

Driving Assistance for Electric Wheelchairs at Pedestrian Crossings and Railroad Crossings Using Infrastructure to Vehicle Communication

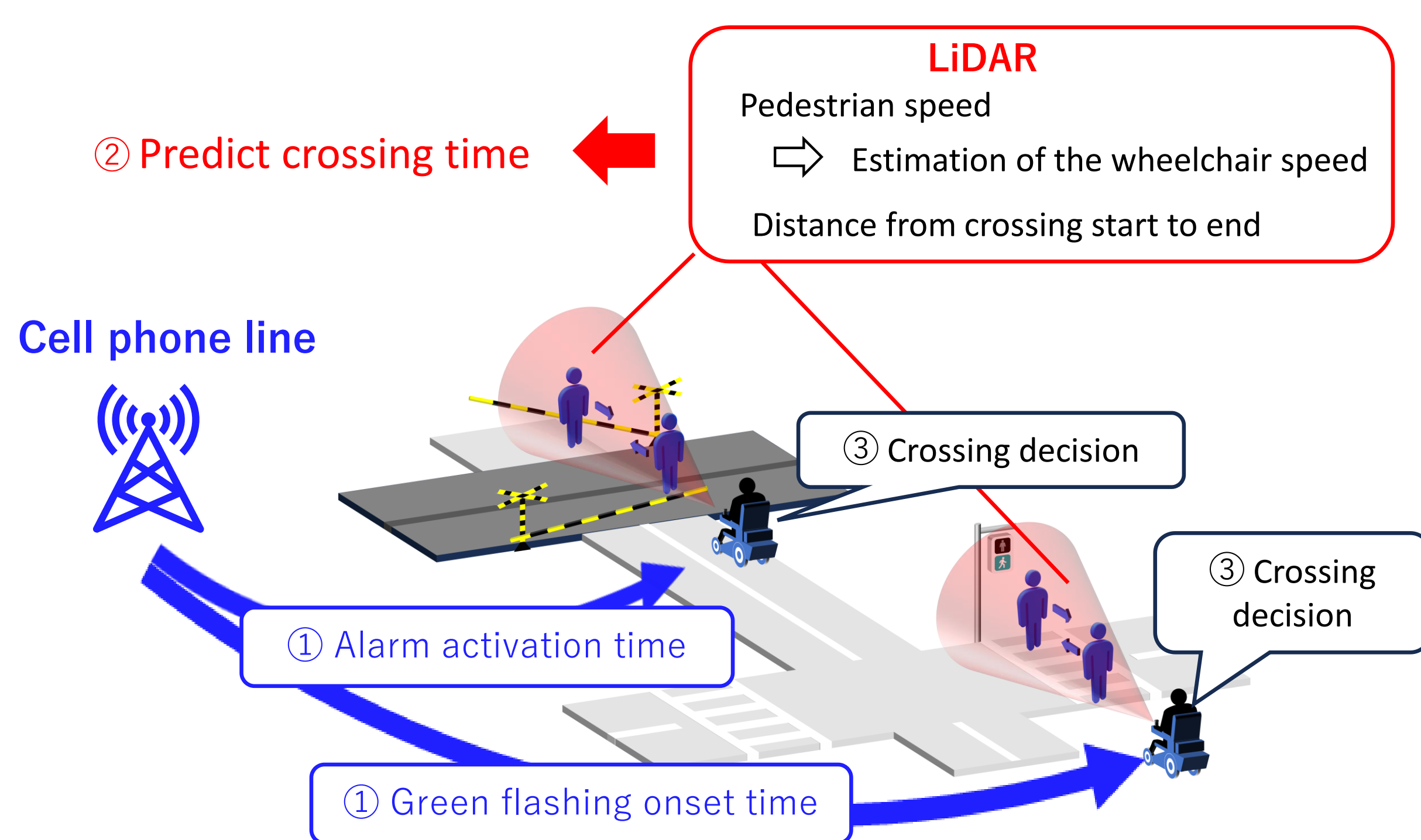
Partner: Kyosan Electric Manufacturing Co.,Ltd., EV Aichi Inc., XXADE Inc.

Objective

A system to assist electric wheelchairs at railroad and pedestrian crossings by controlling signals via mobile networks, with its effectiveness validated experimentally.

Proposed System

The proposed system is outlined in the diagram below. The system repeats steps ① to ③ until stopping before a crossing. If it determines that passage is safe, it announces "Go" via voice.



Estimated Crossing Time Formula

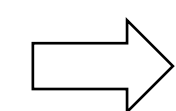
$$t = \frac{l}{v} + \frac{v}{2a}$$

v^* : LiDAR-estimated nearest pedestrian velocity
 l : Distance to crossing end/midpoint from ego position
 a : Acceleration (to cruise): 1.0 m/s²

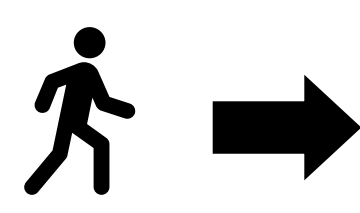
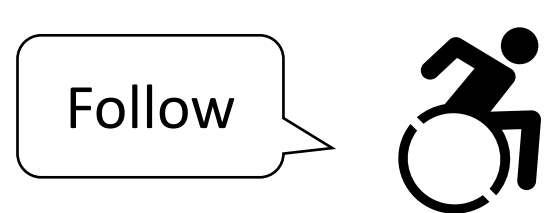
※① Acquisition failure or below 0.5 m/s (half of average) : $v = 1.0$ m/s

② 6 km/h = 1.67m/s (Maximum speed) : $v = 1.67$ m/s

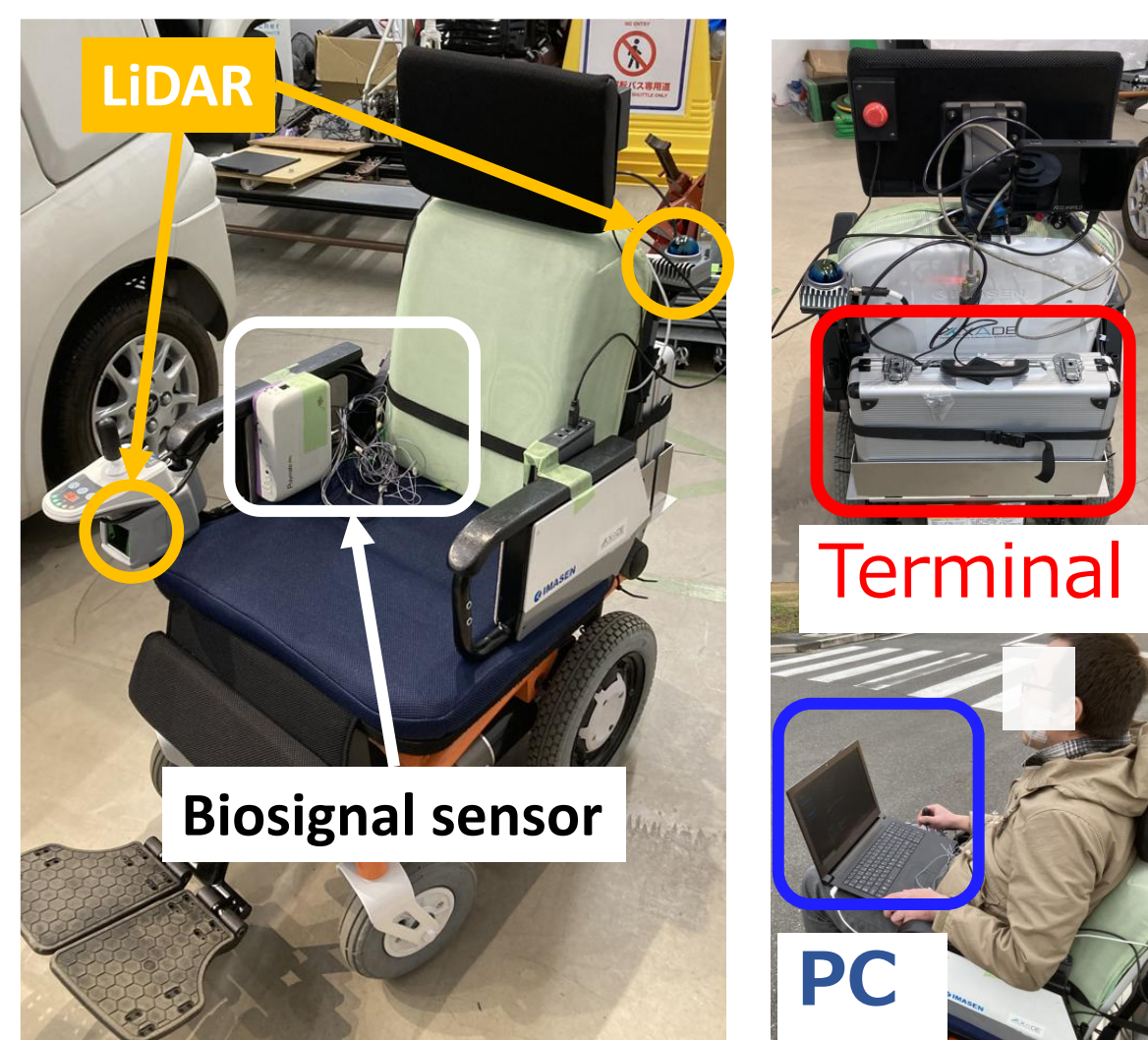
Proceed straight at pedestrian/railroad crossings



Follow the pedestrian ahead without overtaking



Experiments



The electric wheelchair (by EXCEED and EV Aichi) uses LiDAR and Jetson for processing. A terminal device (Kyosan) receives signals via cellular network, and a PC shows crossing decisions.

Participants: 8 (pedestrian), 8 (railroad). Approved by the University of Tokyo Ethics Committee.

Publications

Koki Nakayama, Kimihiko Nakano, Tetsuya Takada, Hiroyuki Nagasawa, Driving Assistance for Electric Wheelchairs at Pedestrian Crossings and Railroad Crossings, ITS Symposium, ITS Japan, 2024.

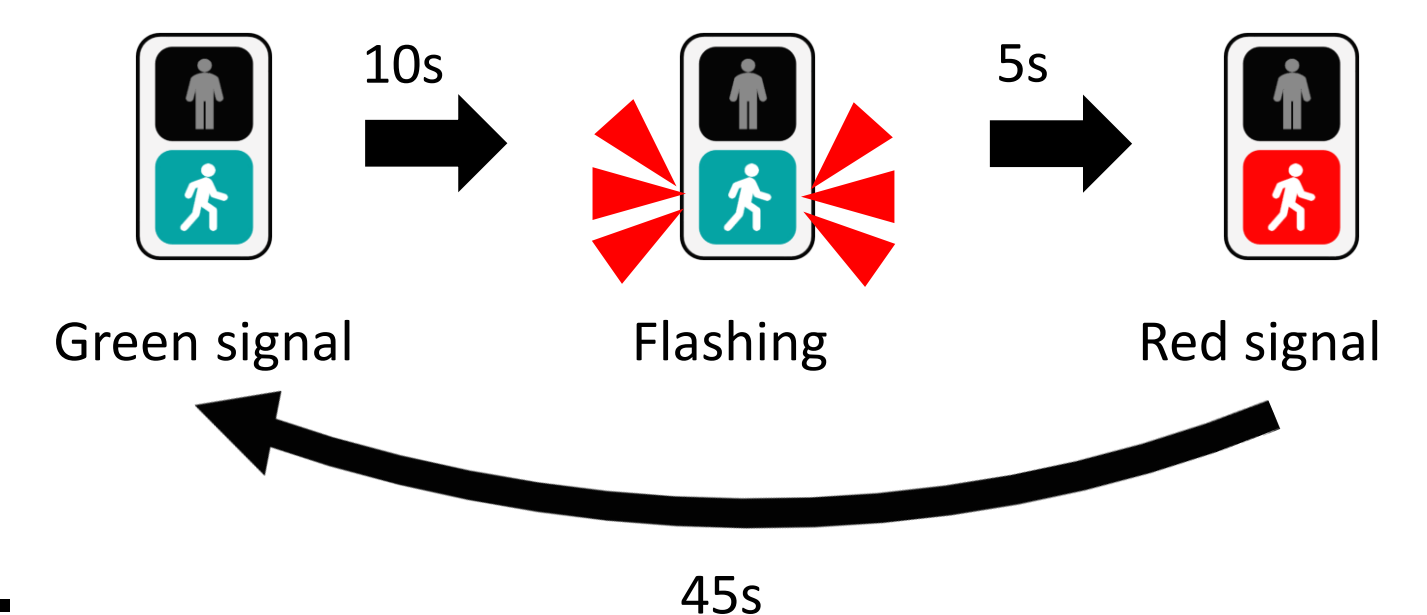
Place : Kashiwa campus in IIS, UTokyo

The ITS experimental field was used, where a test railroad crossing alarm was activated, and a mobile pedestrian signal was employed.



Pedestrian crossing

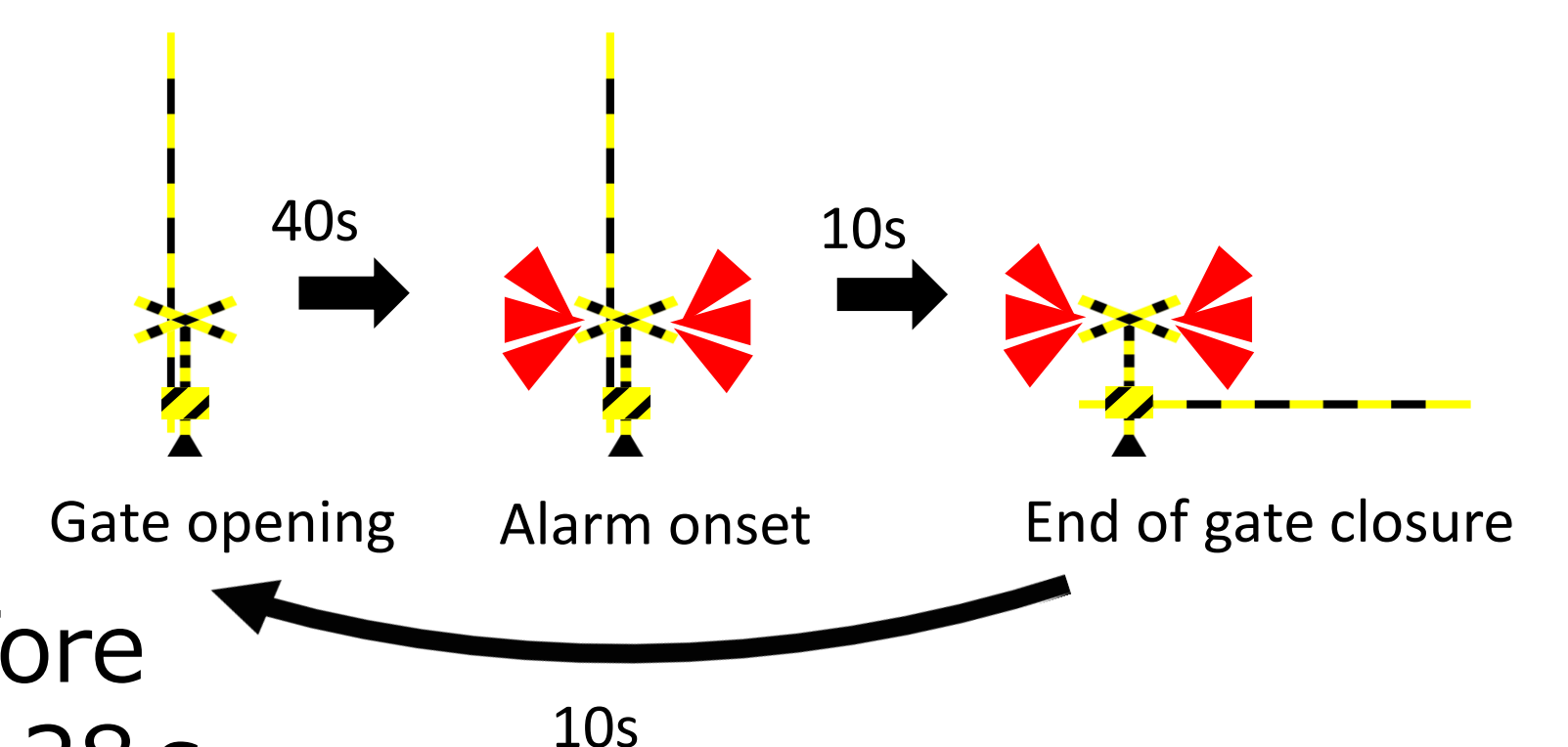
Each participant completed two runs (with/without assistance). Four started 15 s before green, four 20 s before. Signal cycle: 45 s.



Railroad crossing

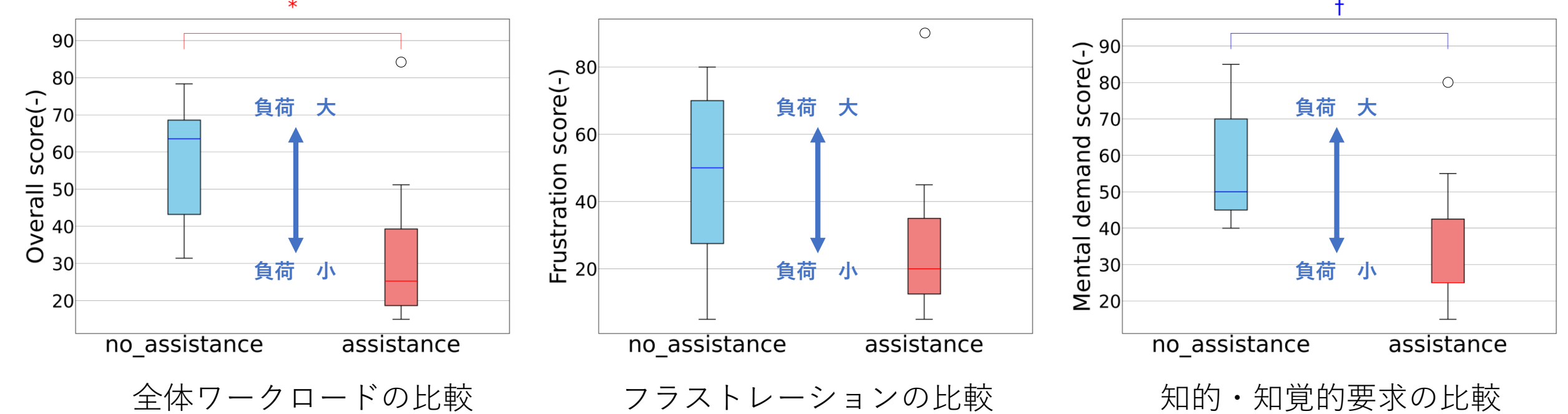
Each participant performed two runs (with/without assistance).

Two started 16 s before alarm activation, six 28 s before. Alarm cycle: 60 s.



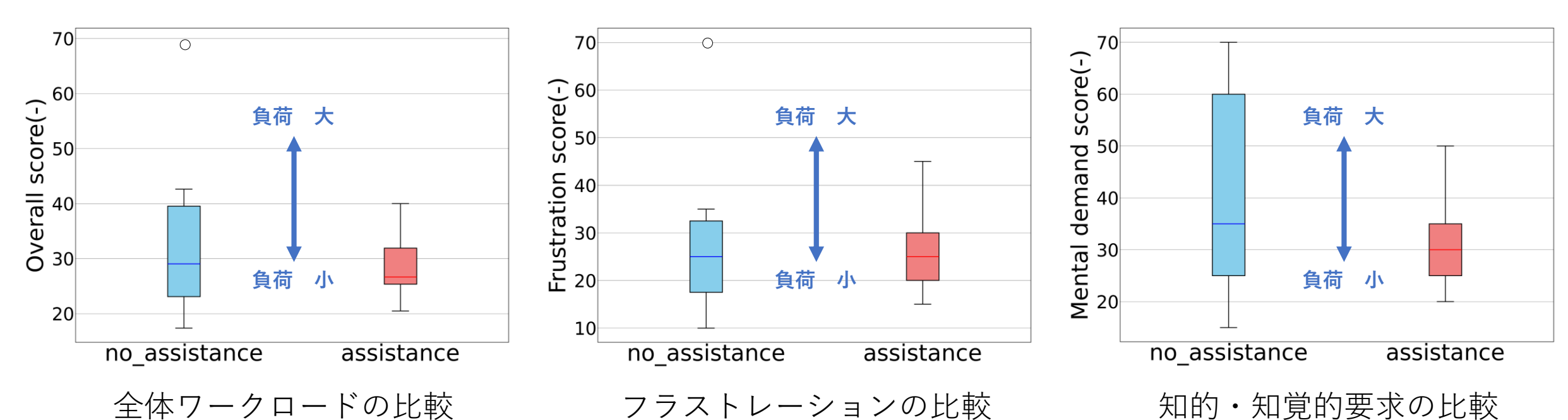
Results

Pedestrian crossing NASA-TLX



Crossing assistance significantly reduced workload and cognitive demand, easing stress from time pressure.

Railroad crossing NASA-TLX



No significant differences or trends were observed. Sufficient time from alarm activation to gate opening and the absence of train traffic likely reduced stress. No significant changes were found in physiological signals such as RRI (R-R interval) or other indicators.