New application using super-long-range PIV system for non-contacting measurement of flow-induced vibration

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Preface

We have extended the Super-Long-Range PIV technology and developed its new application for non-contacting measurement of Flow-Induced Vibration (FIV). This system can measure a wide velocity field with a long distance. Using this system, a velocity field in the location difficult to access and therefore so far difficult to measure is measurable with a long distance without close access to the measurement target. In this study, we used the system (Super-Long Range PIV) which was the combination with the already-developed optical system suitable for long range measurement, and applied it to the non-contacting measurement of flow-induced vibration on structures (rigid bodies). The troubles are caused by FIV have been significant issues for power plant facilities.

System

Fig. 1 is a conceptual drawing of the Super-Long Range PIV System. This system can conduct PIV measurements at a distance of more than 10 m from the measurement target. This study used continuous light from a halogen lamp light source or daylight. For long focal length optics, this system (Fig.1) used a Makstov-Cassegrain telescope ORION OMC-140 (D=140mm, f=2000mm). A C-MOS sensor camera Basler A602f was used. The frame rate is up to 100 fps. The image signal obtained from the camera was transferred in the form of the original digital data through IEEE-1394 board equipped with the computer and then saved in the hard disc after once stored in the computer memory. As required, the shutter function using an external trigger was usable.

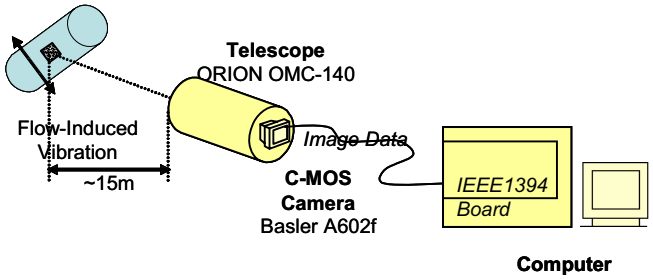

Fig. 1 Super-Long Range PIV System for Non-Contacting Measurement of FIV

Non-contacting measurement of FIV of piping by internal flow

Phenomena that often cause problems to nuclear and other power plants include vibration of piping such as surging caused by pumps or exhaust fans. In power plants, piping is not always located where acceleration sensors can be easily mounted, and the measurement of many locations is required in some cases. Therefore, an easy-to-operate method without the need for construction or works at the site such as footing installation is useful. Taking the application to the measurement method of piping at this type of the site into consideration, the vibration frequency of piping was measured. In lieu of a tracer, VSJ-PIV standard image printed on paper was affixed to the surface of the pipe, and the measurement was done from a distance of 15 m. The power spectrum was obtained using FFT(Fig.2). The result showed the natural period of 0.039 sec and the natural frequency of 25.7Hz.

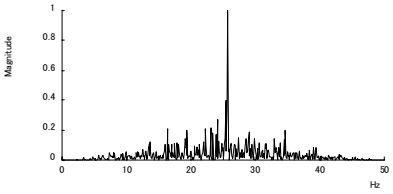

Fig. 2 Power Spectrum (Pipe)

Non-contacting measurements of FIV of power transmission line by external flow

Accidents such as the line break by the galloping phenomenon due to the adherence of icy snow are the issues of power transmission lines. We measured the period of flow-induced vibration of a transmission line (Fig.3) actually in use caused by the natural wind. Also in this case, the direct measurement using an acceleration sensor or the like is usually considered; however, the location is very difficult to access. the power spectrum was obtained using FFT after low-pass filtering. The result showed the natural period of 2.1 sec and the natural frequency of 0.48 Hz

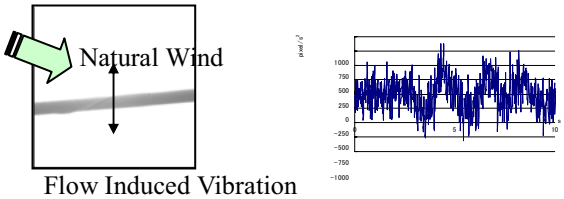

Fig. 3 Time Domain Vibration of Transmission Line

Conclusion

New application using Super-Long-Range PIV system for non-contacting measurement of Flow-Induced Vibration (FIV) has been developed, and vibration originated from FIV caused by internal flows and external flows was measured.