The 1st International Project Competition for Structural Health Monitoring (IPC-SHM, 2020)

Sponsored by:

- ANCRiSST
- Lab of Intelligent Civil Infrastructure, Harbin Institute of Technology, China
- Smart Structures Technology Laboratory, University of Illinois at Urbana-Champaign, USA
- CCCC Highway Consultants CO., Ltd.
- CCCC Civil Big Data Information Technology (Beijing) Co., Ltd.
- State Key Laboratory for Health and Safety of Bridge Structures, China Railway Bridge Science Research Institute, Ltd.
- State Key Laboratory on Safety and Health of In-service Long-span Bridges, JSTI Group, China

Welcome

As the demands on our infrastructure continue to increase, the combination of artificial intelligence (AI) technology with SHM offers exciting research opportunities to better ensure that our infrastructure is safe and reliable.

To foster and encourage innovation in the SHM community, this year we are initiating an international student project competition for SHM. All interested students and young scholars are invited to participate in the competition. The competition consists of three projects, each incorporating data drawn from a full-scale bridge:

(1) image-based identification of fatigue cracks in bridge girders;
(2) data anomaly detection for SHM;
(3) condition assessment of stay cables.

Certificates and cash prizes (1st prize - $1000; 2nd prize - $500; 3rd prize - $300) will be awarded for each of the three project competitions. Participants may take part in one, two, or all three projects.

We will be publishing the IPC-SHM 2020 proceedings online, which will include the papers and presentation videos from contest participants. Papers from winning entries will be recommended for publication in the Journal of Smart Structures and Systems, subject to the Journal's peer review process.

We warmly welcome you to the competition and wish you good luck in your efforts!

Prof. Hui Li, Harbin Institute of Technology, China
Prof. Billie F. Spencer Jr, University of Illinois at Urbana-Champaign, Urbana, IL, USA

Advisory Committee

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Hong-Nan Li	Dalian University of Technology, China
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Jian Li	University of Kansas, USA

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Jiwei Zhong	China Railway Bridge Science Research Institute, Ltd
Yufeng Zhang	JSTI Group, China
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Jian Zhang	Southeast University, China
Dongyu Zhang	Harbin Institute of Technology, China

Rules

- Participants must be full-time undergraduate, M.S., PhD students, or young scholars within three years after obtaining their PhD.
- Participation can be by individuals or teams (each team can have no more than 5 persons).
- Participants can compete in one, two, or all three projects.
- Registration forms must be submitted to ipcshm@yahoo.com by June 21, 2020. A data download link will be opened after registration.
- Contest entries must include:
  (i) commented code that will reproduce your results (MATLAB 2019b or 2020a; Python code using Google Colab notebook; Corresponding dataset shared on Google Drive),
  (ii) a ten-minute presentation video with both the slides and the speaker clearly visible and associated PowerPoint slides,
  (iii) a 10-15 pages paper following the downloadable template on the IPC-SHM website.
- The papers and presentation videos will be included in the proceedings published on the IPC-SHM 2020 website.
- All submitted material should be in English.

Prizes

- Winners will be selected by the Awards Committee based on the identification accuracy, the video presentation of the results, and the submitted paper (see IPC-SHM Evaluation Metrics below).
- First prize (1000 USD cash), Second prize (500 USD cash) and Third prize (300 USD cash) will be awarded for each of the three project competitions.
- All participants will receive certificates.

Publications

- The IPC-SHM 2020 proceedings will be published online.
- The winning teams will be invited to contribute full papers for possible publication in a special issue of the Journal of Smart Structures and Systems. Other participants will have opportunity to contribute a paper to the special issue. All papers will be subject to rigorous review.

Important Dates

- June 21, 2020 – Registration, please send the registration form to *ipcshm@yahoo.com*.
- August 31, 2020 – Submit the Commented code, a ten-minute video presentation, and a 10-15 pages paper to *ipcshm@yahoo.com*:
- September 30, 2020 – Announcement of competition winners.

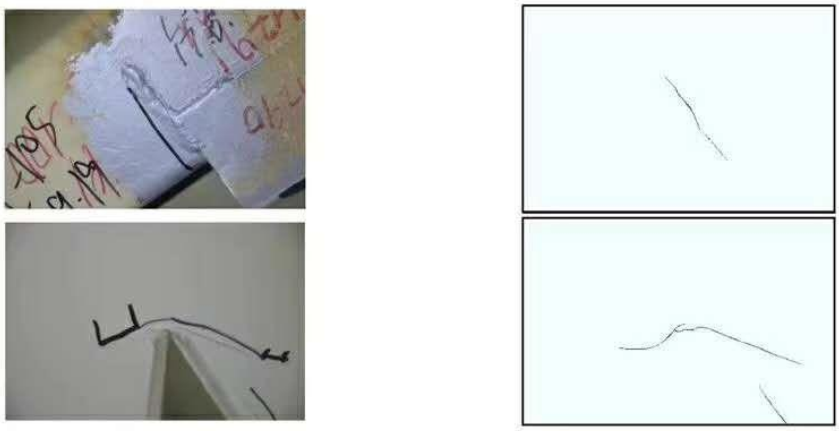
Contact

- **Website:** http://www.schm.org.cn, http://sstl.cee.illinois.edu/ipc-shm2020/
- **E-mail:** ipcshm@yahoo.com

Project 1: Image-based Identification of Fatigue Cracks in Bridge Girders

Data Description

The dataset includes two folders: Images (*.PNG) and Labels (*.PNG) as shown in Figure 1.1. The Images folder includes 200 original fatigue crack images with resolutions of 4928*3264 and 5152*3864. Except for 120 image-label pairs, 80 additional original images are also provided to assist the training process. The images have been obtained by different bridge inspectors and captured with a variety of internal and external camera parameters. The released image dataset is recommended to be included in the training process, while participants are also allowed to use other images to assist the training procedure. In the labeled images folder, cracks are annotated as black pixels.



(a) Original fatigue crack image (b) Pixel-level binary ground-truth label

Figure 1.1. Examples of the steel box girder fatigue crack image dataset.

Goal & Evaluation

The goal of the first project is to train a model for the semantic segmentation of fatigue crack pixels from original image data; this model should be submitted to the organizing committee for evaluation. A blind dataset consisting of 80 images with verified pixel-level labels will be used to evaluate the performance of the code submitted by each team. The performance will be assessed using the average mIoU (Intersection-over-Union) between the ground-truth and predicted cracks for all the test images.

Project 2: Data Anomaly Detection for SHM

Data Description

In this project, a dataset that consists of one-month of acceleration data for a long-span cable-stayed bridge in China is provided. The sampling frequency is 20Hz. Table 2.1 describes the characteristics of the normal data and the six classes of anomalies. Figure 2.1 gives an example for each data pattern. Additionally, a dataset with labels for the time series by hour is provided by the file label.mat.

Goal & Evaluation

Participants should implement anomaly detection for the dataset using a method of their choice. The six data anomaly patterns (No. 2-7) shown in Table 2.1 should be considered, and the occurrence time and type of abnormal data should be identified. The committee will evaluate the performance by the submitted codes using a blind dataset.

Table 2.1 Description of each data pattern.

No.	Anomaly patterns	Description
1	Normal	The time response is normal oscillation curve; frequency response is peak-like (may differ between bridges)
2	Missing	Most/all of the time response is missing, which makes the time and frequency response zero
3	Minor	Relative to normal sensor data, the amplitude is very small in the time domain
4	Outlier	One or more outliers appear in the time response
5	Square	The time response is like a square wave
6	Trend	The data has an obvious trend in the time domain and has an obvious peak value in the frequency domain
7	Drift	The vibration response is non-stationary, with random drift

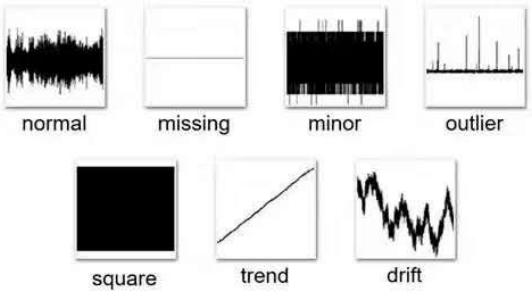


Figure 2.1 The example for each data pattern (duration of each time series: 3600s).

Project 3: Condition Assessment of Stay Cables

Data Description

Here we release a cable tension dataset monitored from an in-service cable-stayed bridge in China (Figure 3.1). Cable pairs are numbered from 01 to 21 on the tower side to the riverside/bank side (Figure 3.1). 'S/N' stands for cables on south tower side and north tower side respectively, and 'A/J' stands for cables on the bank side and riverside, respectively.

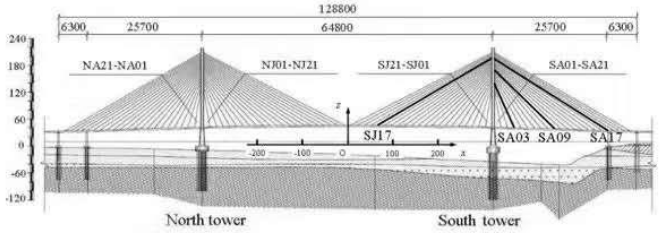


Figure 3.1 The investigated cable-stayed bridge (unit: mm).

The published dataset in MATLAB '.mat' format contains the monitored cable tension data of a group of cables (14 cables of SJS08 to SJS14 and SJX08 to SJX14) for 10 days (2006-05-13 to 2006-05-19, 2007-12-14, 2009-05-05, and 2011-11-01), and monitoring data in each day is saved in a separate mat file. Figure 3.2 illustrates a classical time-varying cable tension measured by load cell incorporated between cable and anchorage of SJS10 in 2006-05-15, in which red solid line is the trend item (dead load effects and environmental effects) and the blue peaks are the vehicle-induced cable tension.

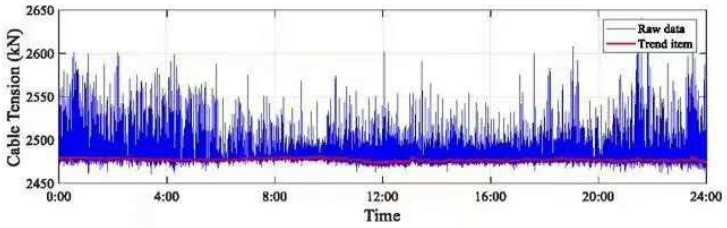


Figure 3.2 Time varying cable tension of SJS10 in 2006-05-15.

Goal & Evaluation

One out of the 14 cables was found damaged (the damage is rupture of wires) in the year 2011. Participants are required to identify which cable is damaged based on the published dataset. Details on the data preprocessing, the feature extraction, and the statistical model should be included in the submitted paper and will be evaluated together with the identification results.

Registration Form

No.	Name	E-mail Address	Affiliation	Current position/title	Highest degree/Year
1					
2					
3					
4					
5					

- Registration forms must be submitted to *ipcshm@yahoo.com* by June 21, 2020.
- A single entry of participant will be registered as an individual; multiple entries (no more than 5) of participants will be registered as a team.
- The first entry of participants will automatically be the team leader, and related notifications are sent to the corresponding email address.

Select Project to Participate (one, two, or all three):	☐ Project 1 ☐ Project 2 ☐ Project 3

Data Policies and Terms of Use

- The dataset provided in the 1st International Project Competition for Structural Health Monitoring (IPC-SHM, 2020) can only be used for this competition and the related publication of special issues of the Journal of Smart Structures and Systems. When you use these data for further research, it is better to let us know or at least to make a statement in the acknowledgement of the paper, thesis and reports.
- Sign to agree to all the rules of the competition.

Sign to agree:

_____ _____ _____ _____ _____

Date: