2016 SIP-adus

Development of necessary function for ART information Center

Hitachi, Ltd.
1. Advanced Rapid Transit (ART) Concept
2. Vision of ART Information Center
3. Objectives and Project summary
4. Consideration about requirements of platform function and prototyping and feasibility studies of the platform
5. Research/consideration/development about cooperation with external systems
6. Research/consideration/development about utilizations of the ART sensor information
7. Conclusions
1. Advanced Rapid Transit (ART) concept

Smooth acceleration control technology with a level of precision suitable even for Shinkansen bullet trains while preventing passengers from falling over

*Automated driving control

Seamless transit with minimal waiting time

*Organically integrated operation system

Improved punctually

*Advanced PTPS
*Automated driving control

Quicker and safer boarding Disembarking

*Auto-maneuvering technology

Quicker boarding/disembarking, prevention of passenger injuries

*Wheelchair securing device
*Automated contactless fare collection

Preventing accidents, reducing driver’s stress

*Automated driving technology
*Advanced driving assistance

Traffic optimization, reducing traffic jams and CO2

*C-ACC (Cooperative Adaptive Cruise Control)

Source: Cabinet Office, Government of Japan HP
2. Vision of ART Information Center

- ART Information Center provides traffic-related data for various utilization with open platform.

Safe, secure and comfortable movement

- Relevant Organization
- Application Service Provider
- Railway Operator
- Dynamic Map
- Train Subway
- Public transport Transfer convenience
- Bus Operator
- Road Operator
- ART speediness
- ART Information Center
- PTPS
- ART
3. Object and Project summary

Objectives:
- Clarification of data contents which should be collected and shared
- Consideration about requirements of platform function and prototyping and feasibility studies of the platform

Project summary:
- Consideration about requirements of platform function and prototyping and feasibility studies of the platform
- Research/consideration/development about cooperation with external systems
- Research/consideration/development about utilizations of the ART sensor information
4. 1. Consideration about requirements of platform function and prototyping and feasibility studies of the platform

Problem investigation
For Bus users
For Bus operators

Use-case study

<table>
<thead>
<tr>
<th>viewpoint</th>
<th>purpose</th>
<th>Use-case</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>Smooth moving</td>
<td>Transit guidance</td>
<td>Advanced transit guidance</td>
</tr>
<tr>
<td></td>
<td>Convenience</td>
<td>Bus navigation</td>
<td>Destination announcement</td>
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<tr>
<td></td>
<td></td>
<td>Information service</td>
<td>Bus congestion information</td>
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<tr>
<td>operator</td>
<td>Improvement of utilization</td>
<td>Passenger support</td>
<td>Wheelchair preparation</td>
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<td></td>
<td></td>
<td>Speediness</td>
<td>Cooperation with PTPS</td>
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<tr>
<td></td>
<td>safe and secure</td>
<td>Monitoring inside Bus</td>
<td>Emergency detection</td>
</tr>
</tbody>
</table>

Consideration for necessary function of ART information center

- IoT infrastructure
- Data infrastructure
- Open data infrastructure
- APP developer supporting infrastructure
- Operation infrastructure
4. 2. ART information center function structure

Third Party Apps

Advanced transit support
Bus Operation support
Bus Location system
Bus anomaly detection

.... more

APP developer supporting infrastructure
Software Parts
Tools, Server resource

Data infrastructure
Business Intelligence
Service Functions
Data Base
Edit, Process
Data Lake

Operation infrastructure
Operation management / Security

ART Information Center PF
5.1. Research/consideration/development about cooperation with external systems

Transit guidance using traffic simulation technology

- Input traffic simulation result to ART info. Center
- ART info. Center provide simulation result to transit guidance APP provider

<table>
<thead>
<tr>
<th>ART Information Center</th>
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</thead>
<tbody>
<tr>
<td>Interface</td>
</tr>
<tr>
<td>Gateway</td>
</tr>
<tr>
<td>API</td>
</tr>
</tbody>
</table>

Traffic Operator

Integrated traffic simulation

Traffic information

Sensor data

Prediction

Search data

Transit guidance Service provider

Transit guidance

Search data

Consumer
Gathering train operation data and road traffic information in real time. Simulate and predict the point of congestion. Prediction result will be utilized for traffic load balancing and transit guidance.

**Daily operation**

- Gather info.
- Train operation
- Traffic volume

**Traffic prediction**

- Road traffic simulation
- Traffic volume prediction

**Train simulation**

- Operation prediction
- Transit prediction

**Consideration of Traffic load balancing**

**Inspection, improvement**

- Traffic results acquisition
- Divergence point detection
- Model adjustment

**Prediction result**

- Consideration item
  - (a) Necessary information for transit guidance
  - (b) Prediction method
  - (c) Traffic load balancing and transit guidance
5. 3. Necessary information for Transit guidance

Integrated Traffic Simulation

Train operation simulator
Train congestion simulator
Road traffic simulator

Simulator management module

Operation status
- Delay
- Speed control
- Suspend section

Congestion status
- Occupancy
- Visitors
- History data

Traffic demand
- Trip information
- Origin Destination
- Route
- Movement purpose
- History data

Road traffic status
- Link traffic volume
- Travel time
- Origin Destination
- Speed limitation
- Accident
- History data

ART information
- Number of passengers
- Waiting Passengers
- Traffic volume
- History data

Prediction
- Train operation change
- Road traffic change
- Demand change

Traffic balancing
- train/road

Guidance
- Information
- Timing
### 6.1. Research/consideration/development about utilizations of the ART sensor information

<table>
<thead>
<tr>
<th>Item</th>
<th>Use case</th>
<th>Bus sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Information service</td>
<td><strong>Bus congestion (Passenger counter)</strong></td>
<td><strong>Inside camera</strong></td>
</tr>
<tr>
<td>2</td>
<td>Wheelchair space confirmation</td>
<td>Inside camera</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bus stop camera</td>
</tr>
<tr>
<td>3</td>
<td>Transit guidance</td>
<td><strong>Bus GPS unit</strong></td>
</tr>
<tr>
<td>4 Operation management</td>
<td>Detecting road side parking vehicle</td>
<td><strong>Outside camera</strong></td>
</tr>
<tr>
<td>5</td>
<td>Detecting road works</td>
<td><strong>Outside camera</strong></td>
</tr>
<tr>
<td>6 Safety management</td>
<td>Bus stop monitoring</td>
<td><strong>Bus stop camera</strong></td>
</tr>
</tbody>
</table>

### Next step

- **Inside Camera**
  - Passenger counter
  - Detecting road side parking vehicle
  - Detecting road works
  - Bus stop monitoring

- **Outside Camera**
  - Detecting road side parking vehicle

- **Bus-stop Camera**
  - Bus stop monitoring
### 6.2 Result of passenger counting by Image processing

<table>
<thead>
<tr>
<th>Item</th>
<th>Empty</th>
<th>Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image of Bus inside</td>
<td><img src="image1.png" alt="Empty Image" /></td>
<td><img src="image2.png" alt="Full Image" /></td>
</tr>
<tr>
<td>The measurement target (Visual inspection average)</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Measurement Result (Average)</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Accuracy (standard deviation) (Target : Lower than 2)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>N/A</td>
<td>Good</td>
</tr>
</tbody>
</table>

Photograph by cooperation of Keisei bus Co., Ltd.
7. Conclusions

1) Consideration about requirements of platform function and prototyping and feasibility studies of the platform
   - Definition of functions of the platform
   - Consideration of requirements about basic functions

2) Research/consideration/development about cooperation with external systems
   - Consideration of required information for transit guidance
   - Consideration of feasibilities of those transit guidance

3) Considerations of Bus sensors utilization
   - Research and analyze about types of sensors
   - Consideration of utilization of collected information from those sensors

Next Plan

- Proof of Concept (FY17-18)
  - Verification on the speediness of ART by Advanced PTPS
  - Verification on the effectiveness of Pedestrian Transfer support system