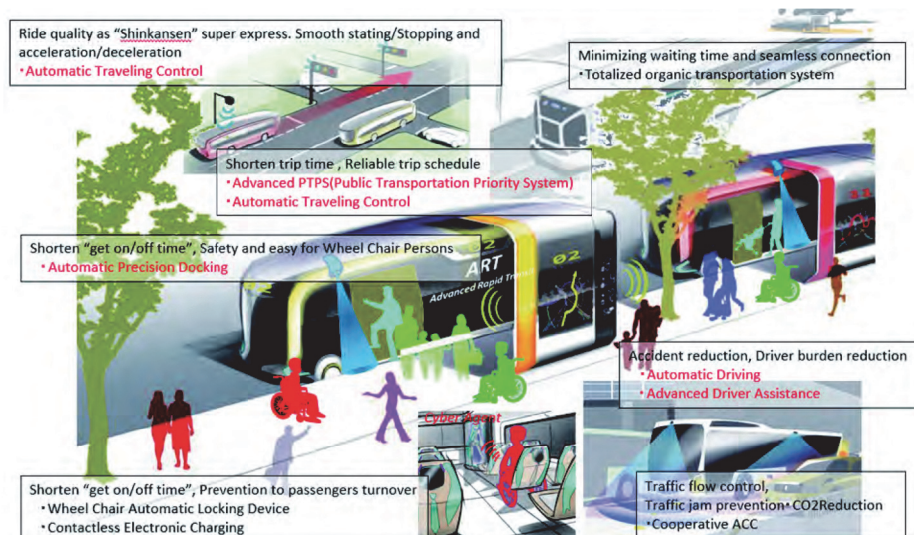


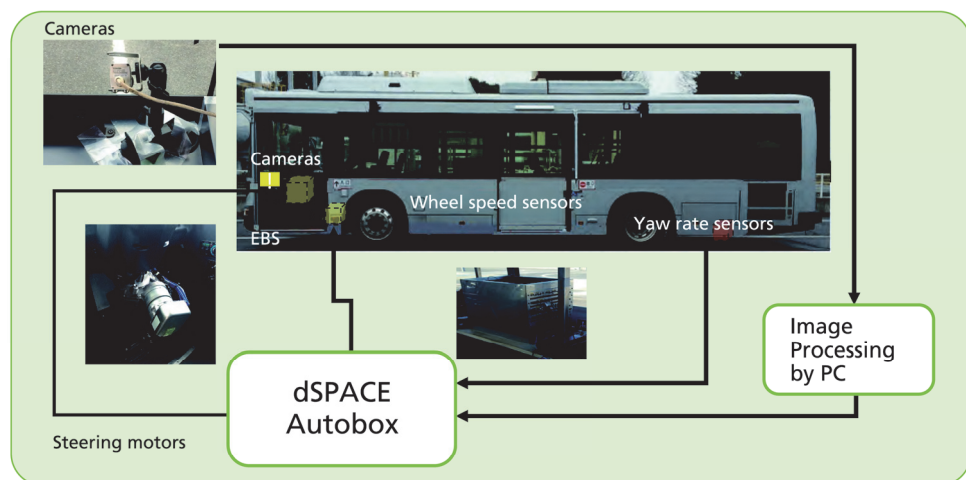
Practical steering control for autonomous docking

Next Generation Urban Transportation System Concept - ART: Advanced Rapid Transit -

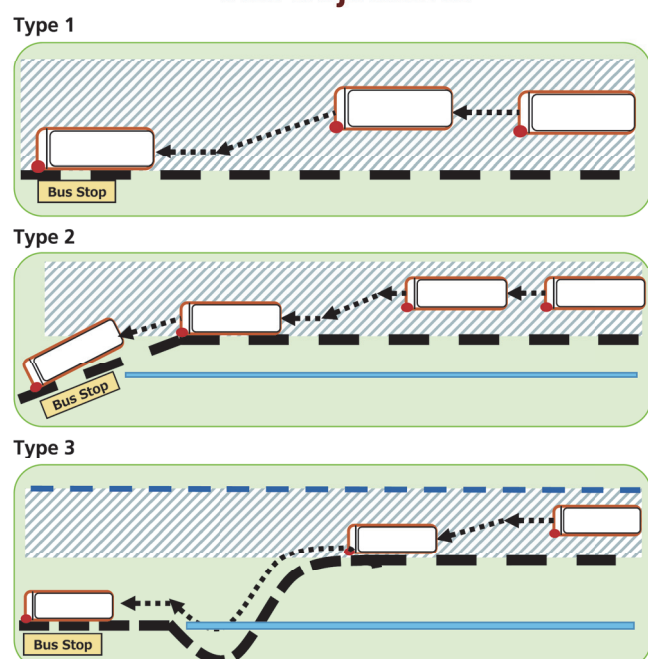


ART will expand from traditionally limited operations in order to provide more convenient transportation service's in advanced road transportation systems. Particularly in terms of automation of high-precision bus docking at bus stops.

Test Bus and System Architecture



Virtual reference trajectories



Experimental step and gap limit evaluation to establish wheelchair friendly conditions

Research subjects: 12-persons (6 male and 6 female)
 Age-range: 20-60 years
 Experimental verdict: Step value:3cm Gap value:6cm



Estimate index	
○	Easy access
△	Requires some effort (reasonable)
▽	Outer limit
X	Assistance required

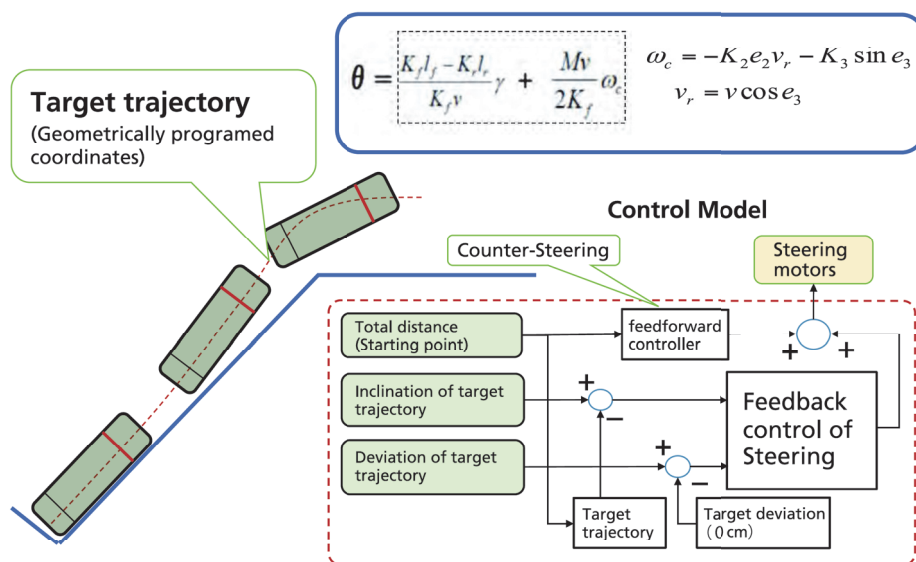
1. The allowable step limit

Step value	MANUAL WHEELCHAIR						Evaluation	Step value	ELECTRIC WHEELCHAIR						Evaluation
	A	B	C	D	E	F			A	B	C	D	E	F	
6mm	○	○	○	○	○	○	○	6mm	○	○	○	○	○	○	○
18mm	○	○	○	○	○	○	○	18mm	○	○	○	○	△	○	○
30mm	△	△	○	○	X	△	△	30mm	△	○	○	○	○	○	○
42mm	X	▽	▽	▽	X	▽	X	42mm	X	▽	▽	▽	X	▽	X

2. The allowable gap limit

Gap value	MANUAL WHEELCHAIR						Evaluation	Gap value	ELECTRIC WHEELCHAIR						Evaluation
	A	B	C	D	E	F			A	B	C	D	E	F	
30mm	○	○	○	○	○	○	○	30mm	○	○	○	○	○	○	○
45mm	○	○	○	○	○	○	○	45mm	○	○	○	○	○	○	○
60mm	○	○	○	○	○	○	○	60mm	△	○	○	○	○	○	○
75mm	▽	○	○	▽	▽	△	▽	75mm	X※	○	○	▽	▽	▽	▽

Control System for Autonomous Docking



Experimental Results

Virtual reference trajectories	Door position	Stopping Distance [cm]			
		Type of vehicle			
		Bus		Articulated bus	
		Maximal value plus direction/minus direction	Average (N=5)	Maximal value plus direction/minus direction	Average (N=5)
Type 1	Front door	0 / -2.0	-1.0	-1.1 / -4.0	-2.4
	Central door			+2.0 / -0.2	1.0
	Rear door	0 / -2.7	-1.5	+4.9 / +1.8	3.8
Type 2	Front door	+5.1 / -0.5	2.5	+0.5 / -4.0	-1.4
	Central door			+1.0 / -1.5	0.0
	Rear door	+3.6 / -2.4	0.8	+1.0 / -2.0	-0.2
Type 3	Front door	+1.5 / -4.0	-1.1	+2.0 / -2.0	-0.02
	Central door			+2.0 / -2.5	0.03
	Rear door	+3.5 / -0.8	1.6	+1.5 / -4.0	-0.02