# Estimation of Dynamic Characteristics of Long-span Bridge Cables Using Image Signal Processing

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## Summary

As to the long-span bridges, the health monitoring of a bridge can be identified by measuring tension force on cable repeatedly. The tension force on cable is measured either by direct measurement of stress of cable using load cell or hydraulic jack, or by vibration method estimating tension force using cable shape and measured dynamic characteristics. In this study, image signal processing was used to estimate the tension force of the remote cable using vibration method. A portable digital camcorder was used as a vision-based system in consideration of user convenience and economic feasibility. A digital image correlation (DIC) technique as one of digital image processing algorithm is applied to develop the image processing algorithm. The image transform function (ITF) was used to correct the geometric distortion between the deformed and undeformed images, and to calculate the subpixel. The motion of the vision-based system was corrected using a fixed object in the image, without installing an additional sensor, the resolution of dynamic responses and modal frequencies were improved.

**Keywords:** long-span bridge; image signal processing; digital image processing; tension force; correction of motion of vision-based system.

## 1. Introduction

With the recent development in coasts, islands, and mountains, the demand for long-span bridges has been increased. In addition, long-span, cable-supported bridges such as suspension and cable-stayed bridges have been rapidly increasing with the continuous development of materials, designs, and construction technologies. The long-span bridge is a statically indeterminate structure wherein the main girder is supported by stay cables, main cables, and hanger cables. This bridge type is applied to many bridges because it enables various types of design and aesthetic structural appearance. In the cable-supported bridges, the safety of the cables is critical to the safety of the whole bridge system, and the tension force of the cable that is estimated using the dynamic characteristics is monitored repeatedly [1].

The tension force of the cable is estimated either by directly measuring the stress of the cable using a load cell or hydraulic jack or through the vibration method [2], which uses the cable shape conditions and measured dynamic characteristics to estimate the tension force. The accelerometer is generally used to measure the tension force of the cable using the vibration method. The existing conventional accelerometer requires considerable cabling to facilitate a direct connection between sensor and DAQ logger. For this reason, a method of measuring dynamic responses of the cable from a remote distance without the mounted sensors is needed. Other non-contact methods of measuring the dynamic responses of the cable include the Doppler effect of a laser, GPS, and image processing methods. The Doppler effect of a laser [3] is relatively accurate but is not economically feasible because the measurement of the dynamic response of even one point requires an expensive instrument. The GPS [4] is also uneconomical and is not suitable for cable response measurement due to the signal error and limited data sampling rate. The image processing method [5] is a simple

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