Cruise-Assist Services Utilizing Up-link Information

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1. Overview

Utilization of Up-link Information for Cruise-Assist Services

OBU
Accumulate up-link information

Central Processing unit (Center)
Extract cruise-assist information

OBU or information boards
Display safe driving support information

Proposal for effective services
- Overview of system
- Necessary up-link information
- Feasibility of services

Proving test of DSRC
- Up-link function
- Communications capacity

Driver
Safe & secure driving
2. Background

AHS (Existing systems)

Beacon

Center

Roadside Sensor

Provide to rear vehicles

Dangerous phenomena

System Effectiveness confirmed

Detect dangerous phenomena with high accuracy

Due to cost restrictions, installation limited to high-accident locations, frequently congested locations, etc.

Solve the issue by utilizing up-link information

Stopped vehicles 200m ahead!

Accident vehicles

Sensor

Beacon
3. Propose of Services

Advantages of Utilizing Up-link Information:

- Range of collecting information is not limited.
- Can construct the up-linking system at reasonable cost.
- Can collect ABS activation, braking strength and so on.

Fields utilizing up-link information

- Road traffic information
- Road management
- Cruise-Assist
3. Propose of Services

Information provision service on forward obstacles at locations with poor visibility

<table>
<thead>
<tr>
<th>Necessary up-link information</th>
<th>Feasibility Of service</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Location</td>
<td>• Establish detection methods</td>
</tr>
<tr>
<td>• Time</td>
<td>• Confirm detection delay time</td>
</tr>
<tr>
<td>• Speed</td>
<td>• Confirm detection accuracy</td>
</tr>
<tr>
<td>• Longitudinal acceleration</td>
<td>Comparison with accuracy of roadside sensors</td>
</tr>
<tr>
<td>• Lateral acceleration</td>
<td></td>
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<tr>
<td>• Angular acceleration</td>
<td></td>
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<tr>
<td>• Braking strength</td>
<td></td>
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<tr>
<td>• Steering angle</td>
<td></td>
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</tbody>
</table>

Rearmost congestion

Provide with information boards

Provide with OBU

CENTER

Data processing
- Event identification
- Event location estimation

DSRC beacon

Establish detection methods
3. Propose of Services

Information provision service at dangerous driving locations

Information collection & provision by DSRC beacon

OBU accumulates braking strength, steering angle, other such vehicle behavior data

Network

Center analyzes up-link information to create map of near misses

Regional Development Bureau

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<th>Feasibility of Service</th>
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<tr>
<td>• Location</td>
<td>• Establish detection method</td>
</tr>
<tr>
<td>• Time</td>
<td>• Determination algorithm</td>
</tr>
<tr>
<td>• Speed</td>
<td>• Studying to provision in real-time using DSRC beacon</td>
</tr>
<tr>
<td>• Longitudinal acceleration</td>
<td>• installation location, etc.</td>
</tr>
<tr>
<td>• Lateral acceleration</td>
<td></td>
</tr>
<tr>
<td>• Angular acceleration</td>
<td></td>
</tr>
<tr>
<td>• braking strength</td>
<td></td>
</tr>
<tr>
<td>• Steering angle</td>
<td></td>
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<tr>
<td>• ABS operation signal</td>
<td></td>
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<tr>
<td>• VSC operation information</td>
<td></td>
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<tr>
<td>• Road surface sensors</td>
<td></td>
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</tbody>
</table>
3. Propose of Services
Information Provision Service for Road Surface Conditions Ahead

Icy road location detected by up-link information

Icy Road = Vehicle stability control system + Outside air temperature < 0°C

Caution! Ice 800 m Ahead

Necessary up-link information
- Location
- Time
- Longitudinal acceleration
- Lateral acceleration
- Angular acceleration
- Road surface sensors
- Temperature & humidity sensors
- Wiper operation
- ABS operation signal
- VSC operation information
- Fog lamps

Feasibility of service
- Acquire VSC and ABS
  - Pros/cons of disclosure of vehicle manufacturer know-how
4. Proving Test: test items

Test 1. Test of Up-link Function of DSRC
: Test up-linking of information accumulated in OBU.
: Use the memory access function in the basic application interface.

Test 2. Test of Communications Capacity of DSRC
: Test up-link data volume when changing down-link data volume and vehicle speed.
: One beacon collects information and provides it in one passage of vehicle.
Features of DSRC in Japan
- 5.8GHz band
- Two-way radio communication
- ASK and QPSK
- Radio communication protocol used for ETC

Equipment specifications
- ARIB STD-T75 (DSRC) conformity
- ARIB STD-T88 (ASL) conformity
- ITS FORUM RC-004
  - Basic application interface conformity
  - Indicate
  - Response

Six app.
- Memory access : up-link
  - Id
  - Card access
  - Push

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Test Equipment Configuration

- Center
- Roadside system
- OBU
- Experimental roadside equipment
- Radio controller
- Roadside radio
- Roadside antenna
- Experimental OBU
- OBU
- Car navigation system
- Basic application
  - ASL
  - DSRC

Vehicle behavior

Memory access
4. Proving Test: Scenes of testing

Test Course of NILIM (Mid-February 2005)
4. Proving Test
Test Results 1: Test of Up-link Function of DSRC

Confirmed the memory access function to up-linking information accumulated in OBU.

- Run the test course
- Up-linking by DSRC
- The center collect Up-link information
- Displayed vehicle behavior on maps
4. Proving Test:
Test Results 1 (Reference Test) : Possibility of Event Detection

Placed an obstacle on the vehicle route

OBU accumulated vehicle behavior when avoiding obstacles

Up-link by DSRC

The center collect Up-link information

Displayed vehicle behavior on maps
## 4. Proving Test:
Test Results 2: Test of Communications Capacity of DSRC

Confirmed up-linking 6KB data.

### Table 1. Test Results

<table>
<thead>
<tr>
<th>Down-link data volumes</th>
<th>Maximum up-link data volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed 60 km/h</td>
</tr>
<tr>
<td>6 KB</td>
<td>20 KB</td>
</tr>
<tr>
<td>25 KB</td>
<td>14 KB</td>
</tr>
</tbody>
</table>
5. Summary

Conclusions
- Proposal for effective cruise-assist services
- Proving test using DSRC
  (1) Confirmed the memory access function to up-linking information accumulated in OBU.
  (2) Confirmed up-linking 6KB data.

Future plans
- Develop and test the algorithm for detecting dangerous phenomena
- Optimum placement of DSRC beacon (installation location and intervals)

Toward earlier realization