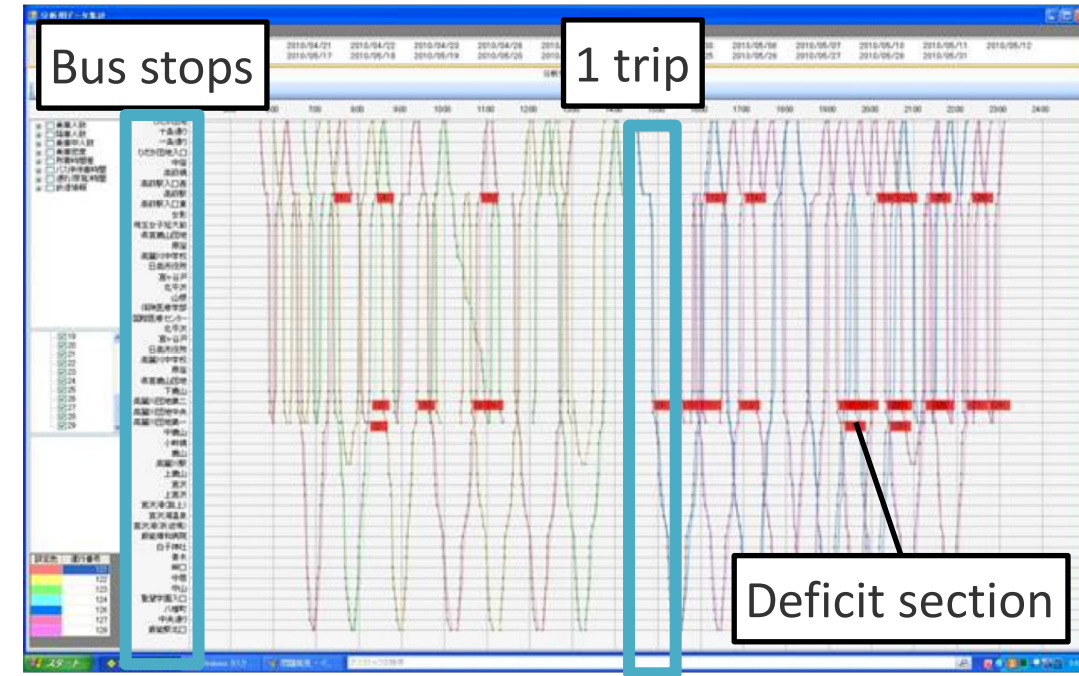# Counting Passengers from Images of Drive Recorder Inside Buses by Using Background Subtraction and OpenPose

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Background

- ◆ Bus company's management crisis
  - ◆ The motorization mainly in local cities
  - ◆ The declining birthrate and aging population
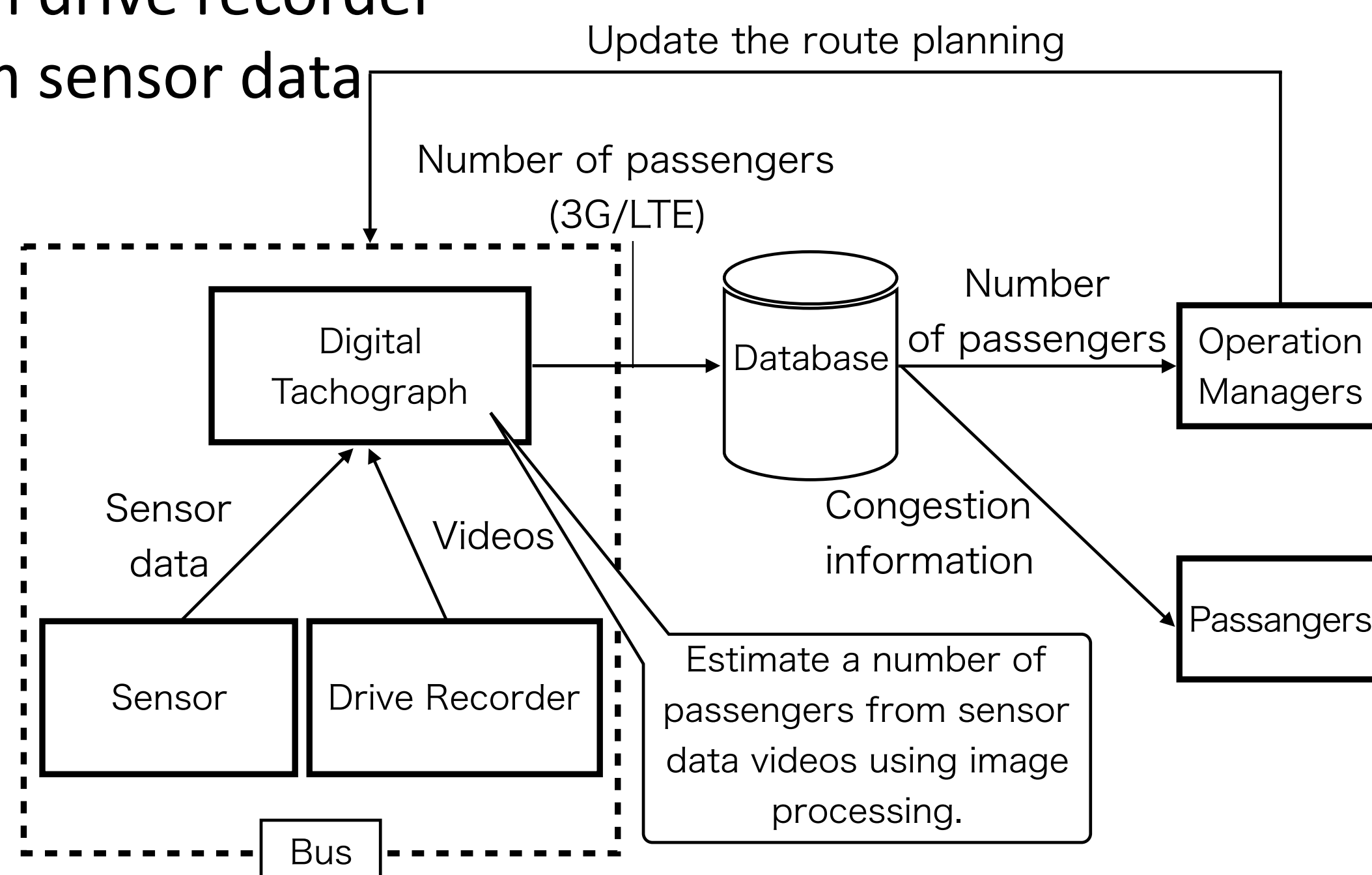 - ◆ The progress of depopulation

- ◆ 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
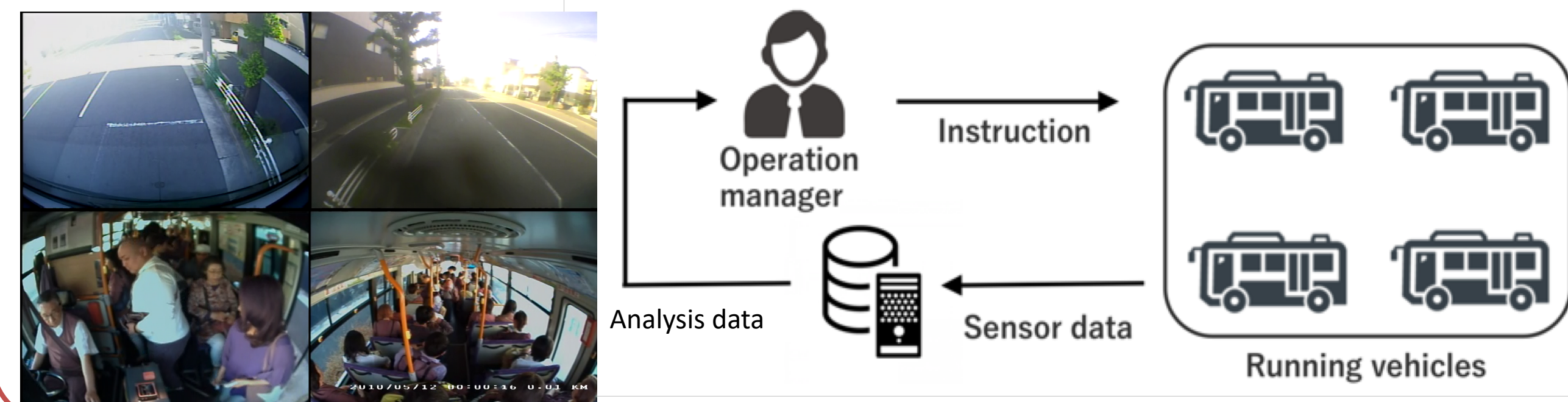 →Need to install equipment for counting
  →Costly: 300,000 Yen/bus

Propose automatically counting at low cost

Counting method

- ◆ Implementation counting passengers
  - ◆ From drive recorder
  - ◆ From sensor data

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
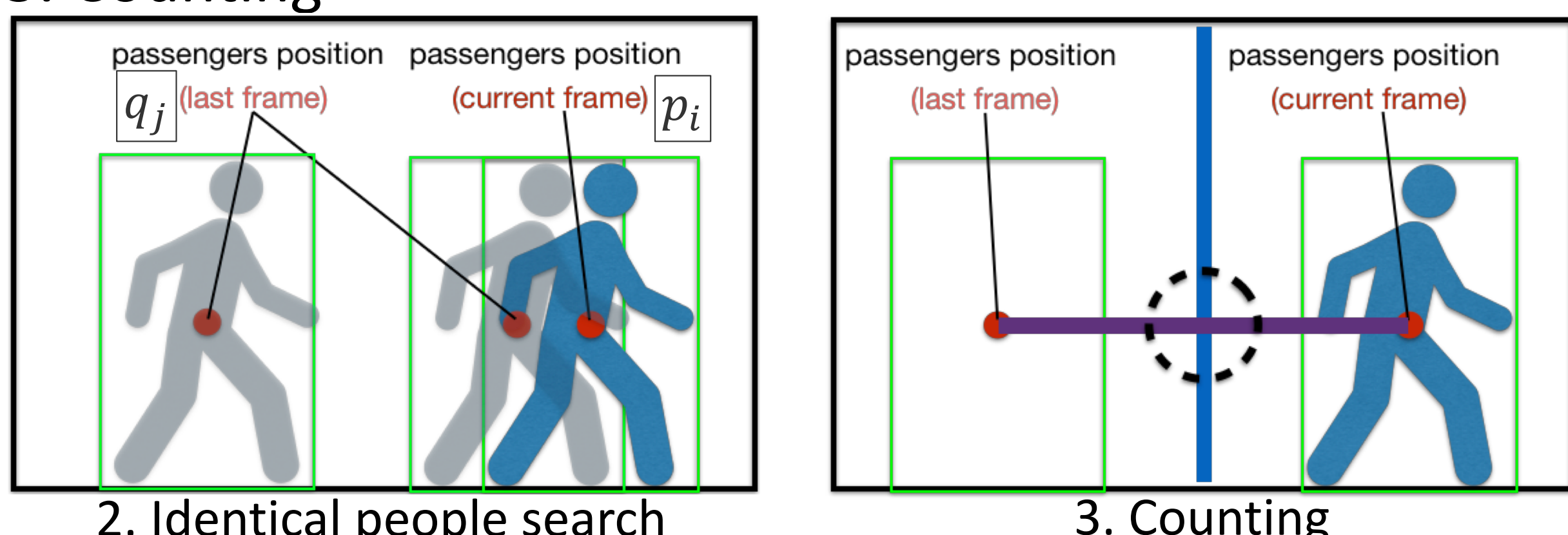
Image analysis method of drive recorder

- ◆ Try 2 methods
  - ◆ Background Subtractor (KNN)
  - ◆ Using OpenPose
    multi-person keypoint detection library for body

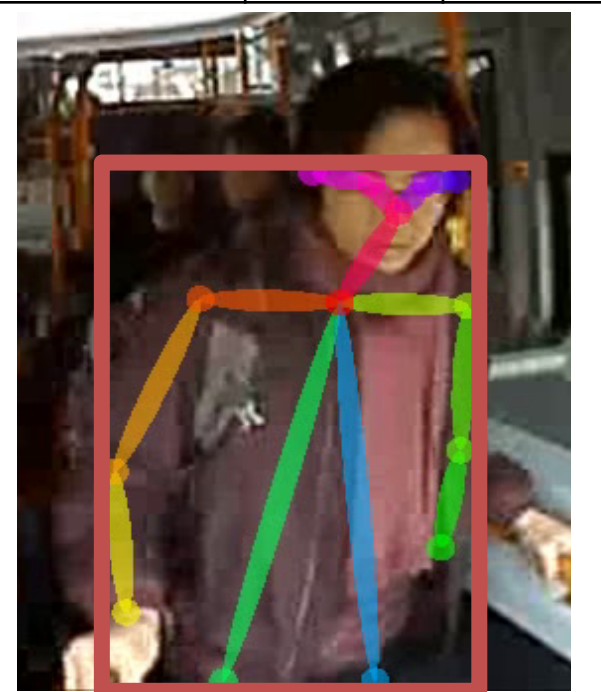|	IN					OUT				
	Correct Peoples	Estimated People	Precision Rate	Recall Rate	F-measure	Correct Peoples	Estimated People	Precision Rate	Recall Rate	F-measure
Background Subtraction	20	13	1	0.65	0.64	19	8	0.875	0.37	0.64
OpenPose	69	52	0.75	0.56	0.32	69	43	0.84	0.52	0.64

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

Last frame — Current frame → BS adapted frame

  2. Identical people search between last & current frames
  3. Counting

passengers position q_j (last frame) passengers position (current frame) p_i

2. Identical people search   3. Counting

- ◆ Using OpenPose
  1. Detection of count target person
  - ◆ Using OpenPose
  - ◆ 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.

Door opening and closing time and number of passengers

The number of passengers / The door opening time[second]