Counting Passengers from Images of Drive Recorder Inside Buses by Using Background Subtraction and OpenPose

Hayato Nakashima¹, Ismail Arai¹, Kazutoshi Fujikawa¹
¹ Nara Institute of Science and Technology

**Background**
- Bus company's management crisis
- The motorization mainly in local cities
- The declining birthrate and aging population
- The progress of depopulation
- Optimal route planning ex) EAGLE BUS (Saitama, Japan)
- Count passengers at each bus stop
- Find out which section on routes is deficit
- Change bus stop / routes for revenue

Need to know the number of passengers at each bus stop

**Problems and purpose**
- Past: Manually counting by investigators
  → Only investigate several times a year
- Recent: Automatically counting system
  → Need to install equipment for counting
  → Costly: 300,000 Yen/bus

Propose automatically counting at low cost

**Equipment on buses**
The bus company in Japan can install equipment with subsidies from the government.
- Drive recorder
  - Verification of accidents and in-vehicle trouble
- Digital tachograph
  - Verification of accidents and in-vehicle trouble
- Operation management
  - Vehicle data (e.g. vehicle speed, engine speed, GPS etc...) can be stored on memory card or cloud

**Counting method**
- Implementation counting passengers
  - From drive recorder
  - From sensor data
- Update the route planning

**Image analysis method of drive recorder**

<table>
<thead>
<tr>
<th></th>
<th>IN</th>
<th></th>
<th>Recall</th>
<th>F-Measure</th>
<th></th>
<th></th>
<th>Recall</th>
<th>F-Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correct People</td>
<td>Estimated People</td>
<td>Precision Rate</td>
<td>F-Measure</td>
<td>Correct People</td>
<td>Estimated People</td>
<td>Precision Rate</td>
<td>F-Measure</td>
</tr>
<tr>
<td>Background Subtraction</td>
<td>20</td>
<td>13</td>
<td>1</td>
<td>0.65</td>
<td>0.64</td>
<td>19</td>
<td>8</td>
<td>0.875</td>
</tr>
<tr>
<td>OpenPose</td>
<td>69</td>
<td>52</td>
<td>0.75</td>
<td>0.56</td>
<td>0.43</td>
<td>69</td>
<td>43</td>
<td>0.84</td>
</tr>
</tbody>
</table>

**Try 2 methods**
- Background Subtractor (KNN)
- Using OpenPose

**Background Subtractor (KNN)**
1. Detection of count target person
2. Calculate rectangular outline and the center of gravity

**OpenPose**
1. Using OpenPose
   - Detection of count target person
   - Use the position of the neck

**Future Work**
- Using other sensor data
  - There is a correlation the door opening time for passenger get on/off the bus and the number of passengers.