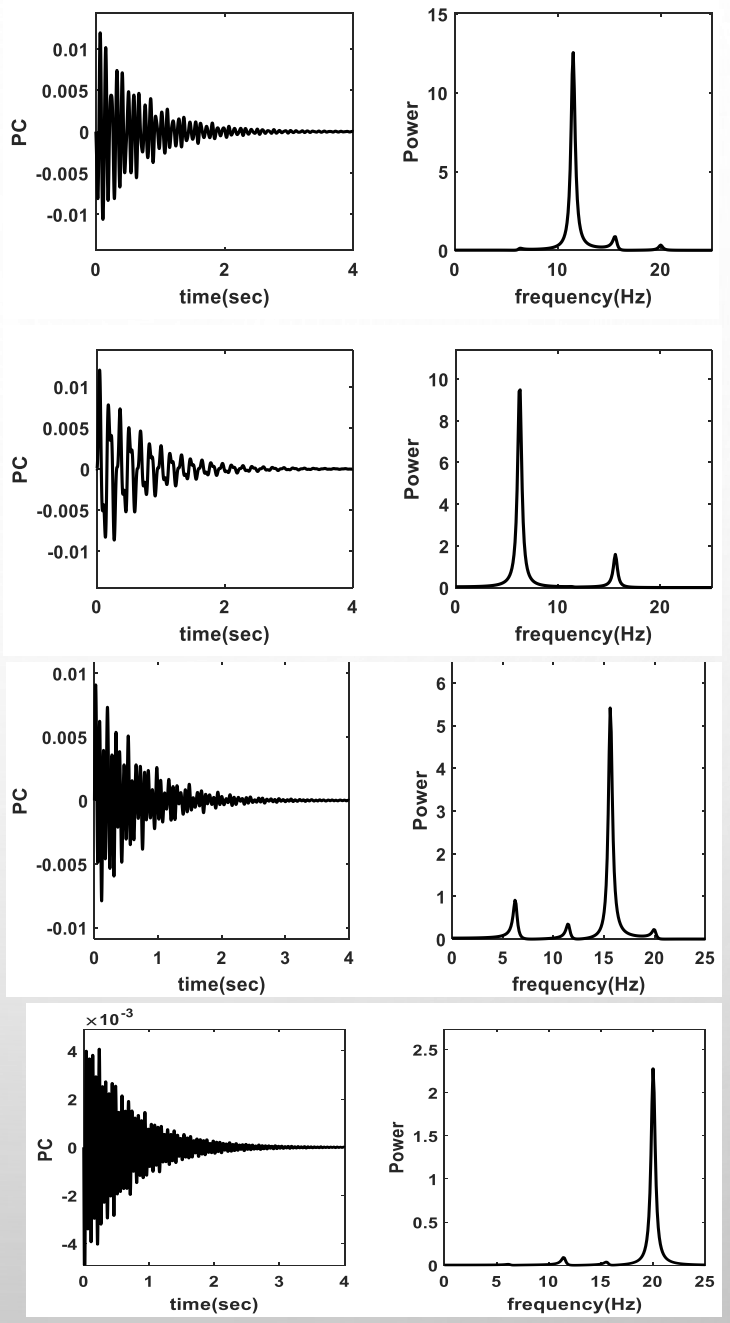


Figure 3 – Eigen Value Decomposition of covariance of motion matrix





(Principal coordinate 1)

(Principal coordinate 2)

(Principal coordinate 3)

(Principal coordinate 4)

Figure 4 – Principal coordinates of numerical model

Results of Numerical model

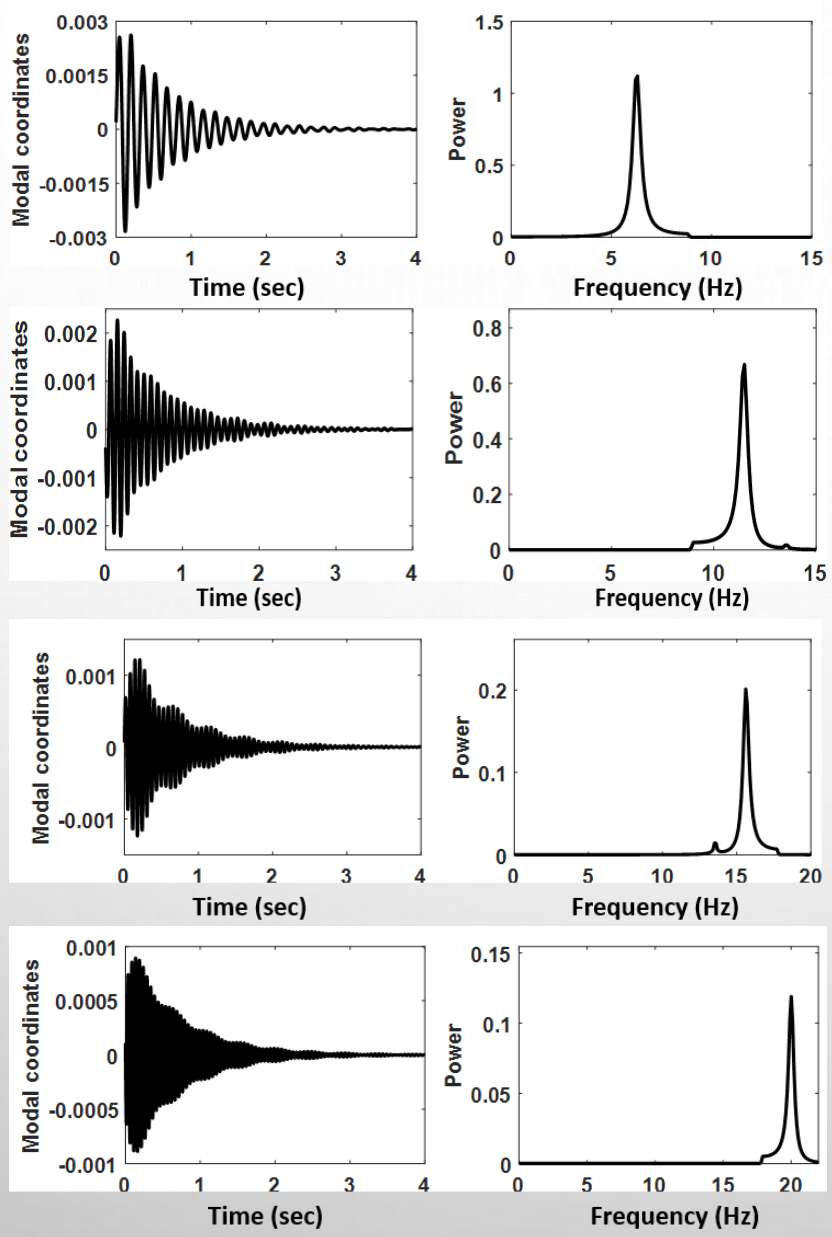


Figure 5 – Extracted modes

Mode	Frequency (Hz)		Error %
	Theoretical	Estimated	
1	6.25	6.30	0.8
2	11.45	11.50	0.09
3	15.62	15.60	0.13
4	20.03	20.00	0.15

Table 1 – Results comparison

Implementation:

Figure 6 – Actual frame of video of London Millennium bridge, used for analysis.

Figure 7 – Cropped frame

Figure 8 – Amplitude part

Figure 9 – Phase part

Results of Numerical model

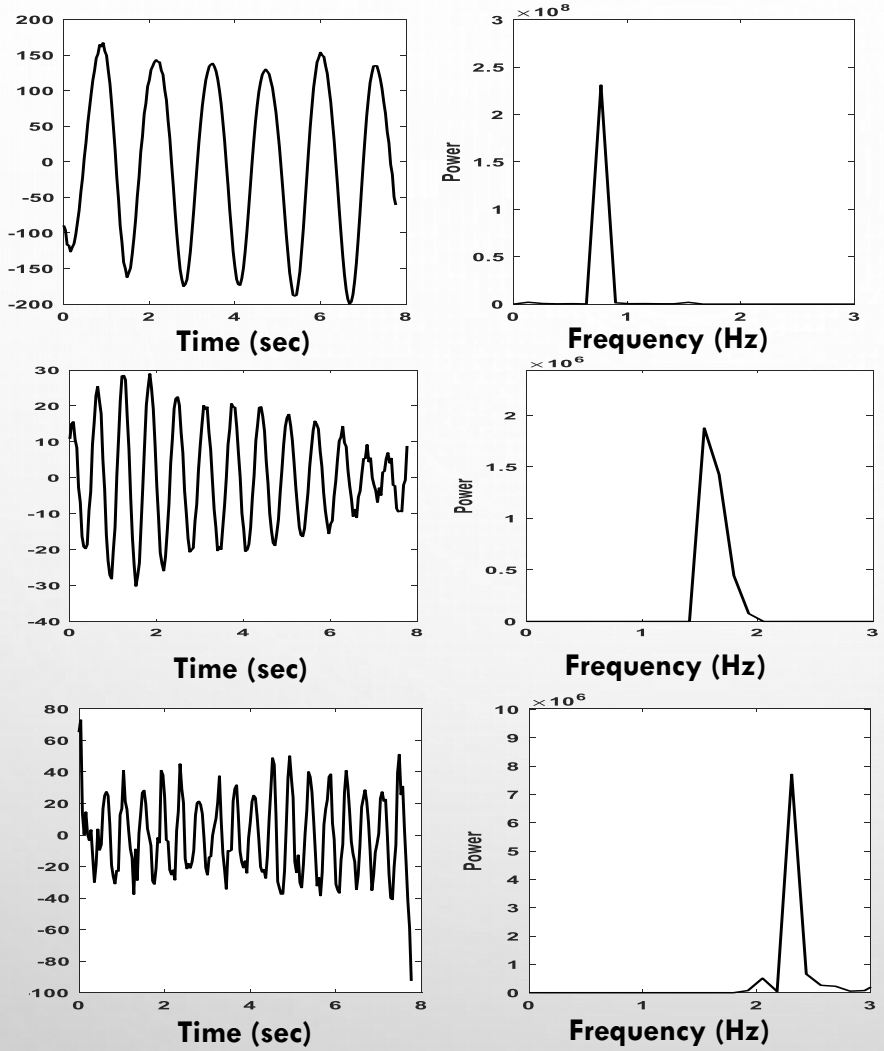


Figure 10 – Modes extracted from video of London Millennium bridge

Mode	Frequency (Hz)		Error %
	From Pavic, A et. Al	Estimated	
1	0.77	0.769	0.13
2	1.54	1.53	0.65
3	2.32	2.31	0.43

Table 2 – Results comparison

Conclusion:

- This study develops a hybrid output-only OMA algorithm that uses PCA and AMD to blindly extract the modal frequencies and modal coordinates from line-of-sight video measurement of the structures
- The 10-DOF dynamic numerical model validation and implementation on London Millennium Bridge resulted in more than 99% accuracy in detecting the modal frequencies.
- Henceforth, the recommended algorithm can be utilized for an effective non-contact OMA using a computer vision monitoring system.


Thank You