RailTokyo2015

Passenger flow simulator for systematic optimization of station layout and train timetable

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1. Background
2. Overview of proposed simulator
3. Case Study – after a big event
4. Conclusion
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1. Background
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Visualization and prediction of passenger flow for safety and comfort assessment.

Application Process

1-1 Background

We developed a passenger flow simulator for systematic optimization of station layout/equipments and train operation.

| Changing environments or conditions | Find problems by using simulator | Planning for the problems | Improving plan by using simulator |
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1. Background
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2-1 Overview of proposed simulator

Proposed simulator covered an entire station, include pathways, concourse, platforms, etc.

- **Control of gates**
- **Boarding and alighting on platform**
- **Visualization of train operation**

Train operation following the schedule
2-2 Technical Feature of Proposed Simulator

Considering the interrelation between train operation and passenger flow

Input Data
- Passenger Demand Data
- Station Layout Data
- Timetable Data
- Train Line Data

Simulation Model
- Passenger Flow Model
  - Including various sub-models
  - Train schedule
  - Alighting passengers
- Train Traffic Model
  - Boarding passengers
  - Delay of departure
  - Prediction of train delay propagation
2-3 Detail of Passenger Flow Model

Train Route Model
(Macro model)
To Search Passenger’s Route on railway network from current location to Destination Station

Pedestrian Behavior Model
(Micro model)
To Search Passenger’s Route inside Station from Current location to Next Platform or Exit inside Station

- Passengers (color coding for each destination)
2-5  Passenger Behavior Model at platform

Passenger behavior of boarding and alighting

Train Approaching

(1) Queuing
(2) Alighting
(3) Boarding

Stairs  Escalator  Platform

Transformation into multiple pairs shortest path problem

○ Origin  ○ Destination  ← Moving direction

(1) Queuing
(2) Alighting
(3) Boarding
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3-1 Case Study – a station after a big event

**Conditions:** Finish time of event is **13:30**
20,000 passengers flow into a station after the event

<table>
<thead>
<tr>
<th>Scenario</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train headway</td>
<td>11min.</td>
<td>6.5min.</td>
<td>6.5min.</td>
</tr>
<tr>
<td>Escalator direction</td>
<td>Up</td>
<td>Up</td>
<td>Down</td>
</tr>
</tbody>
</table>

Underground Station
Island platform
1 lines 2 directions

Connection between Ticket gate and platform

Exit
B1
Ticket Gate
Platform
Escalator
B2
Ticket Gate
Exit

B3
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

Entire station is congested by lack of the transport capacity.

#2
Train headway: 6.5min
Escalator: up

Around ticket gate is congested by lack of stair capacity.

#3
Train headway: 6.5min
Escalator: down

Congestion is reduced by direction change of escalators.
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
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Train headway: 6.5min
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3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

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Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down

Congestion is resolved.
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-2 Comparison of simulation results

#1
Train headway: 11min
Escalator: up

#2
Train headway: 6.5min
Escalator: up

#3
Train headway: 6.5min
Escalator: down
3-3 Evaluation

Simulation result of dwell passengers over entire station

It is important to consider both local congestion and entire congestion.
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4-1 Conclusion

We developed a passenger flow simulator.
- It enables congestion to be estimated over an entire station. considering interrelation between train traffic and passenger flows.
- It is an effective means of showing congestion changes.

We studied congestion reduction at station under various scenarios.
Thank you for your kind attention.

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