Road Tunnel Temperature Monitoring System Using a Simulation Model

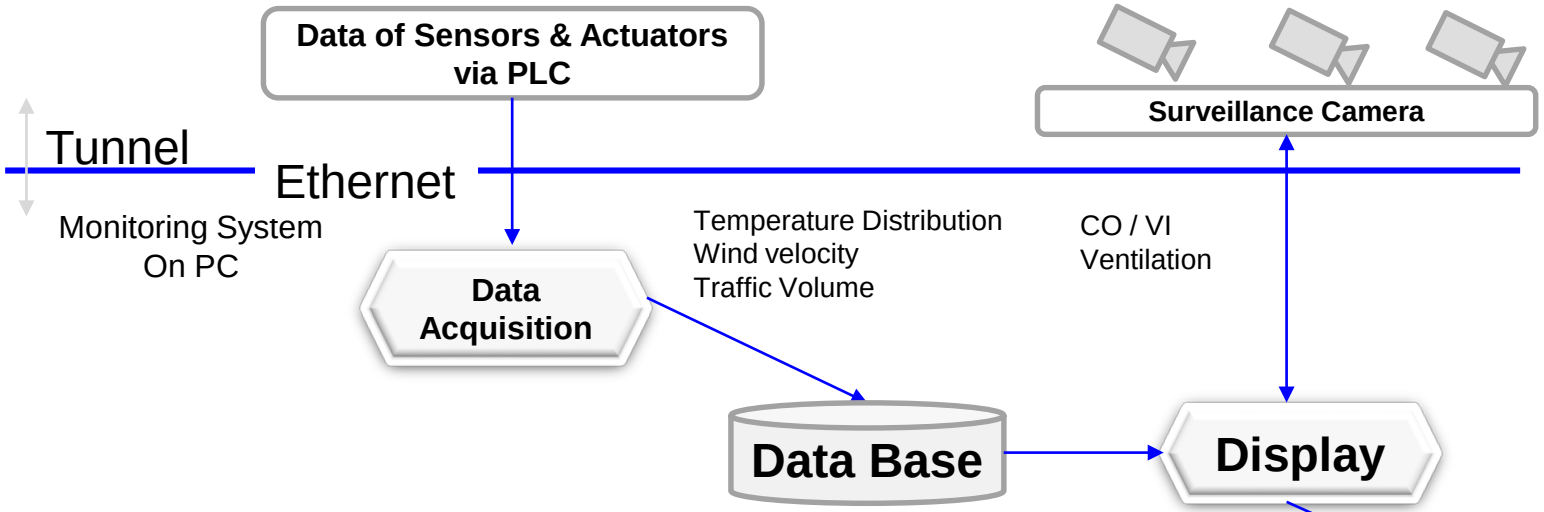
Toshiaki Sakaguchi
Takuya Matsumoto
Koichi Yamamoto
Morikazu Takegaki

Sohatsu Systems Laboratory Inc.
Kobe, Japan

Road Tunnel Temperature Monitoring System Using a Simulation Model

- Architecture with simulator
- How simulator works
- Merits of simulator

Road Tunnel Temperature Monitoring System Using a Simulation Model



Conventional architecture

Surveillance Monitor on 4K Display

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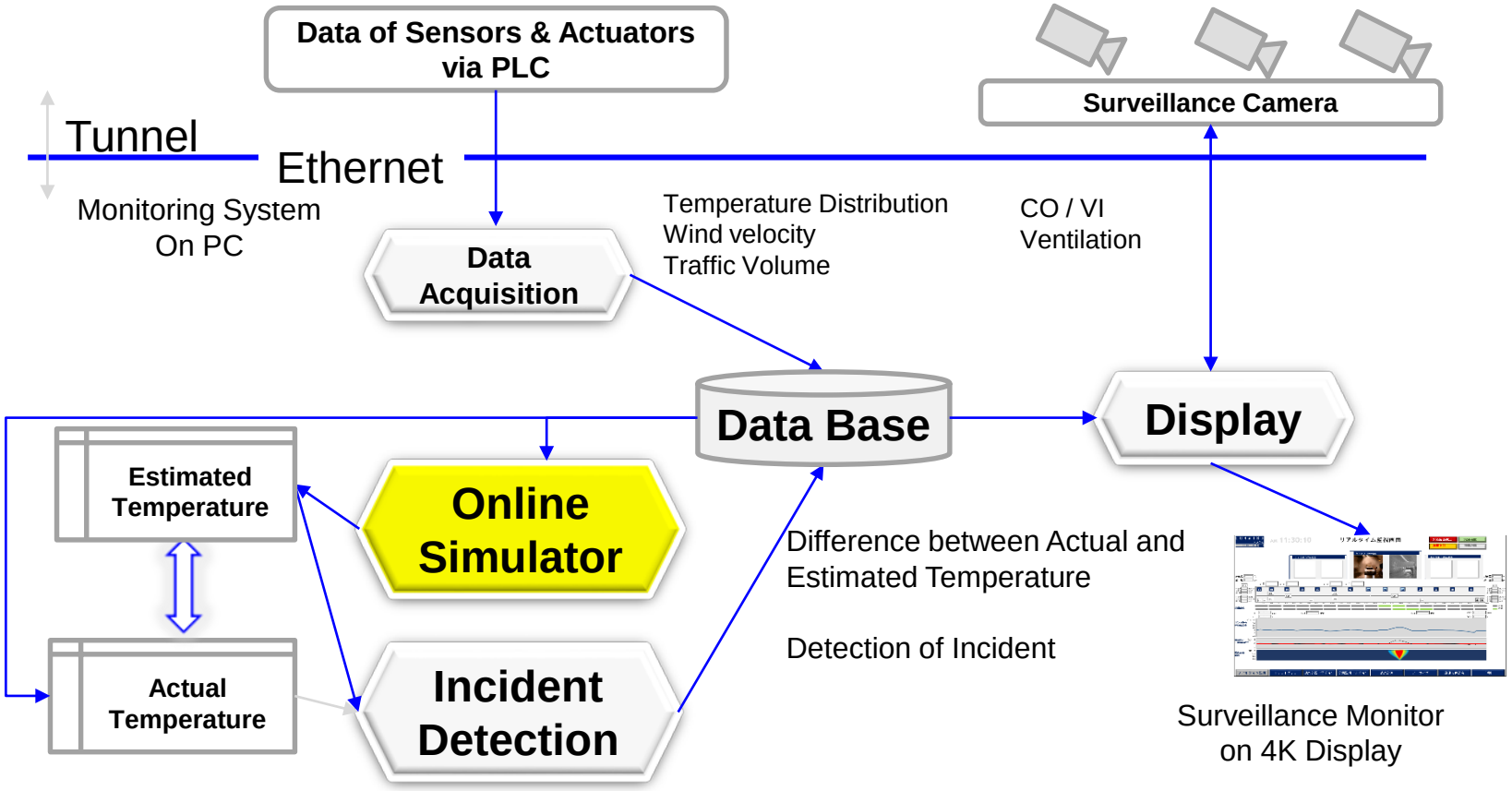
Proposed Architecture



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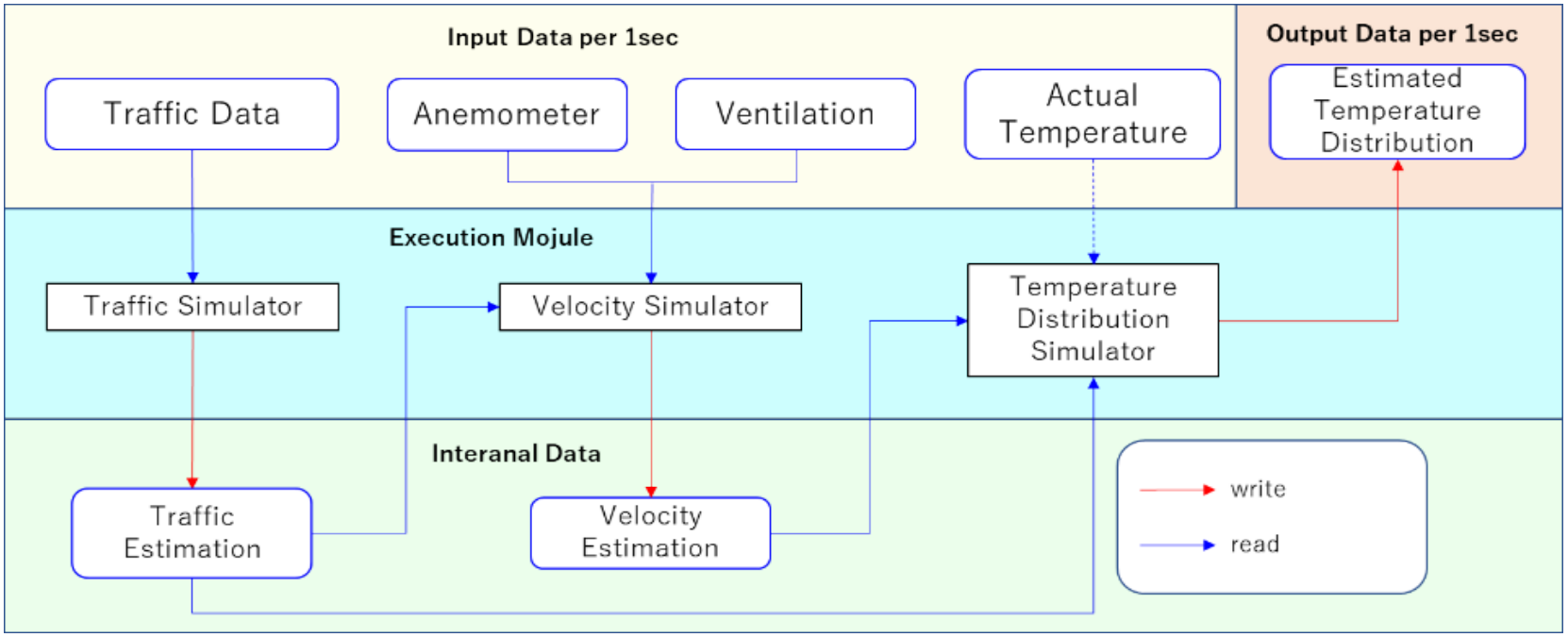
Temperature simulator



$$\frac{\partial T}{\partial t} + \frac{\partial (TV_r)}{\partial x} = D_K \frac{\partial^2 T}{\partial x^2} + \frac{\xi_T}{C_p}$$

T: absolute temperature [K], t: time [s], x: distance [m]

V_r: average flow velocity [m/s], D_k: turbulence thermal diffusion coefficient [m^2/s]

ξ_T: total heat release [J/s m^3] , C_p: specific heat capacity [J/m^3 K]

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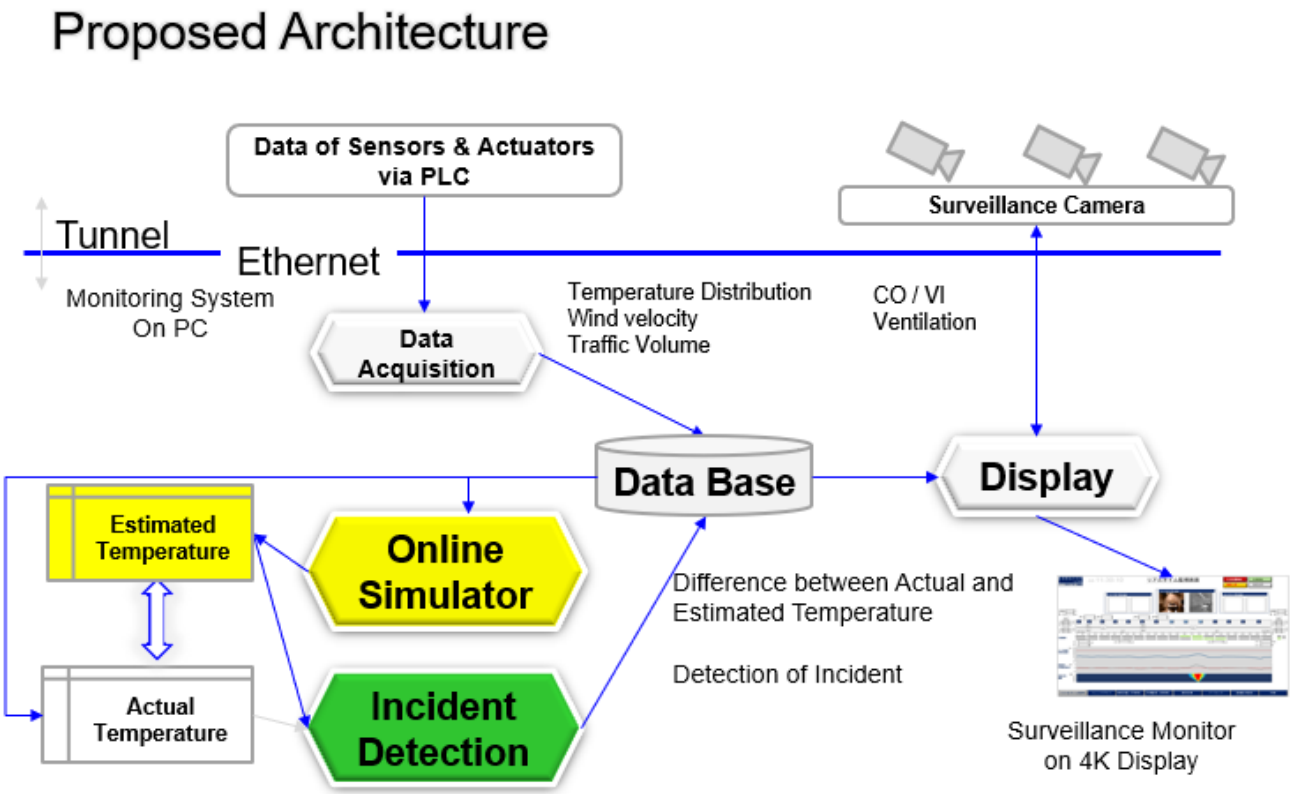

Automated incident detection by a platform approach, “model reference”

Let us see how it works!

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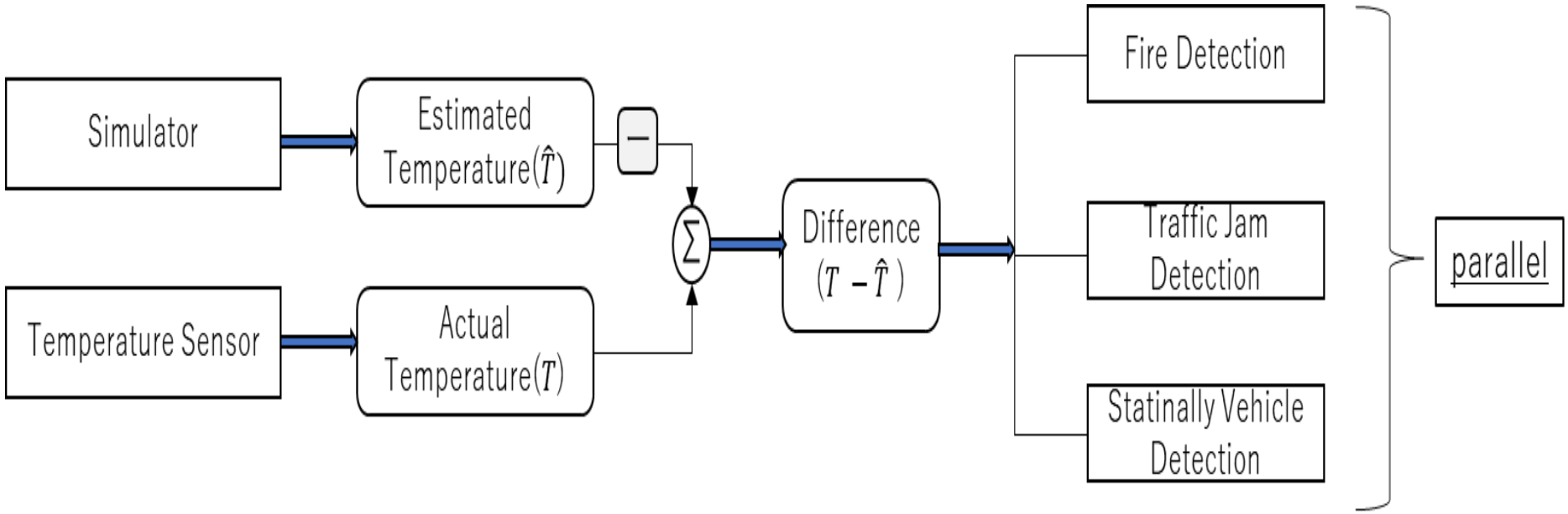

Basic principle of automated incident detection method by model reference

- Will explain the fire detection, traffic jam/congestion detection and stopped vehicle detection

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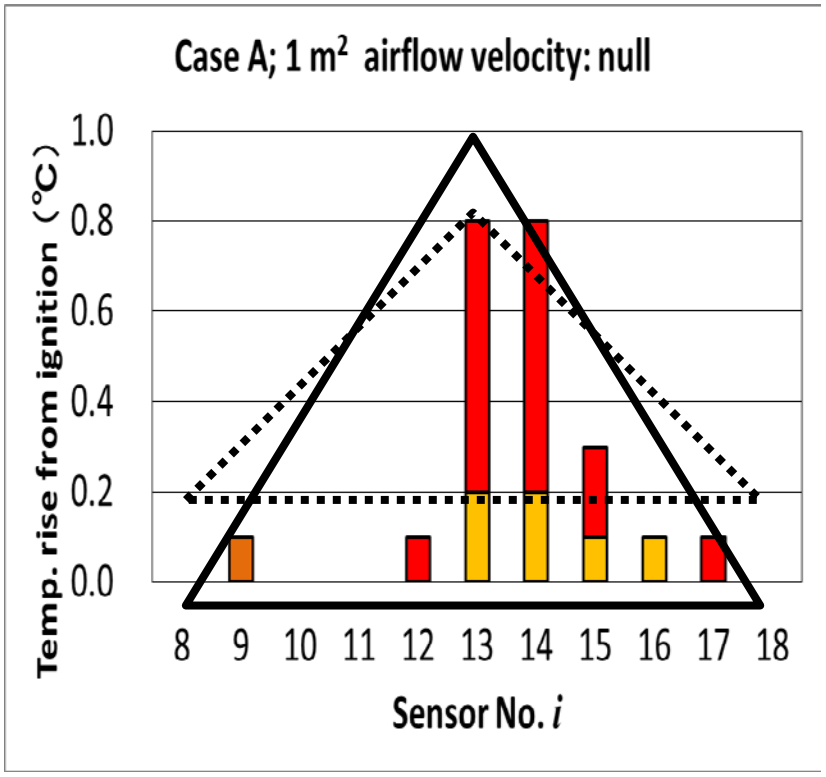
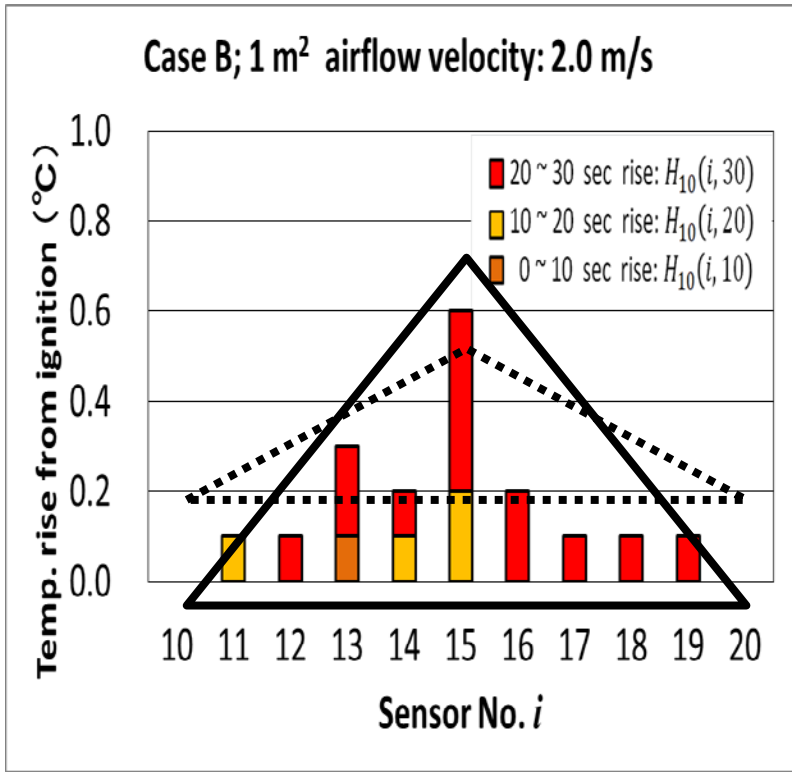
[Fire detection]

(1) Temporary estimate and selection of fire location





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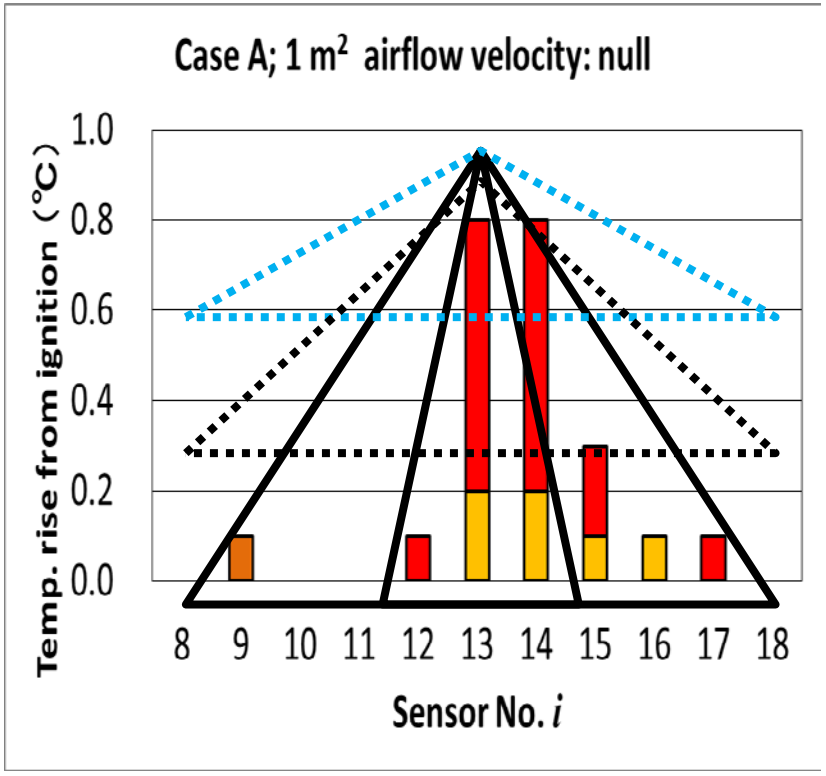
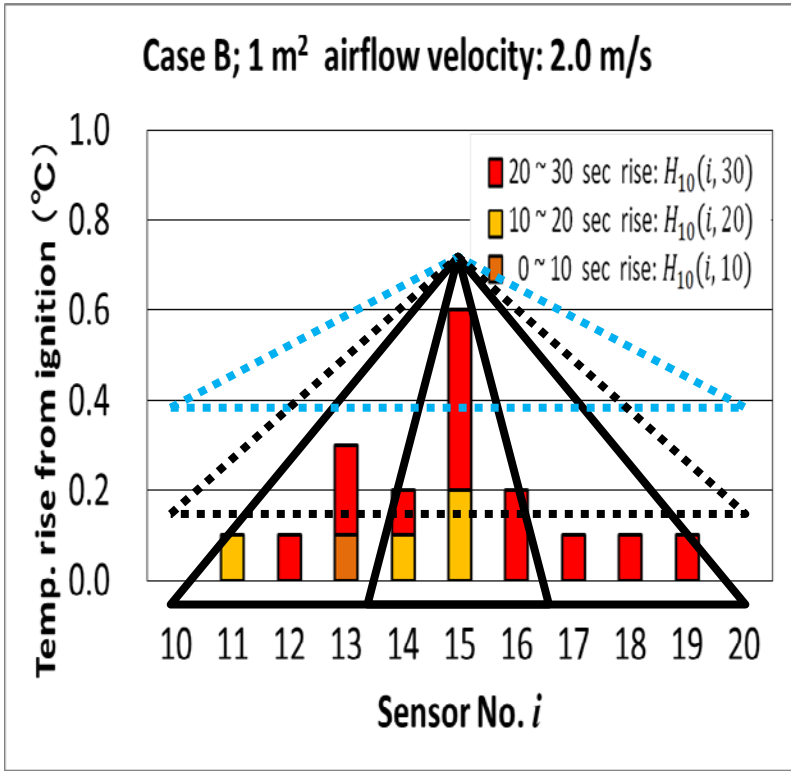
[Fire detection]

(2) Fire detection





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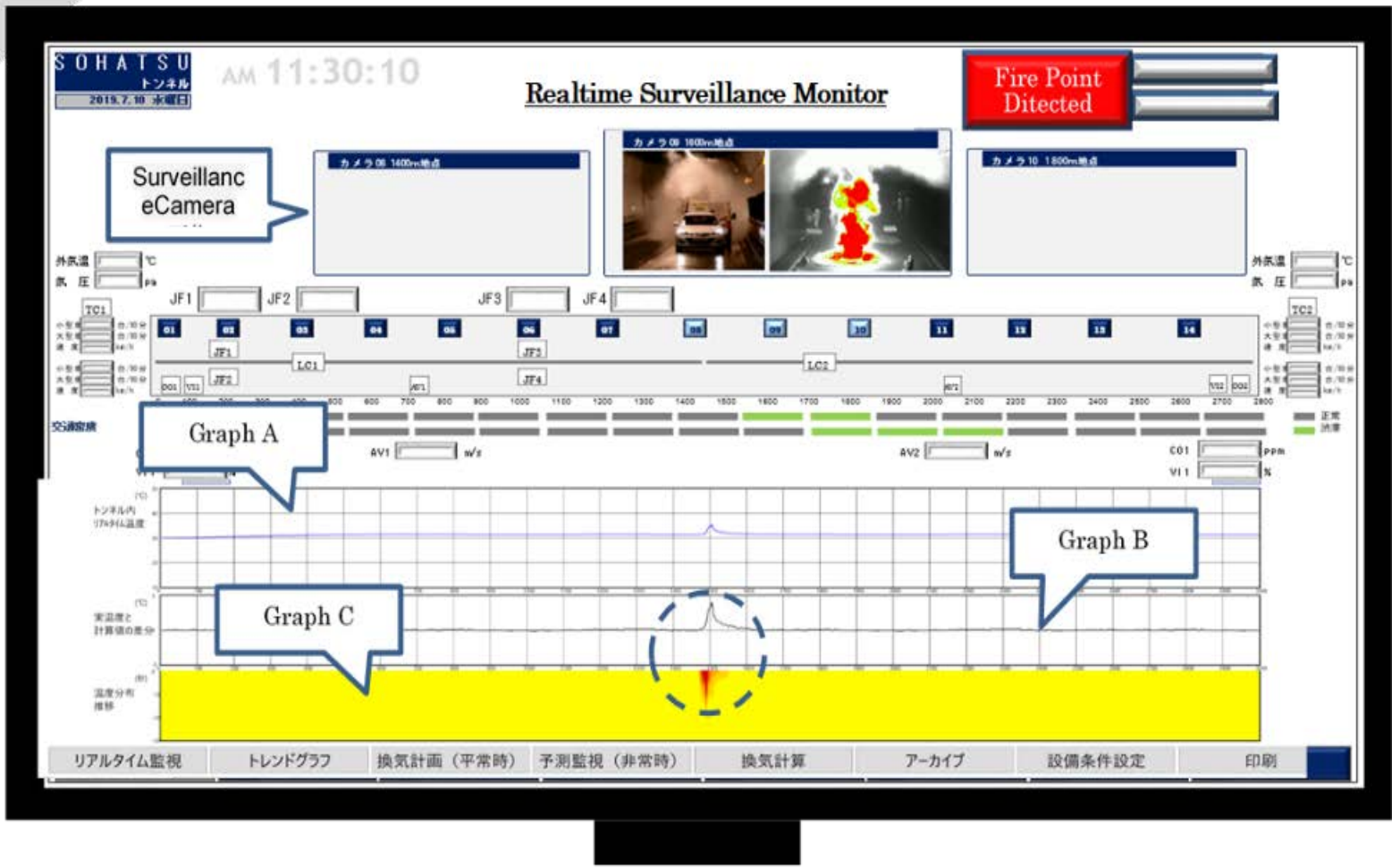
Verification



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[Congestion detection]

$$\Delta T_j(k) = T_j(k) - \hat{T}_j(\mathrm{k})$$

Monitors and initiates congestion if $\Delta T_j(k)$ exceeds Θ_{TJ} at N_{TJ} locations.

[Stopped vehicle detection]

$$\Delta T_j(k) = T_j(k) - \hat{T}_j(\mathrm{k})$$

Monitors and Initiates stopped vehicle if $\Delta T_j(k)$ exceeds Θ_{SV} at N_{SV} locations. The smaller the incident to be detected, the greater the time interval to be used for assessment.

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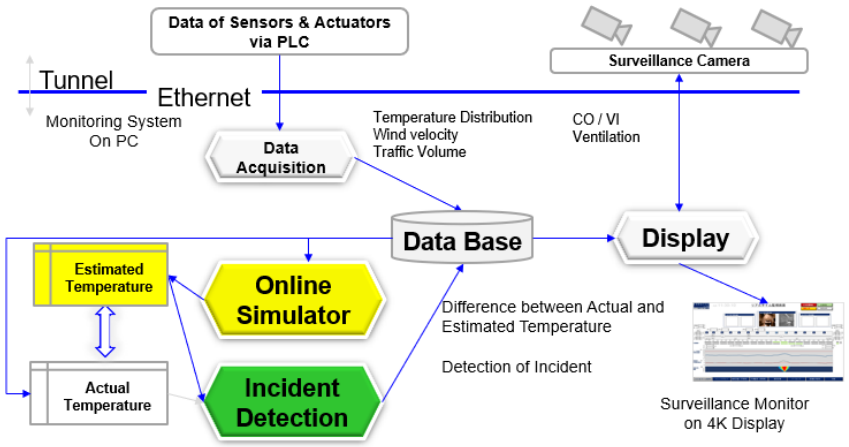
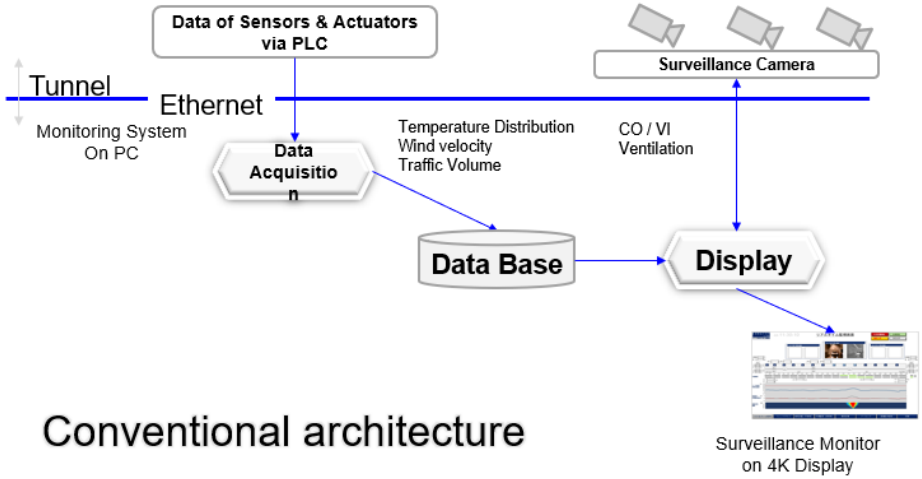
Proposed Architecture





Conventional architecture

Model-based
- immune to normal temperature variation
(traffic change, ventilation control change,
- simulator tracks accurately the temperature,
- easy to apply to other tunnels

Data-based
- susceptible to normal temperature variation
- requires ad-hoc tuning

Road Tunnel Temperature Monitoring System Using a Simulation Model

M

⑩Advantage of temperature-based fire detection against flame-based.

E

⑩Simulator-based fire detection results less false alarm, improving tunnel availability.

R

⑩Online simulator provides operators with a tool to predict future evolutions, e.g. smoke propagation.

I

⑩Online simulator can detect a failed sensor so as to expedite the replacement.

T

⑩Online simulator can be used to train operators for unexpected events.

Conclusions

(1) Proposed the use of online simulator in the road tunnel monitoring system
(2) Has shown how the temperature simulator works in AID.
(3) Discussed the merits of using online simulator in tunnel monitoring systems

Thanks for your attention!

Please contact Toshiaki Sakaguchi at sakaguchi@sohatsu.com
and visit www.sohtaus.com for more details