Dwell Time Estimation by Passenger Flow Simulation on a Station Platform based on a Multi-Agent Model

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Abstract
During peak seasons, Shinkansen station platforms become very congested. Passengers who do not have seat reservations wait for the train forming a queue on the platform. The queues if they are long, prevent passengers from walking smoothly. Thus, dwell times of trains increase and departures of trains are delayed. In addition, passengers feel uncomfortable because it is difficult for them to walk freely. It is essential to estimate effective countermeasures so that passengers can get on and off trains smoothly and trains can depart without delays. In order to estimate the countermeasures in advance, we have developed a multi-agent simulator, in which not only a passenger but also his/her baggage is expressed as an agent because in case of highspeed rails, a lot of passengers carry trolley bags and they sometimes become obstacles for other passengers. In this paper, we present the structure of the multi-agent simulator and show the results of numerical analysis for several different types of passenger alignments and the influence of platform screens to the times of boarding and alighting.

Keywords
passenger flow, dwell time, platform, multi-agent, simulation

1 Introduction

In intercity railways such as Shinkansen (the high speed rail in Japan), platforms become very congested during peak seasons such as new year holidays, summer holidays and spring holidays. In particular, passengers who do not have a seat reservation wait on the platform forming a queue and if the queues are too long, these become obstacles for other passengers. They cannot walk smoothly and feel uncomfortable. They sometimes even have to be very careful so that they are not forced to fall down to the track.

Congestion on the platform may delay trains. Passengers cannot get on or get off smoothly because of the congestion on the platform and the dwell times increase, thus, departure is delayed.

In order to improve such a situation on the platform, railway companies are making various kinds of efforts to make it possible for passengers to move smoothly.

From the viewpoint of operation, the following countermeasures might be taken:

• They urge passengers who wait on the platform to form a queue. In order to let the passenger clearly know where they should wait, a part of the platform is painted (we call this part “an alignment area”). The width and the shape of the alignment area is
different depending on the particular situation of the platform or station. For example,
the width of the alignment area is wide enough so that passengers make a triplex row
if the width of the platform is small and if the railway company does not want to
make the queue too long. If there already exist facilities (such as a kiosk, an office for
station staff and so on) on the platform and it is difficult to extend the alignment area
in the perpendicular direction, the alignment area is made in the longitudinal direction
to the platform.

• They make an announcement when a train arrives at the station to encourage the
waiting passengers to step aside so that alighting passengers can get off the train
smoothly. This is important because otherwise, there appears a disorder of boarding
passengers and alighting passengers and both of them cannot move smoothly, and the
dwell time tends to increase.

From the viewpoint of the facilities, there exist countermeasures such as:

• They install platform screens to secure the safety of passengers. Platform screens,
however, are sometimes disadvantageous for punctuality, because the total dwell
times tend to increase.

• They carefully decide locations of facilities on a platform such as a kiosk, an office
of station staff, trash boxes, benches, waiting rooms, fast food restaurants so that they
do not become obstacles of passengers’ flow.

But it is difficult to foresee how effective these countermeasures are. So, railway compa-
nies are eager to know well in advance what are effective countermeasures and how effective
they are.

In order to fulfill such a request, we have developed a passenger flow simulator, which
simulates the behavior and the movement of each passenger on a platform. We iterate
simulation for a situation assuming some countermeasures are taken and from the results of
the simulation, we can evaluate the effectiveness of the proposed countermeasures.

Our simulator is designed based on the multi-agent model. Not only a passenger but
his/her baggage is also realized as an agent. The reason why we prepare the baggage agent
is that many passengers carry trolley bags in case of the high-speed rail and their baggage
may give significant inconvenience to other passengers. Thus, the baggage agent is designed
so that it follows its holder keeping a certain distance from it.

A lot of papers concerning simulation of pedestrians’ flow are already published as we
discuss in the third section. But none of them deal with queues of passengers on a platform
nor baggage carried by them.

We have also introduced ideas to speed up the simulation and with these ideas, we
have implemented it on a PC. Then we confirmed that it works properly by comparing
the simulation results and the videotaped scenery. Then, we have conducted numerical
experiments for the passenger flow on a Shinkansen platform, such as

• difference of dwell times and passenger flow when we change the shape of the align-
ment areas.

• difference of dwell times and passenger flow when we change the specifications of
the platform screens.
2 Passenger flow simulation on a Shinkansen platform

2.1 Aim of this research

The aim of this research is to develop a simulator which can simulate the behavior and movement of passengers who wait for a train in a queue, alight a train, board a train and to estimate the dwell times and congestion on the platform when some changes about operation or facilities are made.

2.2 Requirements for the simulator

In order to fulfull the aim, the simulator has to satisfy the following requirements:

1. Requirements for the facilities
   - Alignment area: It has to be able to take the alignment areas into account.
   - Wall and pillars: It has to be able to take the walls, pillars and other obstacles on the platform into account.
   - Train: It has to be able to take the trains into account.
   - Platform screen: It has to be able to take the platform screens into account.

2. Requirements for Passengers’ behavior
   - Walk: It has to be able to simulate passengers’ walking behavior from appearance to arrival at the target avoiding obstacles.
   - Align: It has to be able to simulate passengers’ behavior to align and wait along the alignment area.
   - Alighting: It has to be able to simulate passengers’ behaviour who get off a train. We assume they disappear from staircase, an escalator or an elevator.
   - Boarding: It has to be able to simulate passengers’ behaviour who get on a train after all the passengers in the train get off.
   - Appearance: It has to be able to simulate appearance of necessary number of passengers. We assume they appear from a train, staircase, an escalator or an elevator.

3. Requirements for baggage
   - It has to be able to simulate the baggage (trolley bags) and its influence to other passengers.

3 Related works

A lot of papers are already published which aim at estimating necessary dwell times of trains considering passengers’ flow.

One approach is a statistical one. Based on data collections, statistical models can be built using regression methods (Buchmueller (2008)). Statistical models could be used to
analyze dwell times for current situation but it is difficult to apply them for the situation where parameters are drastically changed.

Another approach is simulation. Qi (2008) and Chi (2010) proposed a simulator based on the cellular automata model. The cellular automata model is based on a division of the space into square cells in which there is at most one passenger. This is a very strong assumption and this model is not effectively used for congested situation because in reality, the number of passengers which can exist in one cell varies a lot.

There exist commercial products such as PTV (2014) which can simulate the flow of pedestrians and have versatile functions and good GUI but they do not explicitly deal with passengers with a big baggage nor they do not deal with the alignment of passengers on the platform.

There are reports concerning the pedestrian simulation based on the multi-agent based model (Hoogendoorn (2007), Allesandro (2014), Wen (2013)). But they do not deal with the baggage and the alignment on the platform either.

Sourd (2011) proposed a multi agent simulation for the passengers’ flow when passengers get off. But they are more interested in the design of inside a train and they do not deal with the passengers’ flow on the platform. Kase (2012) is proposing a practical simulator for the passengers’ flow on a congested platform. But their target is a station in the commuter lines and they are not dealing with baggages and difference of alignment areas.

4 Approach based on the multi-agent simulation model

4.1 Multi-agent simulation

A multi-agent simulation model is a model which consists of agents and an environment. Each agent perceives the environment and autonomously decides its behaviour to fulfill its aim. An agent influences other agents and it is influenced by other agents and the environment as well.

In our simulation model, we prepare a baggage agent. A baggage agent corresponds to a baggage (trolley bag) and it moves with its holder and it is an obstacle for other passenger agents. This model can simulate pedestrians with a baggage much more realistically compared with an approach to make the size of a passenger agent large.

![Figure 1: Snapshot of simulation.]

5 Details of the simulation model

In our simulation model, we use the potential model. A potential model is a simulation model in which some amount of charge is given to an agent and attraction and repulsion
forces between agents and those between agents and obstacles are calculated. Then we can
deckide the behavior and the movement of agents by aggregating these forces.

5.1 Parameters of a passenger agent

A passenger agent has parameters as follows:

- current position \( P = (x, y) \)
- target \( G = (x, y) \)
- walking speed \( v \) [m/s]
- maximum walking speed \( V_{max} \) [m/s]
- radius \( r \) [cm]
- direction \( d \) [degree]
- scope range \( \theta \) [degree]
- scope for passengers \( S_p \) [cm]
- scope for obstacles \( S_o \) [cm]

5.2 States of a passenger agent

A passenger changes its behavior based on its current target. So, a passenger agent has a
state corresponding to its current target, which changes reflecting its current target and the
behaviour of the agent is decided according to the state as follows:

- Walk
  The state of a passenger agent who appeared from the staircase is "Walk."
  A passenger agent in "Walk" state sets an alignment area as its target and moves
toward it.
  When a passenger agent arrives at the alignment area, the state changes into "Align."

- Escalator
  The state of a passenger agent who appeared from an escalator is "Escalator."
  A passenger agent who is in "Escalator" state moves at a constant speed.
  The target of the agent is the exit of the escalator. When it arrives there, the state is
  changed into "Walk."

- Align
  When a passenger agent arrives at an alignment area, its state is changed into "Align."
  A passenger agent waits for a train there and when a train arrives, its state is changed
  into "Board."
• **Alight**
  When a train arrives at a station, the state of a passenger agent in a train is changed into "Alight."
  A passenger agent in "Alight" state sets staircase or an escalator as its target and moves toward them.
  A passenger agent in "Alight" state disappears when it arrives at its target.

• **Board**
  A passenger agent in "Alight" state changes its state into "Board" when a train arrives.
  A passenger agent at the top of the queue waits all the passenger agent in the train get off and proceeds into the train.
  A passenger agent not at the top of the queue follows the preceding agent.
  A passenger agent in "Board" state moves into inside the train.

• **Kiosk**
  If a passenger agent in "Walk" state finds a kiosk, the state of the passenger agent changes into "Kiosk" and sets its target a kiosk with a specified probability.
  After the passenger agent arrives at a kiosk, it changes the state into "Buy."

• **Buy**
  A passenger agent in "Kiosk" state makes a queue in front of the kiosk. The passenger agent at the top of the queue changes its state into "Buy." After a specified time, the state is changed into "Walk." The state of the next agent in the queue changes its state into "Buy."

### 5.3 Alignment

A passenger agent in "Walk" state decides its target from its current position and the number of the passenger agents along the alignment area. We use $P_w$ in order to reflect the preference of the passenger agent, which is calculated by (1). A passenger agent sets the alignment area whose $P_w$ is minimum as its target. In this formula, distance means the distance to the alignment area, and number means the number of the passenger agents along the alignment area. $\alpha$, $\beta$ are the weights which express the preference of the passenger agent (if the passenger agent does not like to walk for a long distance, $\alpha$ should be small and if it does not like to wait in the long queue, $\beta$ should be small). At the moment, we set these parameters probabilistically with a condition $\alpha+\beta=1$.

$$P_w = \alpha \cdot \text{distance} + \beta \cdot \text{number}$$

### 5.4 Scope

It is said that a scope of a passenger to another passenger and that to an obstacle such as a wall are different. The visible distance for the former is said to be 7,500mm while the visible distance in the latter case is 25,000mm. The range of the scope when a man is walking is said to be 110-160 degrees. We set these figures as parameters of passenger agents.
5.5 Visibility of walls

If a wall satisfies 2, we check the visibility of the wall. \( \theta_{d,w} \) is an angle between \( \vec{d}_i \), the direction vector of the passenger agent \( i \) and the normal vector of the wall.

\[
\theta_{d,w} > 90\degree
\]  

(2)

If the wall satisfies either of the following conditions, we judge the wall is visible from the passenger agent.

- **Condition 1** - wall in a scope

\[
||\vec{f}_{iw}|| < S_o
\]  

(3)

\[
\theta_{f_{iw},d_i} < \theta_i/2
\]  

(4)

\( \vec{f}_{iw} \) is a vector from the passenger agent \( i \) to the closest point of the wall. This means if the distance to the closest point of the wall is smaller than \( S_o \) (agent’s scope to an obstacle) and the angle \( \theta_{f_{iw},d_i} \) which is the angle between \( \vec{d}_i \) (the direction vector of passenger agent \( i \)) and \( \vec{f}_{iw} \) is smaller than one half of the passenger agent’s range of scope \( \theta_i \).

- **Condition 2** - wall in right or left

Let \( \text{right} \) and \( \text{left} \) be the vectors at the rightmost position and the vector at the leftmost position of the scope of the passenger agent \( i \) respectively. If either of these vectors intersects with a wall, the wall is judged to be visible.

Figure 2: Wall visible from a passenger agent.
5.6 Judgement about the scope

A passenger agent \( j \) is judged to be in the scope of a passenger agent \( i \) if the following two conditions hold.

\[
\| \vec{f}_{ij} \| < S_p \quad (5)
\]

\[
\theta_{\vec{f}_{ij}, \vec{d}_i} < \theta_i / 2 \quad (6)
\]

This means that the distance between the two agents is smaller than the scope of the agent \( S_p \) and the angle \( \theta_{\vec{f}_{ij}} \) which is an angle between the distance vector \( \vec{f}_{ij} \) and \( \vec{d}_i \), the direction vector of agent \( i \) is smaller than one half of the range of the scope of agent \( i \).

![Figure 3: Agent visible from a passenger agent](image)

5.7 Speed vector

A passenger agent calculates its position based on the speed vector as follows:

- Attraction force to the target

\[
\vec{E}_{ig} = Q_g \cdot \frac{\vec{e}_{ig}}{||\vec{e}_{ig}||} 
\]

- Attraction force from other passengers who proceed to the same direction
Attraction force from other passenger agents who proceed to the same direction is calculated as follows:

\[
E_{ik}^* = \frac{m}{s} \cdot Q_k \cdot \frac{e_{ik}^*}{|e_{ik}^*|}
\]  

(8)

\(E_{ik}^*\) is an attraction force from other passengers who proceed to the same direction. \(S_i\) is the size of the scope, \(m_i\) is the number of the agents in the scope, \(e_{ik}^*\) is the distance vector from the current position of agent \(i\) to agent \(k\) and \(Q_k\) is the charge of agent \(k\).

- repulsive force to the agents who proceed to the opposite direction

The repulsive force to the agents who proceed to the opposite direction is calculated by (9):

\[
F_{ij}^* = \sum_j^n \left( \frac{Q_j}{|f_{ij}|^2} \cdot \frac{f_{ij}^*}{|f_{ij}|} \cos \theta_{d_i, d_j} \right)
\]  

(9)

\(F_{ij}^*\) is the repulsive force to the agents who proceed to the opposite direction. \(f_{ij}^*\) is the distance vector from passenger agent \(i\) to passenger agent \(j\), \(n\) is the number of the passenger agents who proceed to the opposite direction and \(Q_j\) is the charge of passenger agent \(j\).

- Repulsive force to baggage agent

repulsive force to a baggage agent is calculated by (10):

\[
F_{ib}^* = \sum_b^n \left( \frac{Q_b}{|f_{ib}|^2} \cdot \frac{f_{ib}^*}{|f_{ib}|} \cos \theta_{d_i, f_{ib}} \right)
\]  

(10)

\(Q_b\) is a charge of the baggage agent and \(f_{ib}^*\) is the distance vector from agent \(i\) to the baggage agent.

- repulsive force to walls

The repulsive force to walls is calculated as follows:

\[
F_{iw}^* = \sum_w^n \left( \frac{Q_w}{|f_{iw}|^2} \cdot \frac{f_{iw}^*}{|f_{iw}|} \cdot \left(1 + \cos \theta_{E_i, f_{iw}} \right) \right)
\]  

(11)

\(F_{iw}^*\) is the repulsive force from the wall to passenger agent \(i\). \(f_{iw}^*\) is the distance vector from passenger agent \(i\) to the closest point of the wall, \(\theta_{E_i}\) is the angle between the
direction of passenger agent \( i \) and \( \vec{f}_{iw} \), \( Q_w \) is the charge of the wall and \( n \) is the number of the walls.

- Walking speed

The walking speed of passenger agent \( i \) is calculated from the resultant force of the attraction force and the repulsion force. The attraction force of passenger agent \( i \) is calculated as follows:

\[
\vec{E}_i = \vec{E}_{ig} + \vec{E}_{ik}
\]  

(12)

The repulsion force to passenger agent \( i \) is calculated as follows:

\[
\vec{F}_i = \vec{F}_{ij} + \vec{F}_{iw} + \vec{F}_{ib}
\]  

(13)

\( V_{new} \), the walking speed of the agent after a time unit \( dt \) is calculated by the following formulae (14) and (15).

\[
v_{tmp} = \frac{v_i + \left( \vec{E}_i - \vec{F}_i \right) \cdot dt}{\left\| v_i + \vec{E}_{ig} \cdot dt \right\|}
\]  

(14)

\[
V_{new} = \begin{cases} 
V_{tmp} & \left( \| V_{tmp} \| \leq v_{max} \right) \\
v_{max} \cdot \frac{V_{tmp}}{\| V_{tmp} \|} & \left( \| V_{tmp} \| > v_{max} \right)
\end{cases}
\]  

(15)

\( p_{new} \), the position of the agent is calculated by (16), where \( \vec{p}_i \) is the current position of the passenger agent:

\[
p_{new} = p_i + V_{new} \cdot dt
\]  

(16)

5.8 Behaviour of a baggage agent

A baggage agent has the following parameters:

- current position \( P_b = (x, y) \)
- target \( G_b = (x, y) \)
- radius \( r_b \) [cm]
- weight \( w_b \) [kg]
- holder(passenger agent) \( T_b \)
A baggage agent follows its holder. So, we set the target of a baggage agent as the same as that of the holder and likewise it is renewed every time unit.

\[
\mathbf{E}_b = Q_{bp} \mathbf{e}_{bg}
\]  

(17)

\(Q_{bp}\) is the attraction force of the passenger agent (its holder) and \(\mathbf{e}_{bg}\) is a distance vector from the current position of the baggage agent to its target.

\(p_{b,\text{new}}\), the position of a baggage agent after a time unit is calculated as follows:

\[
p_{b,\text{tmp}} = \begin{cases} 
\|\mathbf{E}_b\| (\|\mathbf{E}_b\| \geq r_p + r_b) \\
r_p + r_b (\|\mathbf{E}_b\| < r_p + r_b)
\end{cases}
\]  

(18)

\[
p_{b,\text{new}} = p_b + p_{b,\text{tmp}} \frac{\mathbf{E}_b}{\|\mathbf{E}_b\|}
\]  

(19)

6 Numerical experiments and applications

6.1 Analysis of validity of the simulation

Numerical Experiments

In order to analyze the validity of the simulator, we compared the times consumed for alighting and boarding times in the actual scene we videotaped and those obtained by our simulator. We observed 15 passengers get off and 7 passengers get on. So, we set parameters of the simulator so that the same number of passengers get on and off.

Results

We show the actual times for getting on and off and the results of the simulation in Table 1.

The difference between these two results is only 0.03 %. We have repeated similar experiments and confirmed that there exists only a small difference in times.

Then we compared the behaviour of passengers in detail. We observed a slight difference between actual scenery and the simulation process in their behaviour. For example, if there is a pillar in front of a passenger, in the videotape, the passenger walked in the lefthand side of the pillar but in the simulation, the passenger agent walked in the righthand side of the pillar. But in the next scene, they moved to the same place.

From these results, we can conclude that the accuracy of the simulator is good enough to estimate the time for passengers’ getting on and off.

<table>
<thead>
<tr>
<th></th>
<th>Alighting</th>
<th>Boarding</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>24.10</td>
<td>11.27</td>
<td>35.37</td>
</tr>
<tr>
<td>Simulation</td>
<td>22.35</td>
<td>12.11</td>
<td>34.46</td>
</tr>
</tbody>
</table>
6.2 Application to estimate alighting and boarding times when we changed the alignment area

Passengers wait on the alignment areas. This means if we change the shape of alignment areas, passengers can move more smoothly and there is a possibility that the time for alighting and boarding is shortened.

Comparison
We have compared three types of the alignment areas. We assumed that passengers appear at random and we iterated the simulation 10 times. The number of boarding passengers is 80. This is an average number of passengers for one door during the peak season. We set the sizes of baggage at random between 14 cm and 28 cm.

- Alignment 1: L shaped alignment area. Passengers wait in front of the door of the train (Fig.4left).
- Alignment 2: L shaped alignment area. Passengers wait with a certain distance from the door of the train (Fig.4middle).
- Alignment 3: I shaped alignment area. Passengers wait in front of the door of the train (Fig.4right).

We measured three types of times as follows:
1. Time needed until 80 passengers make a queue.
2. Time needed until all the waiting passengers get on.
3. Time needed until all the alighting passengers disappear from the platform.

![Figure 4: Three types of alignment](image)

Result of the comparison
We show the result of comparison of the three types of alignment in Table.2.

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Queueing (in seconds)</th>
<th>Alighting+Boarding (in seconds)</th>
<th>Disappear (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment1</td>
<td>388.50</td>
<td>78.24</td>
<td>223.05</td>
</tr>
<tr>
<td>Alignment2</td>
<td>369.18</td>
<td>73.71</td>
<td>204.84</td>
</tr>
<tr>
<td>Alignment3</td>
<td>351.12</td>
<td>78.00</td>
<td>197.25</td>
</tr>
</tbody>
</table>
As for the time for alighting and boarding, Alignment 2 is the smallest. We have observed the process of the simulation and learned that in Alignment 2, there exist a room in front of the alighting passengers, they can smoothly go out of the train. As for the time for making a queue and the time for disappearance, Alignment 3 is the minimum. From the observation of the simulation process, the reason is that the queue does not become an obstacle for the walking passengers and passengers who arrive and make a queue and passengers who walk to the staircase can walk smoothly. From these results, we can get a conclusion that if we want to reduce the whole time, we should adopt Alignment 3.

6.3 Where a platform screen should be set?

Recently, it is popular to introduce platform screens. Shinkansen is not an exception and recently railway companies are interested in introducing platform screens on the platform of Shinkansen. But due to complicated reasons such as the detailed specifications among trains are slightly different, the width of the platform screen must be very large, which means those platform screens become very heavy and hence, they become extremely expensive. One idea is to set the platform screens not at the edge of the platform but a certain distance (set back) behind the edge. This makes it possible to use platform screens with smaller width which are much cheaper. But there is a concern that the area on the platform decreases and this may affect the flow of the passengers. So, we have conducted simulation changing the parameters such as the place of the platform screens, the width of the platform screens and the alignment of passengers.

Comparison

We have measured the time for getting on and off and the time needed for passengers to disappear from the platform. We have counted the time when the platform screen is set at the edge of the platform and the time when the platform screen is set 1m inside from the edge of the platform.

We set the width of the moving part of the platform screen at the edge as 3 m and that of the platform screen inside of the platform as 2 m as shown in Fig.5.

We also examined the difference of the alignment area. We compared L shaped alignment area and I shaped alignment area with a platform screen inside the platform.

We conducted the simulation 10 times in which times of appearance of the passenger agent were set to be randomly.

Result of comparison

We show the result (average of 10 trials) in Table.3.

From these results, we can know that if the platform screen is set inside the platform, the boarding and alighting time increases by 4.24 seconds and the disappearance time increases by 10.18 seconds. This is because the walking distance from the alignment area to the train increased and the alighting passengers cannot walk smoothly because the space on the platform decreased.

But if we adopt the I shaped alignment area, the boarding and alighting time increases by 1.11 seconds but the disappearance time was decreased by 9.8 seconds. This is because the waiting passengers make a queue along the platform and there is enough room on the platform. Hence, passengers are able to smoothly walk to the staircase etc.
7 Conclusions

In this paper, we introduced a mult-agent simulator for the passenger flow on a platform. Not only a passenger but his/her baggage is also expressed as an agent because many passengers have trolley bags when they use the highspeed rail. These baggage become obstacles for other passengers and we should not ignore the baggage in order to get a more realistic result. This simulator can simulate passengers’ behaviour on a platform such as boarding, alighting, wait for a train forming a queue along the alignment area, to drop in a kiosk and so on.

We showed that the simulator properly estimates boarding, alighting and disappearing

<table>
<thead>
<tr>
<th></th>
<th>Alighting + Boarding</th>
<th>Disappear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge of platform</td>
<td>51.96</td>
<td>76.91</td>
</tr>
<tr>
<td>Inside platform (L-shaped queueing)</td>
<td>56.20</td>
<td>87.09</td>
</tr>
<tr>
<td>Inside platform (straight queueing)</td>
<td>57.31</td>
<td>77.29</td>
</tr>
</tbody>
</table>
times of passengers by comparing the videotaped scenes and the simulation results. We also showed how we can use this simulator using some examples in which the shapes of alignment areas are different and the positions of the platform screen gates are different.

References


