Nanjing Yangtze River Tunnel

- Nanjing, China
- 2009

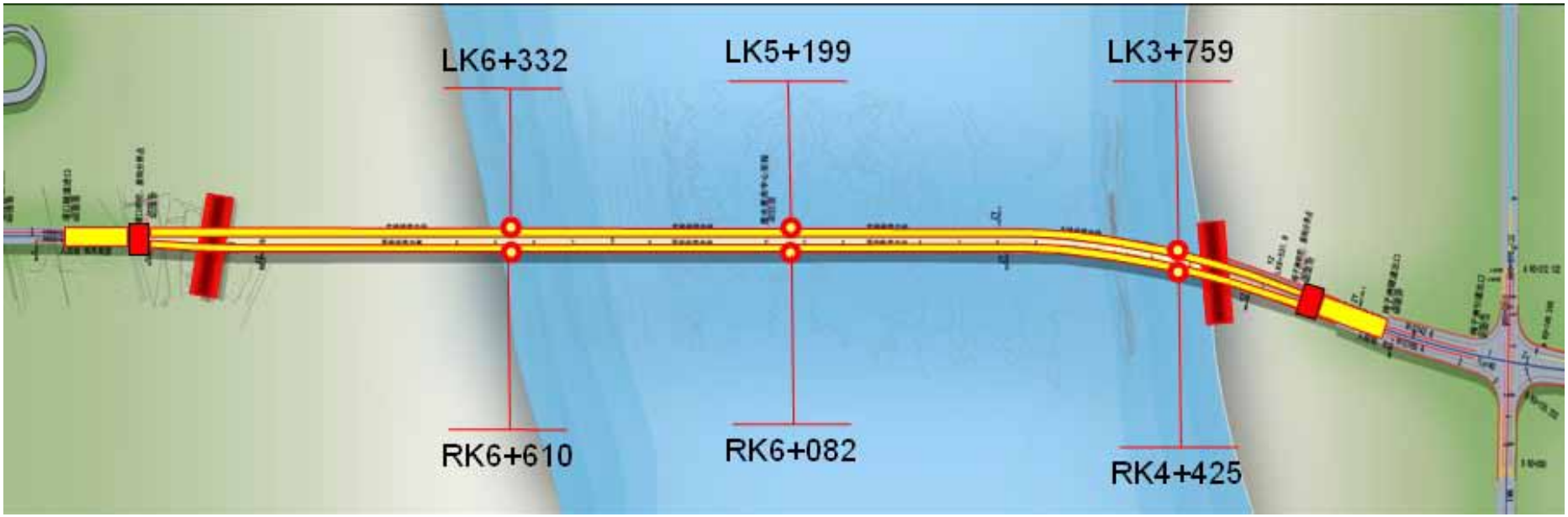
Nanjing Yangtze River Tunnel: General Characteristics

- Construction type: Shield Tunnel
- Length: 3,837m, Tunnels: 2, Diameter: 14.93m,
- Maximal Depth underground: 51m
- Maximal water pressure: 0.65MPa
- Location: Nanjing City, Jiangsu Province, China
- Under construction since Sep. 2007 and in service from 2010

Nanjing Yangtze River Tunnel: Structural Monitoring System Overview

Aim	To monitor the integrity and mechanical behavior of the segment structure of shield tunnel under environmental effects and traffic loads for the second largest shield tunnels in the world
Location	Nanjing, China
System Designer & Integrator	Nanjing University http://nju.edu.cn; wzhang@nju.edu.cn
Customer	Nanjing Yangtze River Tunnel Inc.
Date	June, 2008-September,2009
Instrumentation	(1) Micron Optics si325-500 Optical Sensing Interrogator (6) Micron Optics sm125-500 Optical Sensing Interrogator (6) Micron Optics sm041-416 Channel Multiplexer
Sensors	(144) Embedded FBG Reinforcing Bar Strain Sensors (144) Embedded FBG Concrete Strain Sensors (60) Embedded FBG Temperature Sensors (120) Surface-mounted FBG displacement sensors (90) FBG Bolt Sensors (60) Viberating Wire Soil Pressure Cells (60) Viberating Wire Osmometer (4) Anode Ladders
Project Scope	• Construction and in-service monitoring of structure and environmente at 6 different sections of the 2 tunnels. • On-site and remote data retrieval. • Sensors monitor the reinforcing bar stress, concrete strain, concrete temperature, segment displacement, bolt stress, water pressure, soil pressure and the of the corrosion level of the reinforcing bars • Geology disaster prevention

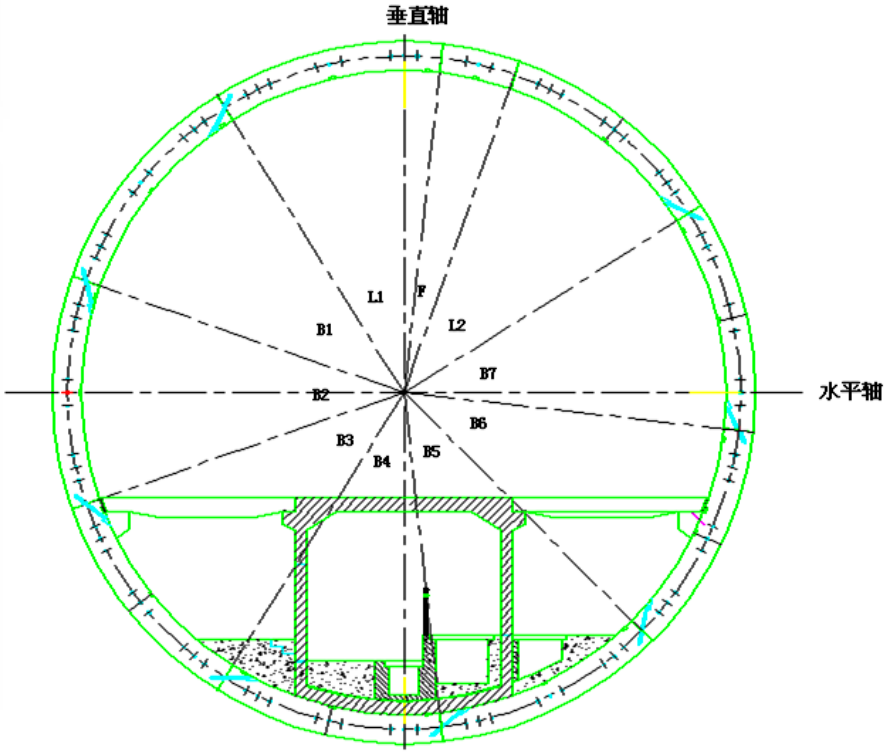
Nanjing Yangtze River Tunnel: Longitudinal Section



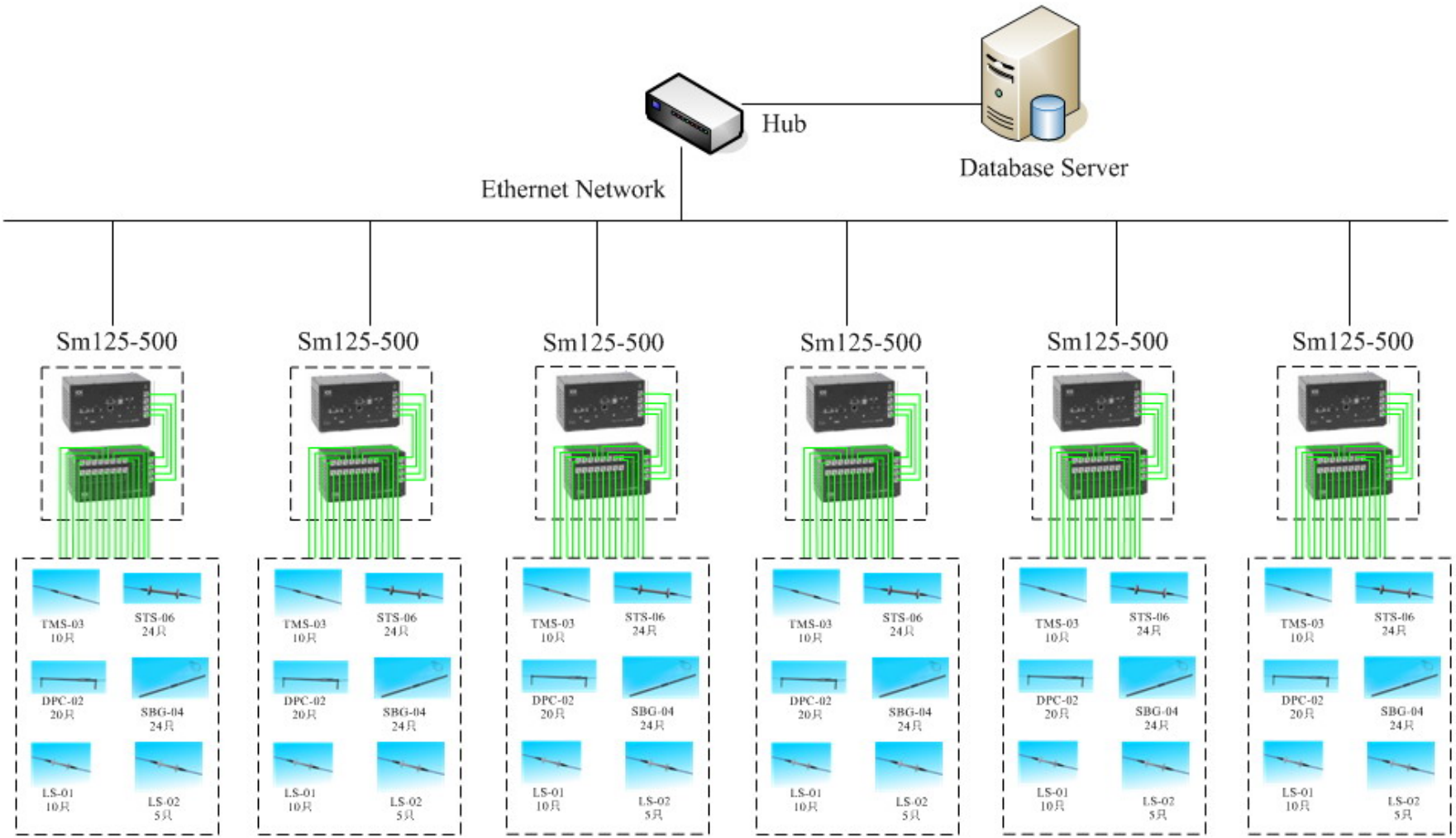
- Sensors were installed along the length of tunnels at 6 different rings.
- 115 sensors were installed at each middle ring and 113 sensors at each other ring
- A total of 682 sensors were installed, among them 558 are FBG sensors.
- There are 3 gratings in each Bolt Sensor. Therefore, totally 123 grattings in each ring were interrogated by 1 sm 125-500 and 1 sm041-416.
- All the 6 sm125-500s controlled by only by one workstation and one set of software developed by NJU.
- The sm325 is used in field during the construction period.

Nanjing Yangtze River Tunnel: Cross-Section and Sensor Locations

Every monitoring ring consists of 10 segments. In each segment, FBG strain sensors and temperature sensors are embedded before concrete cast, and displacement sensors are mounted after all segments are installed in site.



Nanjing Yangtze River Tunnel: Sensor Network Configuration



Nanjing Yangtze River Tunnel: Installation

- The segments with embedded sensors of the monitored rings are carried to the site in the tunnels.
- The *smart* segments are installed to their positions respectively by the automatic shield tunnelling machine.

Nanjing Yangtze River Tunnel: Installation

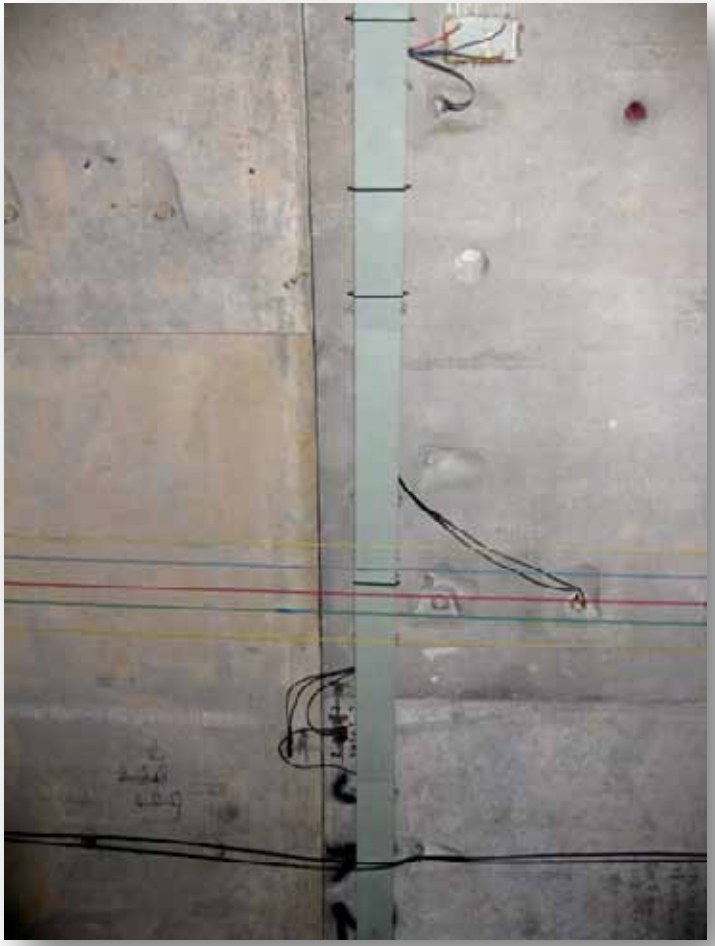
- All the FBG sensors were divided into several groups and connected each other and finally led to the interface box.
- The *smart* Bolt have two pieces of optical fiber led from inside.

Nanjing Yangtze River Tunnel: Installation

Displacement sensors were mounted along the monitored ring and vertically respectively.

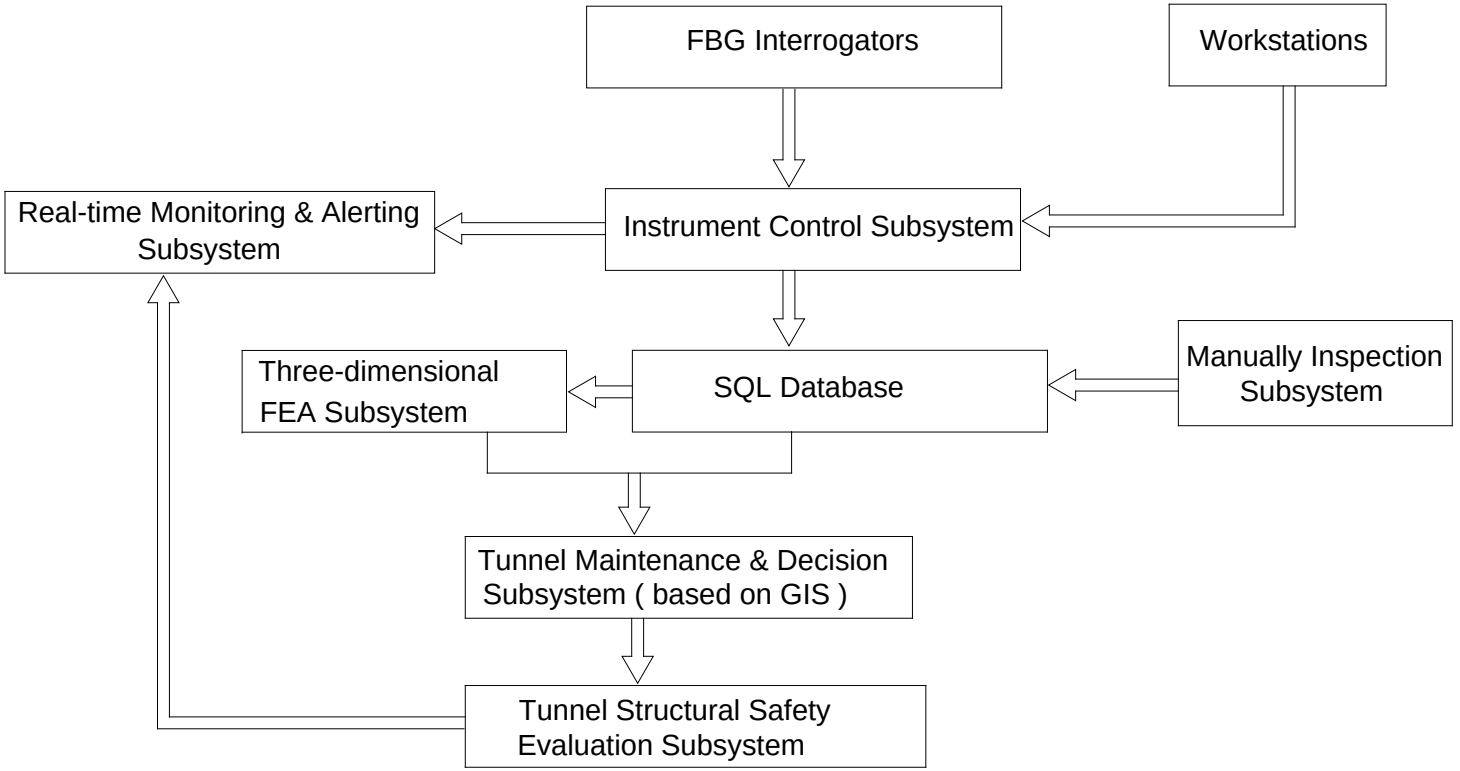
Nanjing Yangtze River Tunnel: Aspect of Installed Sensors

All the cables along one monitored ring were settled within a metal slot around the ring.



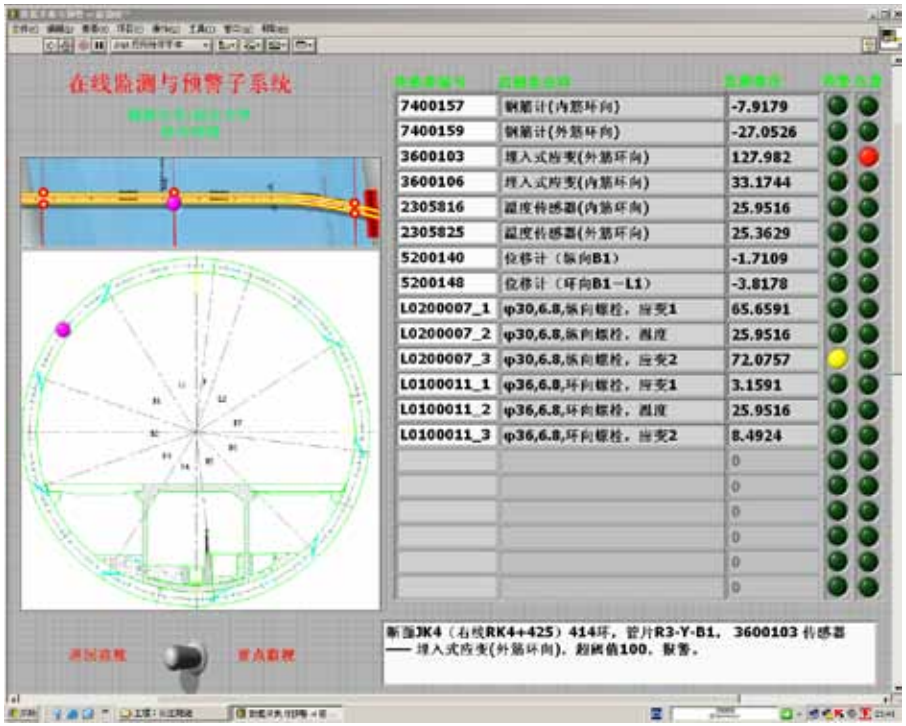
Nanjing Yangtze River Tunnel: Software System Topology

All the measurements collected automatically and manually were managed by the background software system. The system consists of 5 subsystems functionally. The Instrument Control Subsystem can control the 6 sm125-500s or even more simultaneously.

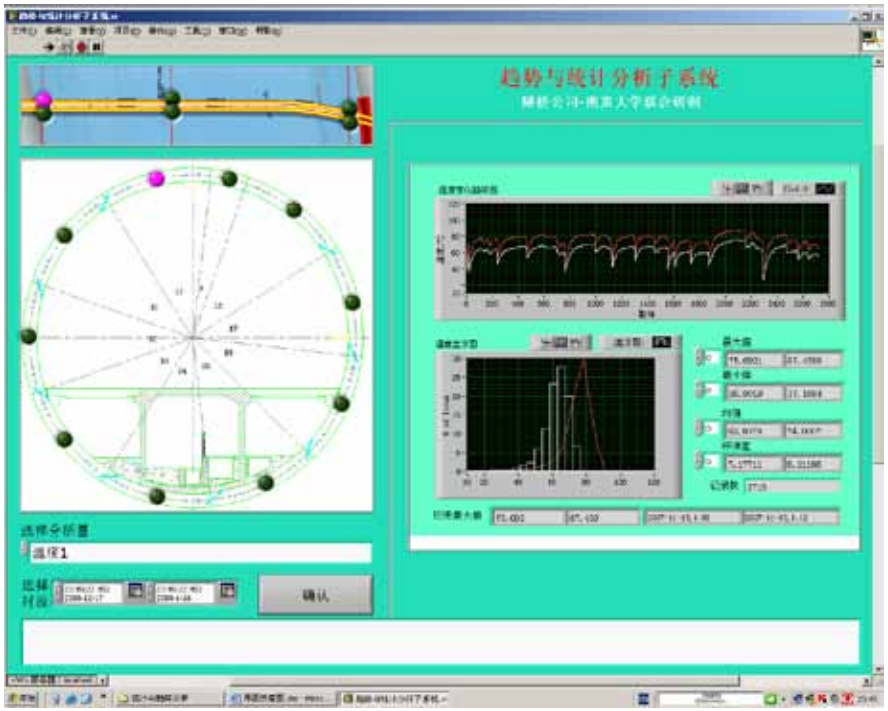


Nanjing Yangtze River Tunnel: Software Subsystems

The Real-time Monitoring and Alerting Subsystem is developed based on LABVIEW 8.2.



Real-time Monitoring & Alerting Subsystem



Trends and Statistic Analysis Function

- Results
  - Customer is currently monitoring the segment behavior in construction period. The whole structural monitoring sysytem will be in operation from the end of 2009.
  - All the Micron Optics instruments placed in the central monitoring hall, where the integration interface of the whole system is presented to the end user.

- Acknowledgements
  - Nanjing Yangtze River Tunnel Inc. - end customer and operator of the monitoring system.
  - Prof. Wei Zhang of Nanjing University - system designer and integrator.
    - wzhang@nju.edu.cn
  - Nanjing Tunnel & Bridge Administration Company - contractor and on-site installer.
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