

# The Development of a Vision-Based Vibration Measurement System for Characterizing Civil Structures

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## Acknowledgement



Faculty mentor: Shirley Dyke

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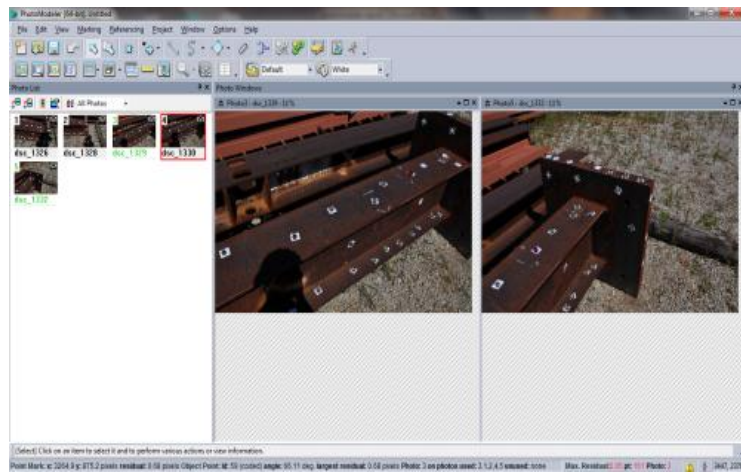
School of Engineering

## Motivation

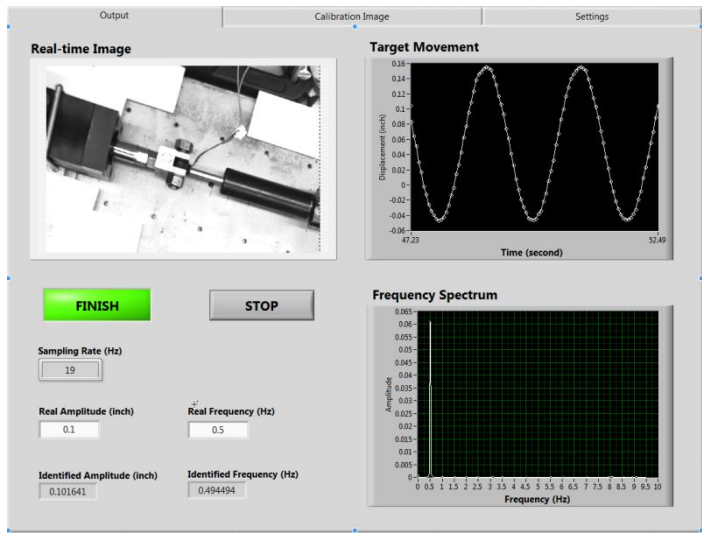
- ❖ Detecting the condition of a structure is very common in civil engineering
- ❖ Traditional contact sensors like accelerometers have limitations in some cases
- ❖ This project focuses on developing a vision-based vibration measurement system for characterizing civil structures



## Two focuses



- The modeling of the testing structure
- Use PhotoModeler to get the 3-D model of an I-beam



- The detection of the vibration of the structure
- Validate the vibration measurement system using an actuator

# Introduction of PhotoModeler



PHOTOMODELER

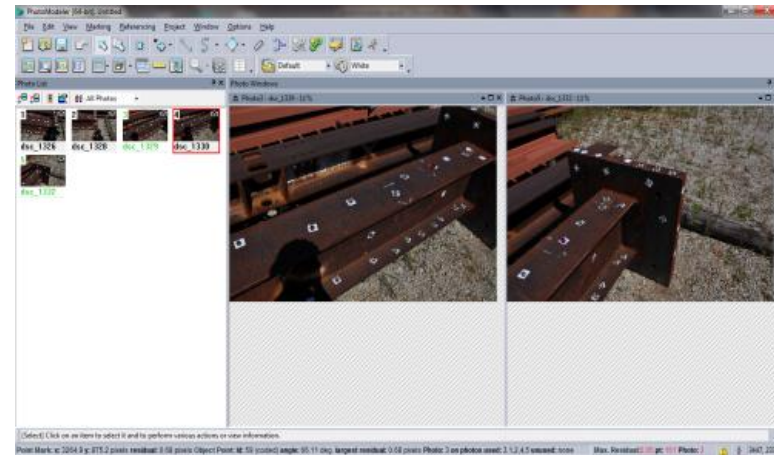


# Procedure in using PhotoModeler

1. Take photos of the structure (after calibration)

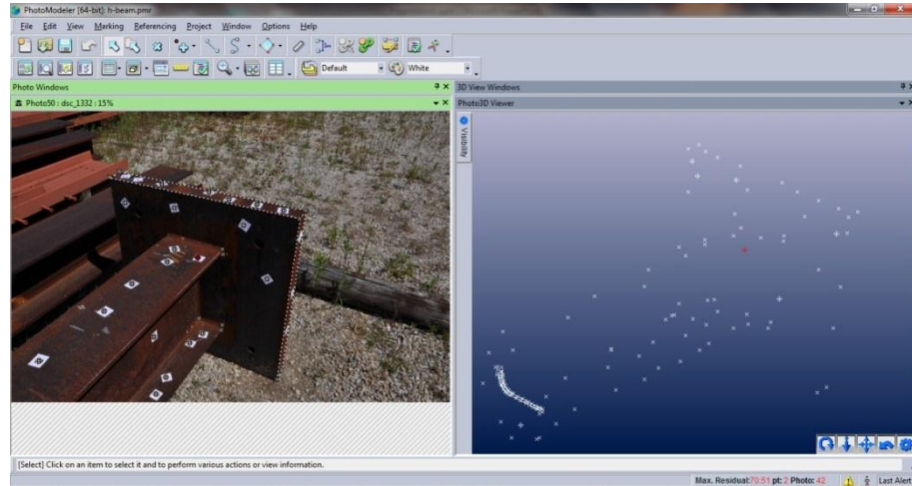


2. Load the photos in the software

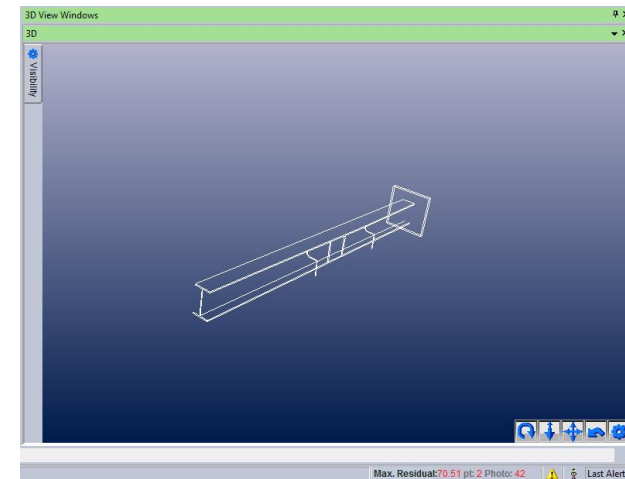


# Procedure in using PhotoModeler

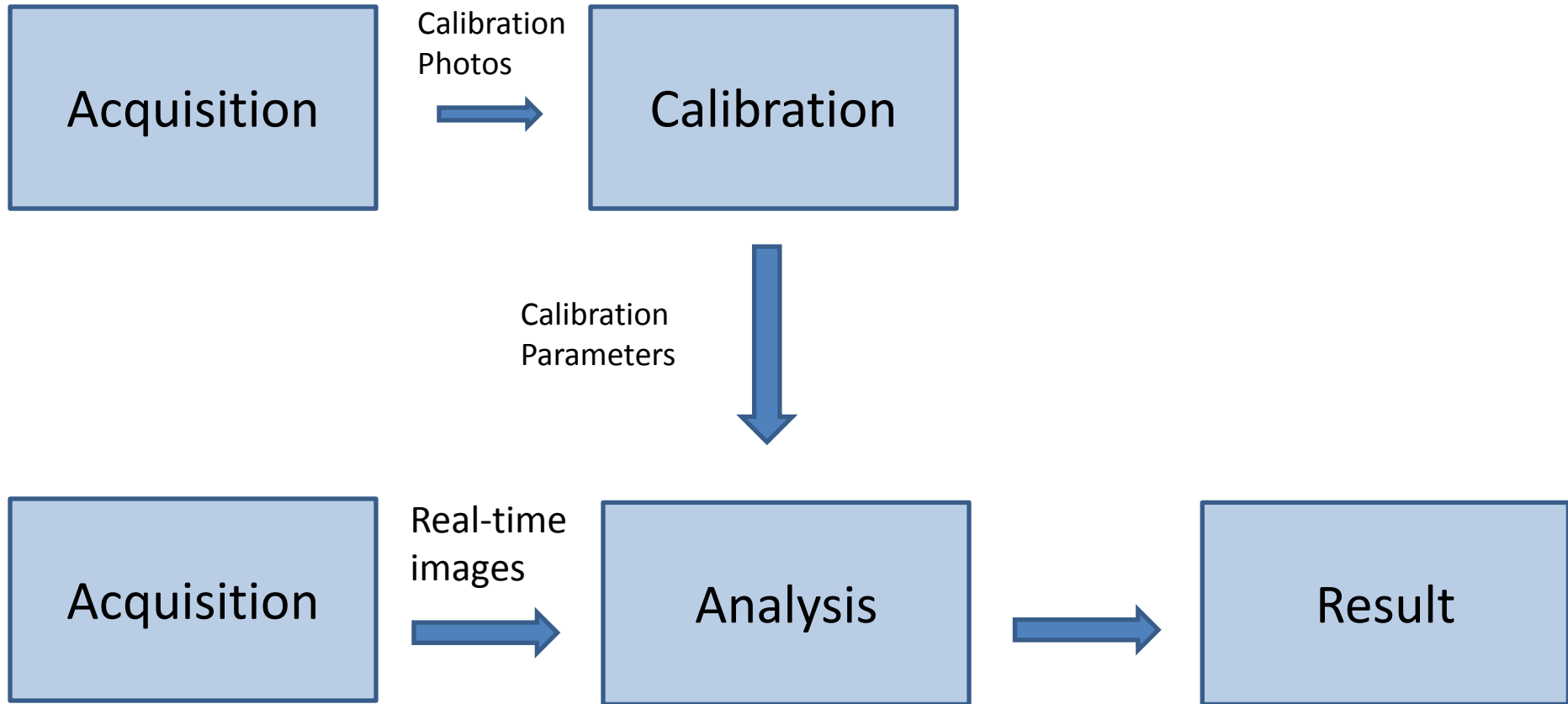
3. Mark the points on the structure and get the point cloud



4. Generate the 3-D model

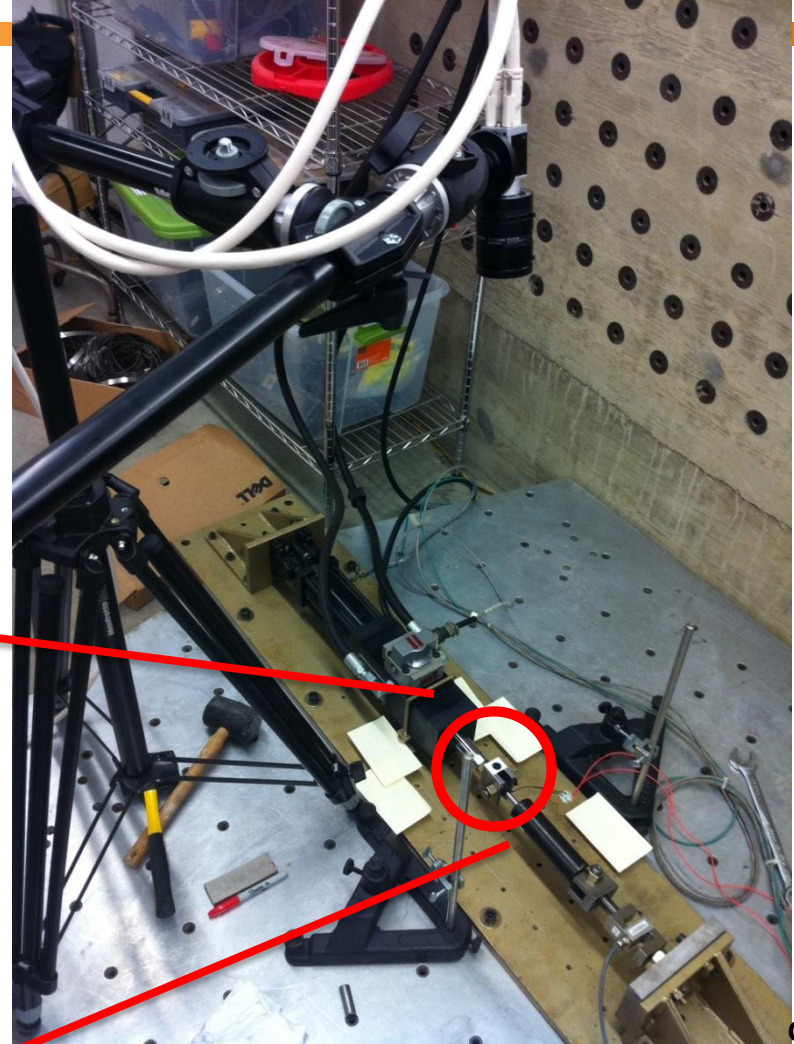
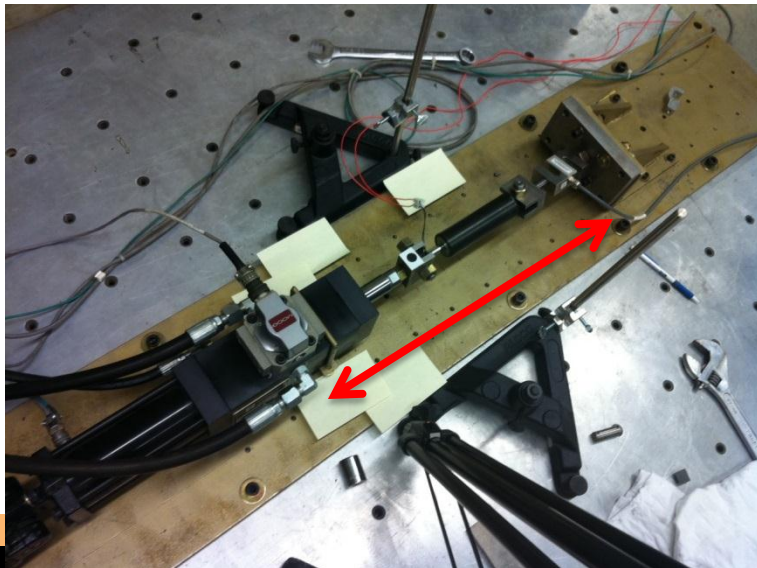


# Vibration Measurement System





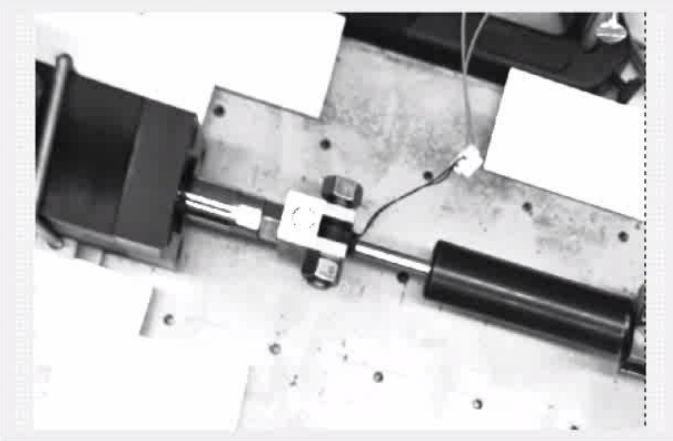
## Experiment Setup



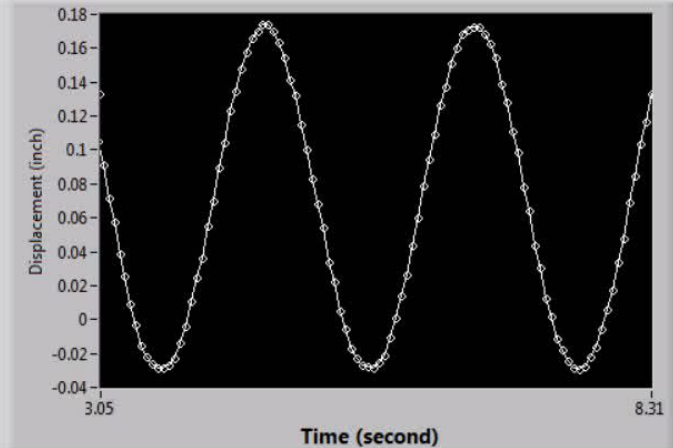
# Experiment Results

Output      Calibration Image      Settings

### Real-time Image



### Target Movement



Time (second)	Displacement (inch)
3.05	0.10
3.50	0.00
3.95	0.17
4.40	0.00
4.85	-0.03
5.30	0.00
5.75	0.17
6.20	0.00
6.65	-0.03
7.10	0.00
7.55	0.17
8.00	0.00
8.31	0.13

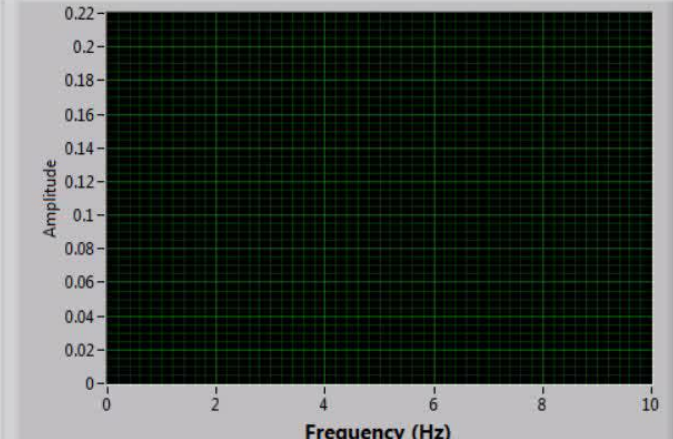
**Tracking...**      **STOP**

**Sampling Rate (Hz)**  
19

**Real Amplitude (inch)**      **Real Frequency (Hz)**  
0.1      0.5

**Identified Amplitude (inch)**      **Identified Frequency (Hz)**  
NaN      -Inf

### Frequency Spectrum

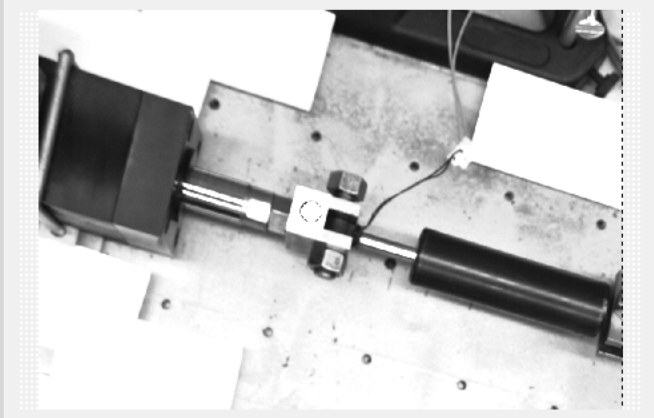


Frequency (Hz)	Amplitude
0	0.00
2	0.00
4	0.00
6	0.00
8	0.00
10	0.00

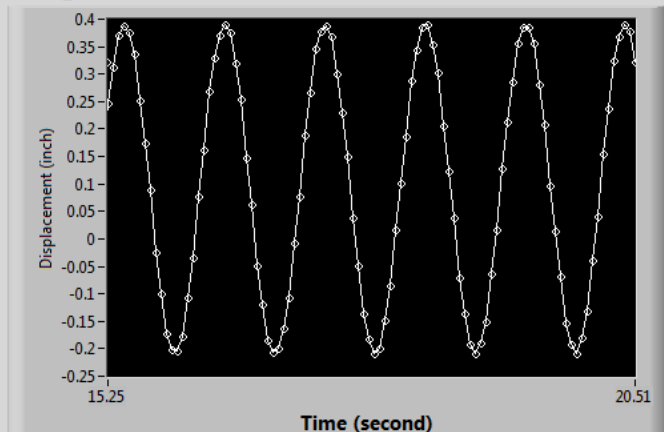
## Experiment Results

Output Calibration Image Settings

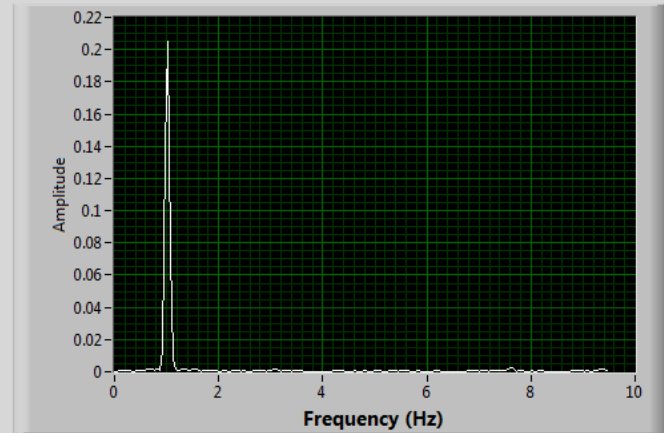
### Real-time Image



### Target Movement



### Frequency Spectrum



**FINISH** **STOP**

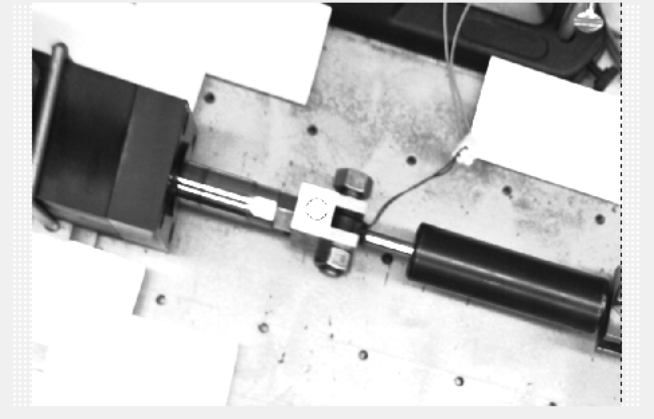
Sampling Rate (Hz)  
19

Real Amplitude (inch)	Real Frequency (Hz)
0.3	1
Identified Amplitude (inch)	Identified Frequency (Hz)
0.298962	1.02046

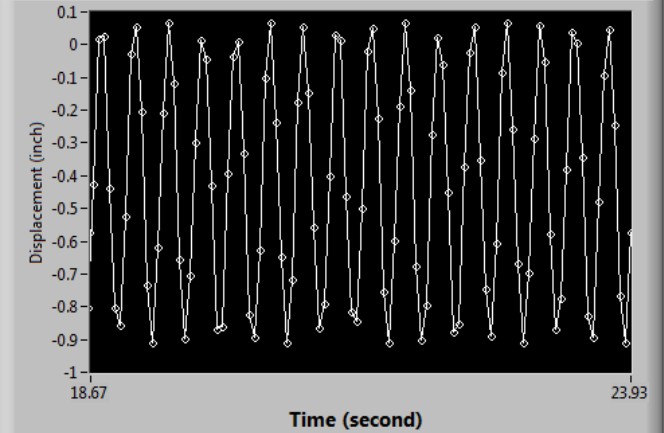
## Experiment Results

Output Calibration Image Settings

### Real-time Image



### Target Movement



Displacement (inch)

Time (second)

18.67 23.93

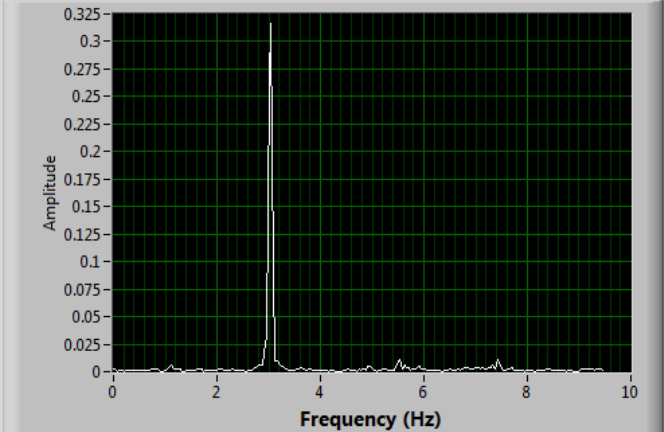
**FINISH** **STOP**

Sampling Rate (Hz)

19

Real Amplitude (inch)	Real Frequency (Hz)
0.5	3
Identified Amplitude (inch)	Identified Frequency (Hz)
0.48876	3.04167

### Frequency Spectrum



Amplitude

Frequency (Hz)

## Conclusion

- ❖ Photogrammetric software such as PhotoModeler provides us a powerful tool to generate 3-D models of structures
- ❖ The newly developed vibration measurement system is validated by actuator test under low frequency cases
- ❖ This technique can be applied to many civil engineering or other engineering fields
- ❖ The analysis of the acquired dynamic data is left for future study

## Citations

- ❖ American Association of State Highway and Transportation Officials. n.d.. Veterans Memorial Bridge. [*Photograph*]. Retrieved from <http://bridges.transportation.org/Pages/Massachusetts.aspx>
- ❖ PhotoModeler. n.d.. Overview. [*Photograph*]. Retrieved from <http://www.photomodeler.com/applications/default.html>
- ❖ Meggitt Sensing Systems. n.d.. Accelerometers. [*Photograph*]. Retrieved from [http://www.wilcoxon.com/vi\\_index.cfm?CatM\\_ID=1](http://www.wilcoxon.com/vi_index.cfm?CatM_ID=1)

Thank you!