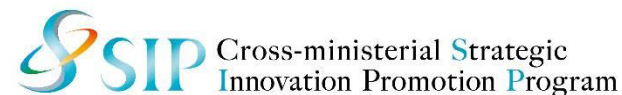■**R&D Topics** : **Information and Communication Technologies**
■**R&D Theme** : **R&D of Integrated Data Management Platform for Civil Infrastructure Sensing**
■**Principal Investigator** : **Jun Adachi (Professor, National Institute of Informatics)**
■**Collaborative Research Groups** : **Hokkaido University**

R&D Objectives and Subjects

SIP Cross-ministerial Strategic Innovation Promotion Program

Objectives

❖ Data Management Technologies : to develop efficient multimodal monitoring data management technology for analyzing, storing and utilizing massive data.

❖ Analysis Technologies : to extract features that may reflect structural deformation for defining new structural-deformation indices through the collaboration between structural analysts and data scientists.

❖ Time Synchronization Sensing Technology : to develop multimodal sensing technology for integration of various sensors with autonomous time synchronization.
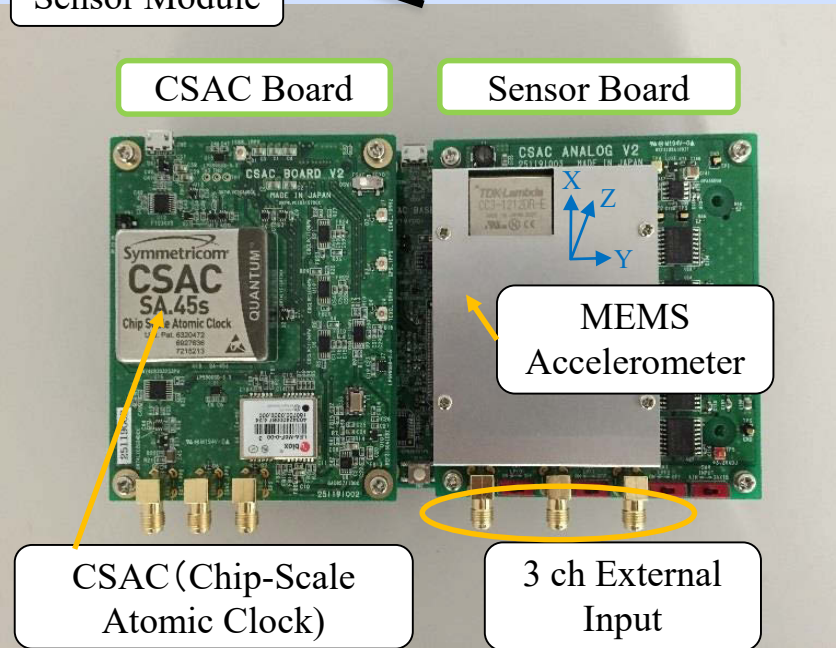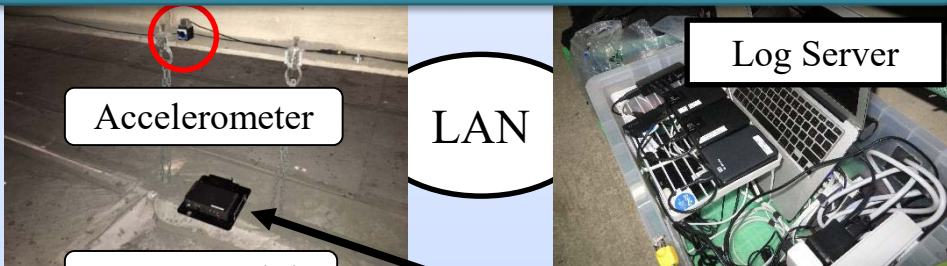
Subjects

❖ R&D on an exploratory visual analytics environment that integrates varieties of analysis and visualization tools with database systems.

❖ Accurate vehicle detection and feature extraction related to structural deformation of bridges by combination of frequency analysis, signal processing and data integration technologies.

❖ R&D on a multimodal sensing module with an autonomous time synchronization using Chip-Scale Atomic Clock (CSAC) that integrates various sensors.

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Current Accomplishments (1/2)
Data Management Platform

Autonomous Time Synchronization Sensor Module with CSAC (On-site)

Accelerometer

LAN

Sensor Module

Log Server

CSAC Board

Sensor Board

CSAC（Chip-Scale Atomic Clock）

MEMS Accelerometer

3 ch External Input

Autonomous Time Synchronization Sensing without GPS, Wired and Wireless Network

Massive Multimodal Sensor Data Analysis (Data Center)

Flexible Data Analysis by Combining DBs, Visualizers, and Analyzers Adaptively

Integrated DB

Visualizers

Federation

Analyzers

Visualizers

fluentd

Log Collection Middleware

TSV （Data Files）

elastic

Distributed Search Engine
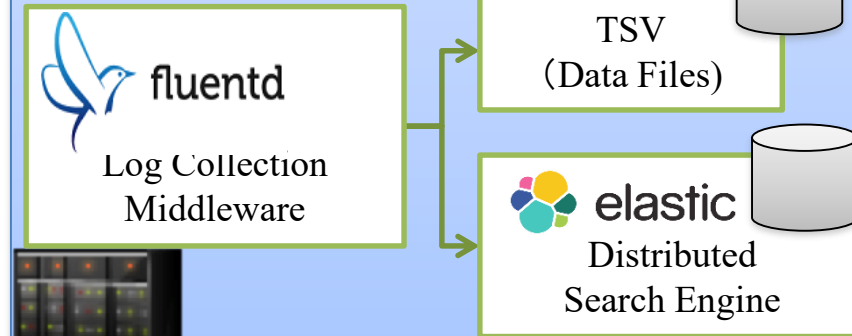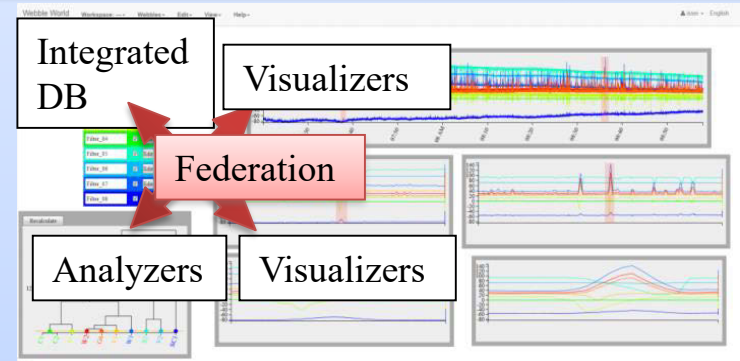
Real-time Data Collection & Management

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Sensor Data Analysis

◆ Vibration analysis system for long-term multi-sensor monitoring with high-precision accelerometers

❖ Detecting vibration characteristic change caused by external factors such as temperature changes, using long-term multi-sensor monitoring

Visual analyses of long-term vibration data
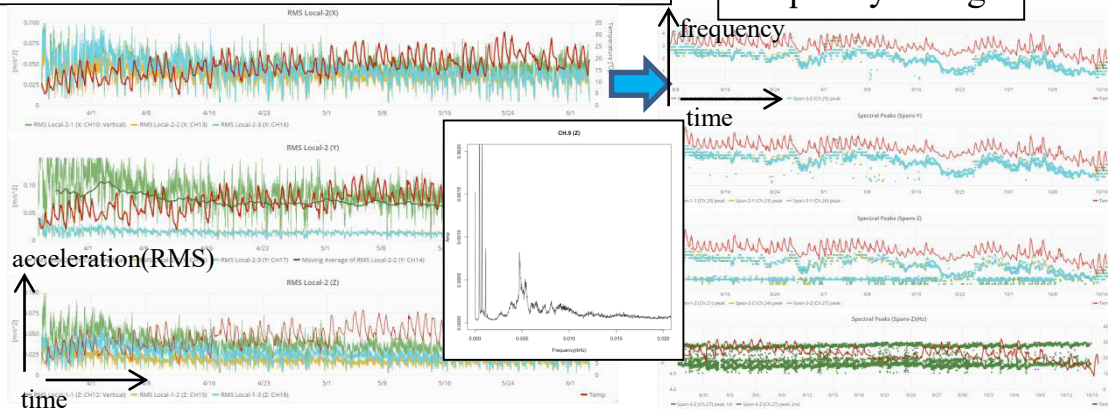
Tracking peak frequency change

Improving the detection accuracy of the natural frequency change caused by the temperature and/or traffic change

Radial distribution of average acceleration differences in 36 directions
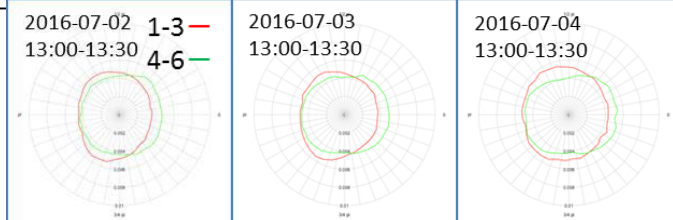
Placement of three neighboring sensors

Analyzing the change of pseudo-stress distribution

◆ Accurate Vehicle Detection

❖ Integrated analysis of video and sensor data for accurate vehicle detection

Data from cameras and sensors installed at bridges
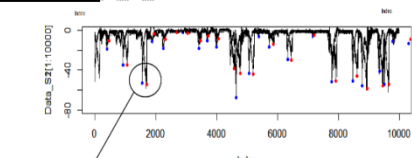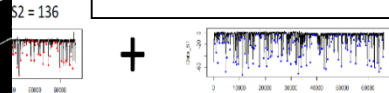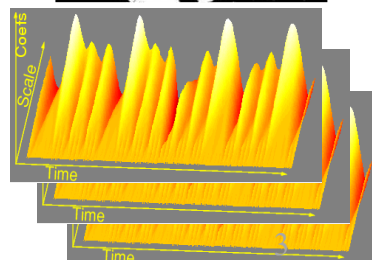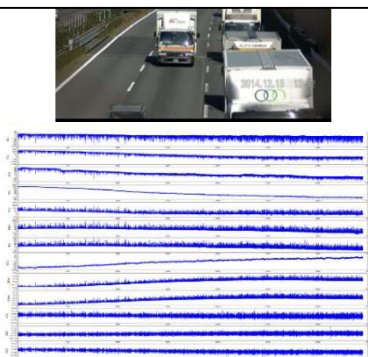
Video Processing

Signal Processing

Vehicle Images

Peaks corresponding to Vehicles

We have to look for pairs of peaks that represent a passing vehicle.

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Goals toward efficient road management

Bridge Management Support

Metrics for structural deformation based on visual and hammering tests, and nondestructive inspection

Bridge Structural Analysts
- Physical model
- Simulation

Interpretation of **features**

Mapping between **metrics** and **features**

Features related to structural deformation extracted from sensor data

- Feature extraction by data analysis/mining
- Flexible and speedy monitoring with portable sensing
- Multi-modal monitoring with time synchronization

Output

Sensing data analysis for supporting road maintenance planning
- DB prototype system for managing various infrastructure maintenance data
- Accurate bridge-weigh-in-motion
- Metrics and use guidelines for sensing data analysis

Promotion of Developed Systems

Multi-sensing technology by autonomous time synchronization

Technical specifications of sensor module that can be commercialized

Open source software for integrated sensing data management, visualization and analysis

① Open package software
- Publish integrated software
② Open software libraries easily portable to other systems
- DB system modules, data visualization libraries
- BWIM libraries, feature extractor for structural deformation detection
- Expansion of sensors and data formats
- Tutorial, manuals

Promote software usage by publishing modules and libraries with a commercially usable license (e.g., Apache 2.0, New BSD license）

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