The Application of Visible Image Road Surface Sensors to Winter Road Management

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A large number of closed circuit television (CCTV) cameras have been deployed in recent years, especially in places requiring checking of site conditions.

Efficient and effective use of such technology will be necessary in the future.
1. Efficient monitoring of large numbers of camera images
2. Effective use of acquired information in the control of individual roads

This research, therefore, seeks to enhance the efficiency and quality of road management and starts by examining specific ways of using imaging sensors.

The use of sensing technology (imaging sensors) achieved under AHS R&D is expected to solve these issues.
1 What is AHS?

2 Expectations of IT in road management
   2-1 Efficiency and advances needed
   2-2 Problems in road management
   2-3 The significance of IT in road management

3 Application in winter road management
   3-1 What are visible image sensors?
   3-1 (supplement) Detection screen
   3-2 Uses in road management
   3-3 Problems in winter road management

4 Test results
   4-1 Early detection of freezing
   4-2 Detection of refreezing
   4-3 Discussion
1 What is AHS?

- AHS\(^1\) is a system that links the road and vehicles, providing information, warnings and operating assistance to the driver in real time.
- It seeks to enable the driver to take action immediately before an accident occurs.

Service image

- Road status sensor
- Stopped vehicles!
- Road-vehicle communication device (antenna)

STOPPED VEHICLES!

Vehicles stopped 300 meters ahead!

Brake!

*1 AHS: Advanced Cruise-Assist Highway Systems
As the social conditions surrounding road administration change, there is a need for greater efficiency and advances of road management.

- **Achieving results-oriented road administration management**
  1) Time lost to traffic jams
     → Reduce by 10% by 2007
  2) Road construction time
     → Reduce by 20% by 2007, etc.

- **Society's road administration needs**
  - Efficient use of road resources
  - Services meeting users' needs

Seek to improve road management quality by using sensing technology (a form of IT*1) with monitoring cameras

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*1 IT: Information technology
In order to answer the needs of road administration accurately, it is necessary to enhance the efficiency and quality of road management.

**Problems in road management**

- Enhancing the quality of road management
- Enhancing the efficiency of road management

Society's road administration needs

Budgetary and human resource limitations
2-3 The significance of IT in road management

- Advancing the use of information (that is, implementing IT) makes it possible to improve work efficiency and quality.

Flow of road management and IT

- Information collected
- Information stored up
- Information processed
- Decision / judgment
- Execution / cancellation of countermeasure, regulation, etc.
- Information provided
- Improved work efficiency / quality
- Use of IT technology
  1. Increasing the capacity to acquire high-quality information quickly and efficiently
  2. Increasing the capacity to store up and manage miscellaneous information
  3. Increasing the capacity to analyze and express information to provide judgment support
  4. Increasing the capacity to convey / communicate information through various means
3 Application in winter road management

3-1 What are visible image sensors?

Visible camera image

Learning road surface conditions through image processing

Real time / surface conditions measurement / distinguishing of 5 states / high precision
3-1 (supplement) Visible image road surface sensor output screen

- : Dry
- : Wet
- : Water film
- : Accumulated snow
- : Ice

Camera image

Sensor output image
**3-2 Uses in road management**

- Knowing changes and trends in road surface conditions can support the job of road management.
- This is also effective source material for providing information to road users.

<table>
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<tr>
<th>Freezing, etc.</th>
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- **Road surface detection**
  - Until the present
    - Reporting from the site
    - Discover phenomena from weather data
    - Prediction based on experience
    - Checking site by making regular patrols
    - Performance of road surface management (years of experience necessary)
  - After implementing sensors
    - System automatically detects conditions
    - Automatic report from system (cell phone, PC, monitoring terminal)
    - Performance of road surface management (support for uniform work judgment)
  - Support for road surface management
  - Information provided to users
    - (site images, etc.)
  - Information provided to users
    - (road surface status, etc.)

- **Road surface checking**

- **Performance of work**
3-3 Problems in winter road management

- It may be possible to increase road safety by detecting freezing conditions early
- Additionally, it may be possible to mitigate the job burden of monitors

**Problems**

- Early detection of freezing
  - Work and cost burden of monitoring with traditional patrols and CCTV cameras
- Detection of refreezing
  - Difficulty of detecting freezing in real time when monitoring with traditional patrols

**Hypothesis**

- Finding changes in conditions without constantly monitoring a terminal
- Instructions to apply freeze inhibitors at the most appropriate time
- Instructions to apply freeze inhibitors in quantities suitable for road surface conditions

**After implementing sensors**

- System automatically detects freezing
- Automatic report from system (cell phone, PC, monitoring terminal)
- Performance of road surface management (support for uniform work judgment)
- Information provided to users
  - (road surface status, etc.)

**Mitigating the job burden of monitors, improving road safety**
4 Test results
4-1 Early detection of freezing

Application of freeze inhibitors

Application before freezing

Application after freezing

Important to apply in advance to prevent road surface from freezing

It is necessary to be able to see signs that road surface is frozen

Monitoring for freezing with visible image road surface sensors

It is possible to detect signs of freezing from changes in observed phenomena, air temperature and road temperature
4-2 Detection of refreezing

Detection of application of freeze inhibitors

Change in road surface temperature after application of freeze inhibitors

By finding sharp drops or mild rises in road surface temperature

it is possible to detect the application of freeze inhibitors
By finding an evenly maintained temperature or temperature drop after a road surface temperature increase, it is possible to detect road surface refreezing.
4-2 Detection of refreezing

Assessment of freezing with sensors

By adjusting the frozen road surface temperature threshold to changes in road surface temperature, one can properly assess the road surface from application of freeze inhibitors to refreezing.
4-3 Discussion

By using visible image road surface sensors for road management...

- It is possible to apply freeze inhibitors in the optimal timing for the freezing status
- It is possible to minimize the time the road surface is frozen
- It is possible to reduce the amount of freeze inhibitors applied
- It is possible to improve road safety, reduce road maintenance and management costs, mitigate the burden on road managers and reduce environmental burden