Use of ICT in infrastructure maintenance

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In the SIP infrastructure maintenance initiative, our work is comprised of the topics related to Internet of Things (IoT), such as sensing technologies for use in inspection and network systems for efficient acquisition of sensing data, and the topics on information systems, such as visualization and database systems to compile various types of acquired data and analyze the data using AI. In this paper, from among four teams, we will introduce R&D on data management infrastructure and utilization of 3-D data as well as the development of a shared data platform.

Integrated data management for infrastructure sensing data

A data management infrastructure is necessary in order to compile and analyze time series data based on the long-term data acquisition from various sensors that are installed to detect deterioration and anomalies in bridges and other infrastructure over time. As shown in Fig. 1, the goals of our R&D project on integrated data management for infrastructure sensing data are: (1) Remote acquisition[(1)] of video data from road monitoring cameras, in addition to data from sensors installed on bridges to measure strain, displacement, and acceleration; (2) Multifaceted analysis using an exploratory visualization and analytics software environment; (3) Development of autonomous multi-sensing modules[(2)] that are capable of precise time synchronization based on atomic clocks in order to handle large numbers of sensors; and (4) developing data management infrastructure as a platform for data acquisition and compilation.

About 5.5 gigabytes of time series data and 20 to 60 gigabytes of video data are obtained from sensors installed on the Myoko Bridge every day. This is sent over the internet to the database system in Tokyo where it is indexed in preparation for analysis, including time series analysis. In this data management infrastructure, the visualization and analytics software components of the "compilation, visualization, and analysis system" block shown in Fig. 1 have been prepared, and the configuration of the system can be flexibly modified by simply adding software with the cooperation of infrastructure experts. Various kinds of deterioration

indicators are being evaluated, using methods for outlier detection developed in the field of statistical machine learning for the waveform signal processing, and using the latest object recognition techniques for the vehicle detection from images.

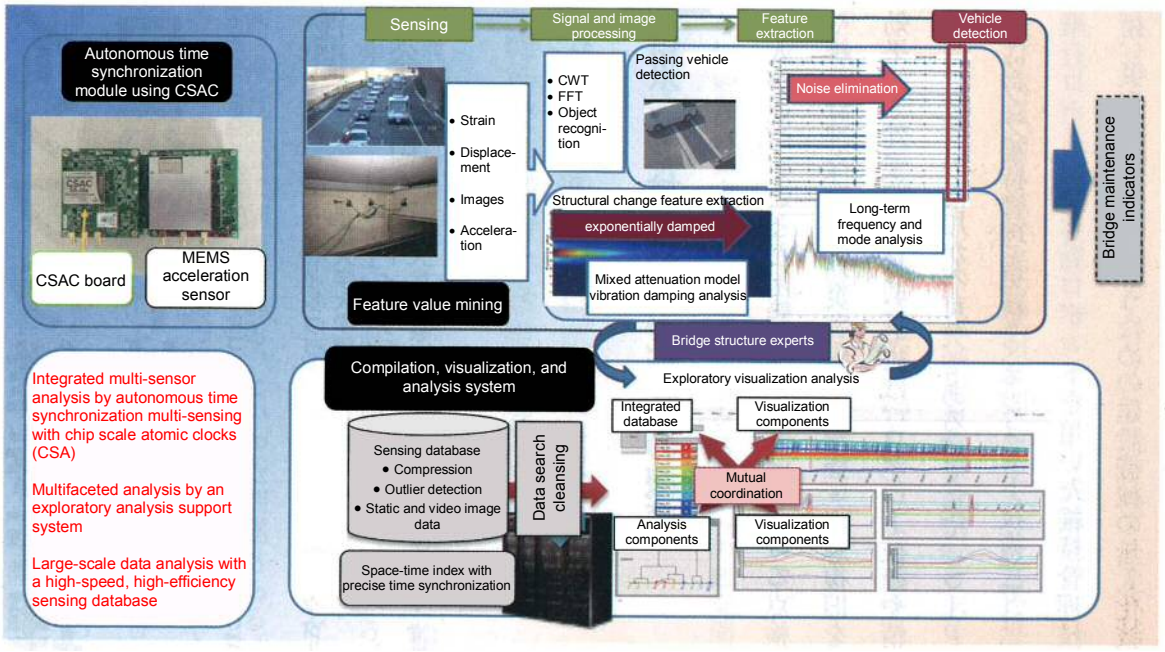

Fig. 1. Data analysis system for infrastructure maintenance

In addition, in the project led by JIP Techno-Science Corporation on a method for road surface and bridge screening based on large-scale sensor integration technology, ICT is being employed for implementation of big data acquisition and analysis of road surface management indicators, new wireless sensors for bridge monitoring, and compilation and visualization processing of petabyte-scale data.

System to manage inspection information using 3-D models of structures

Attempts are also being made to manage image and damage information obtained during inspections with three-dimensional models. One example is a SIP project[3] involving one of the authors (Kanai). The goals of this project are to develop a two-wheeled drone that performs close-up photography while maintaining contact with the surface of the bridge structure, and to develop an information system that automatically adds location information to the photographed images based on a 3-D model of the bridge. However, there are only a few bridges in Japan that already have 3-D models. To solve this problem, a technology to automatically generate a 3-D CAD model of a bridge based on laser scanning, etc. is being developed. In order to maintain the inspection information in a stable form over the long-term service lifetime of a bridge, we have expanded a draft international standards for bridge product models, designed a bridge maintenance information data model[4] that is compatible with the current inspection report's format, and created a prototype system (Fig. 2) that makes it possible to read management information in combination with a CAD model using a web browser.

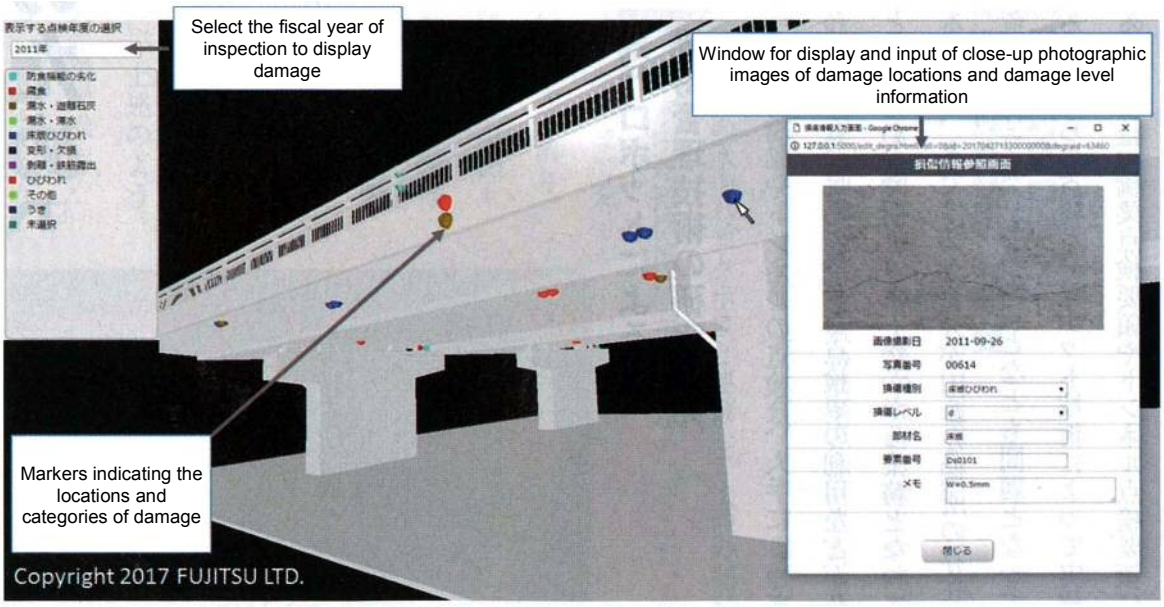

Fig. 2. Example of a system to manage and browse bridge inspection information using the web and 3-D modeling (Source: Fujitsu)

Toward a shared data platform including infrastructure maintenance

New value in future will be created through the sharing of data across multiple fields, not only infrastructure maintenance. As a first step, we are proposing the concept of a data platform that is needed for infrastructure maintenance at present, and this could also include sensor information from other teams and expand the scope of the platform by further taking in map and 3-D spatial information. We are promoting the design of a data sharing infrastructure that will make full use of "big data" processing technologies such as cloud computing, distributed computing, and parallel processing.

References

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