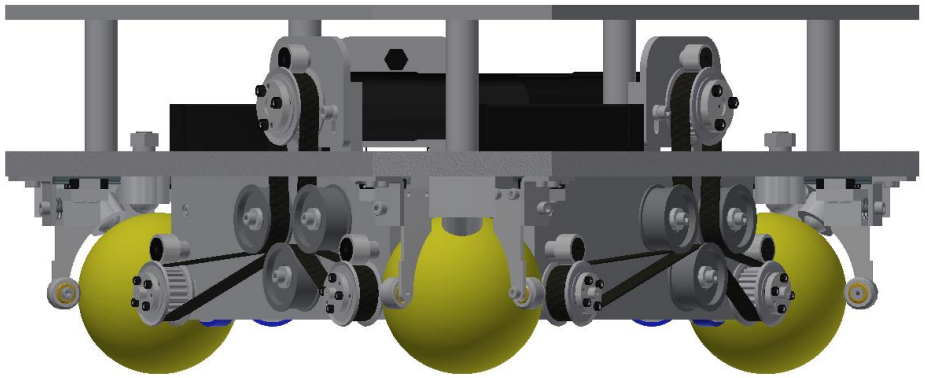
Introduction to ball-driven omnidirectional movement mechanism



Sensing System Research Center

Production process evaluation research team

Shuichi Ishida

2020 University New Industry Creation Program (JST) Selected project

project overview:

A movable device that uses balls instead of wheels.ball drivenWe will develop an omnidirectional movement device. As a trolley for efficient operation of human collaborative robots, transportation robots, AGVs, etc.

Unique in the worldindustrialA venture company that manufactures and sells omnidirectional movement devices.We aim to establish a company.

Project members:

Associate Professor Miyamoto

(Research Representative)

Specially Appointed Professor Rikitake

Kyushu Institute of Technology

Chief Researcher Ishida

(Main joint researcher)

Korenaga Research Group Leader

Chief Researcher Mano

Koga Technical Staff

National Institute of Advanced Industrial Science and Technology

Yamaguchi Executive Vice President

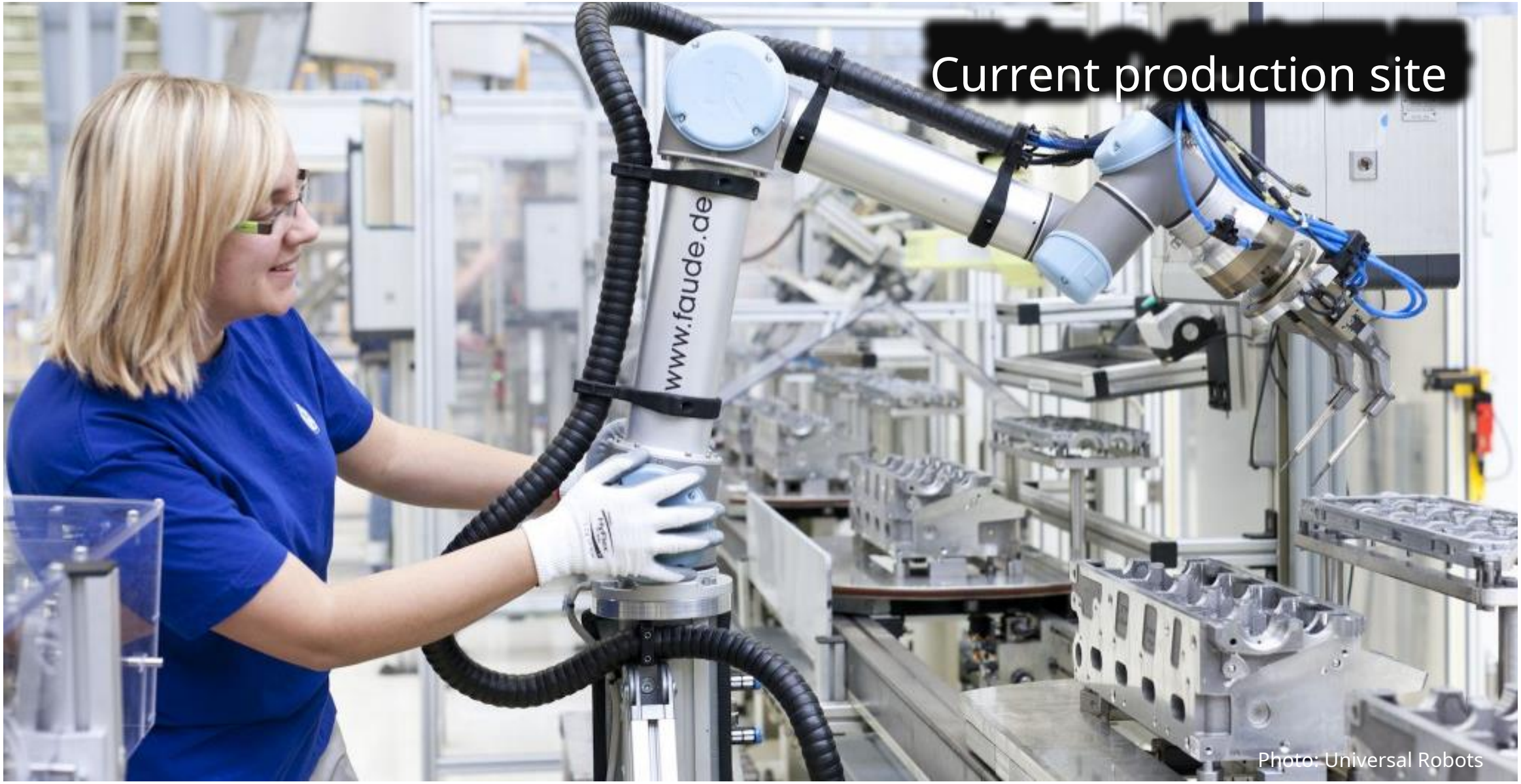
Sasaki Manager

(Business promoter)

FFG Venture Business Partners Co., Ltd.

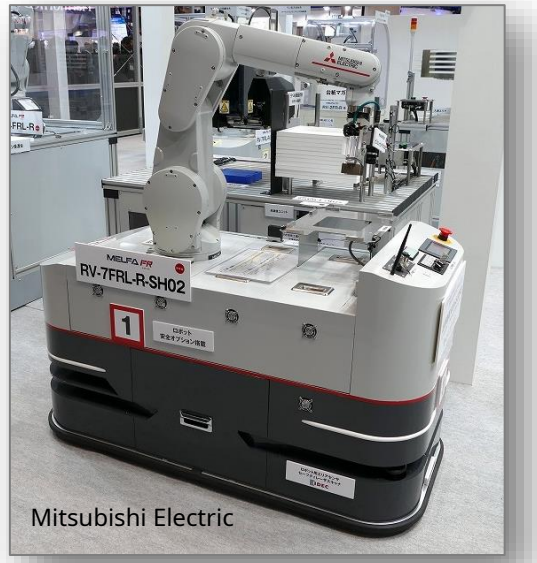
Project period budget: 2020.11.5 - 2023.3.31, After project completion: Plan to start a venture
Project budget: ¥117,000,000

with peopleisolationwas doneStationary typeindustrial robot



with peoplesame spacework withStationary typecollaborative robot

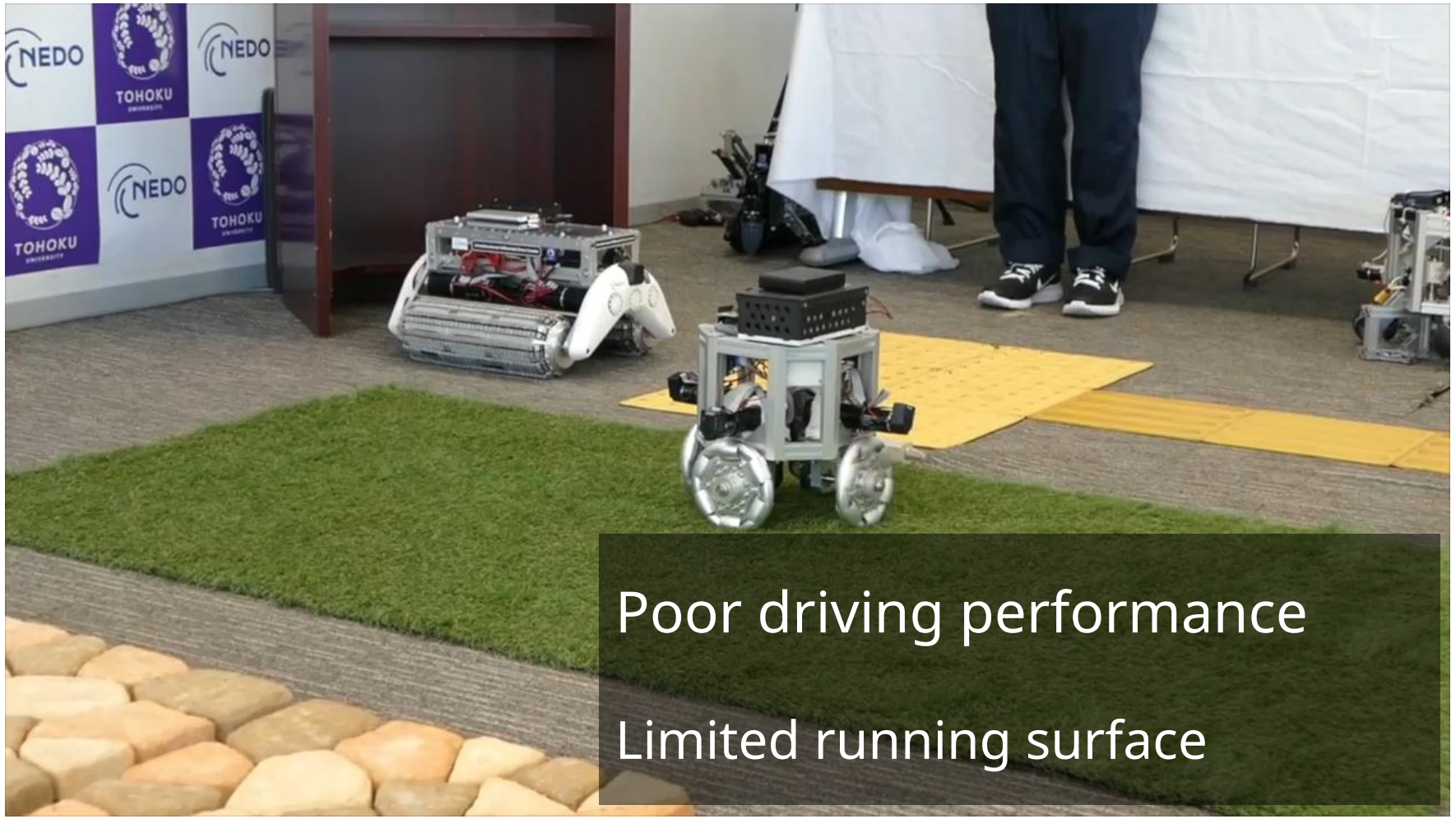
coexist with people walk around Expectations for collaborative robots



There is virtually no choice other than the free method.

free method
Omni Mecanum

Vector compositioncontrol based on

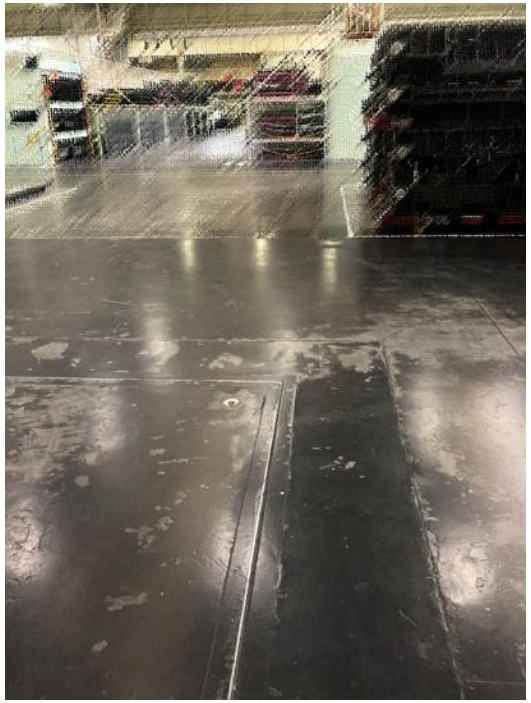


https://www.youtube.com/watch?v=6eTIWaCIstM

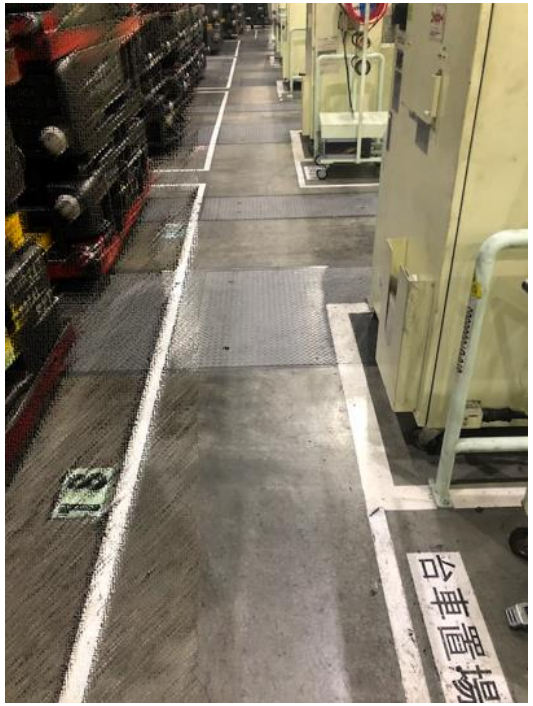
The running surface at the production site is not flat.

Operating while building and maintaining the building → Optimized for people, not kind to robots

Floor paint peeling off



Renovation ruins

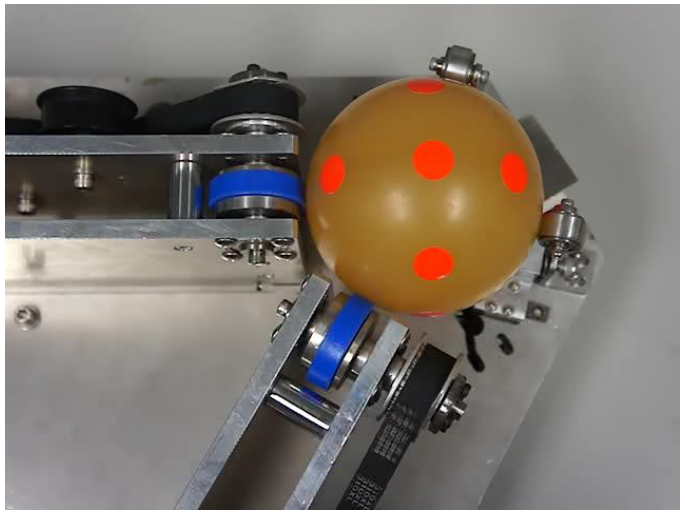


Piping/metal plate

In existing facilities, environments such as steps and flooring materials vary.

There is a need for a movement mechanism that runs stably and with high precision.

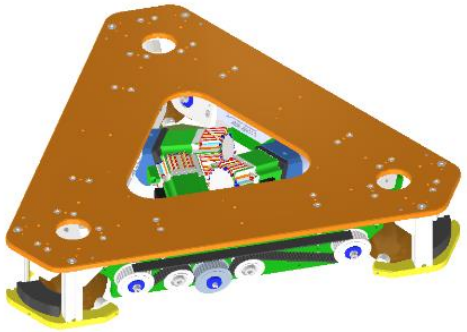
Solution: Omnidirectional movement using spheres



Ball drive system

Pressure drive

Advantages of ball drive mechanism



Sphere Φ100mm x 3
size:663 x 584 x 136mm

High running stability

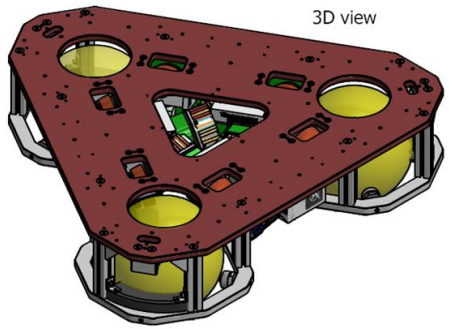
Stops suddenly and is not affected by uneven floors, etc.

Contribution to sensing

Smooth rotation of a sphere: images (cameras), range sensors, etc.

sphere

Ball material: collaboration with material manufacturers, tribology evaluation



Sphere Φ200mm x 3
size:730 x 680 x 200mm

High degree of freedom of movement and easy route planning

Existing programs can also be used

low cost

Simple structure and small number of parts

Low floor/low center of gravity

Can be integrated into existing equipment without modification

Relaxing constraints on trolley height and increasing design freedom

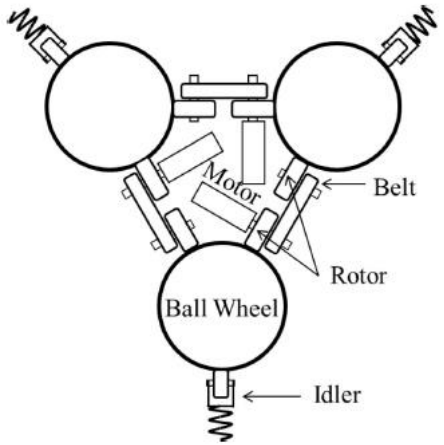
Intellectual property right

Basic patent: Ball-driven omnidirectional movement device

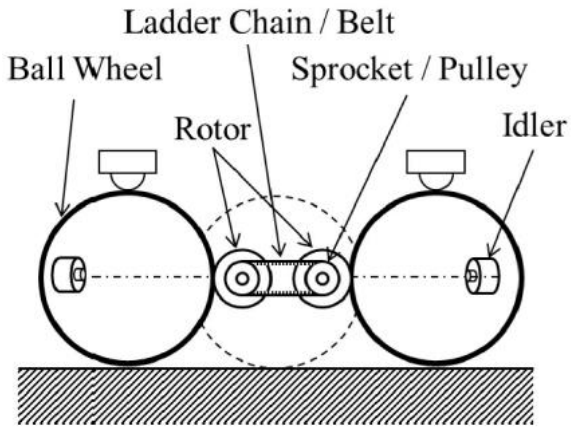
Patent No. 5305285

Inventor: Hiroyuki Miyamoto, Shuichi Ishida

Applicant: Kyushu Institute of Technology, July 25, 2008



(a) Top View



(b) Side View

- Key points of this basic patent

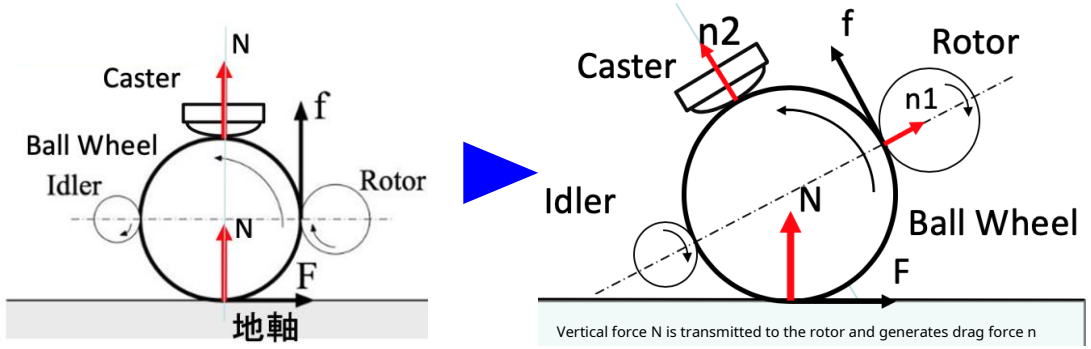
  There must be three driving means that rotate and drive the driving spheres placed next to each other in the same direction at the same time.

Enhanced patent: Ball-driven moving device

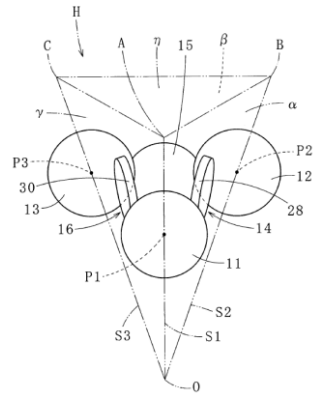
PCT/JP2019/043715(WO2020/110651A1)

Inventor: Hiroyuki Miyamoto, Yoshiki Matsumoto

Applicant: Kyushu Institute of Technology, November 7, 2020



- Key points for PCT application
  - Problem of rotation after non-contact occurs
  - virtual inverted n-pyramidinvented the concept of
  - From the center of the sphere that each rotating body touches
    This solves the problem by allowing contact at a high position.



- patent search

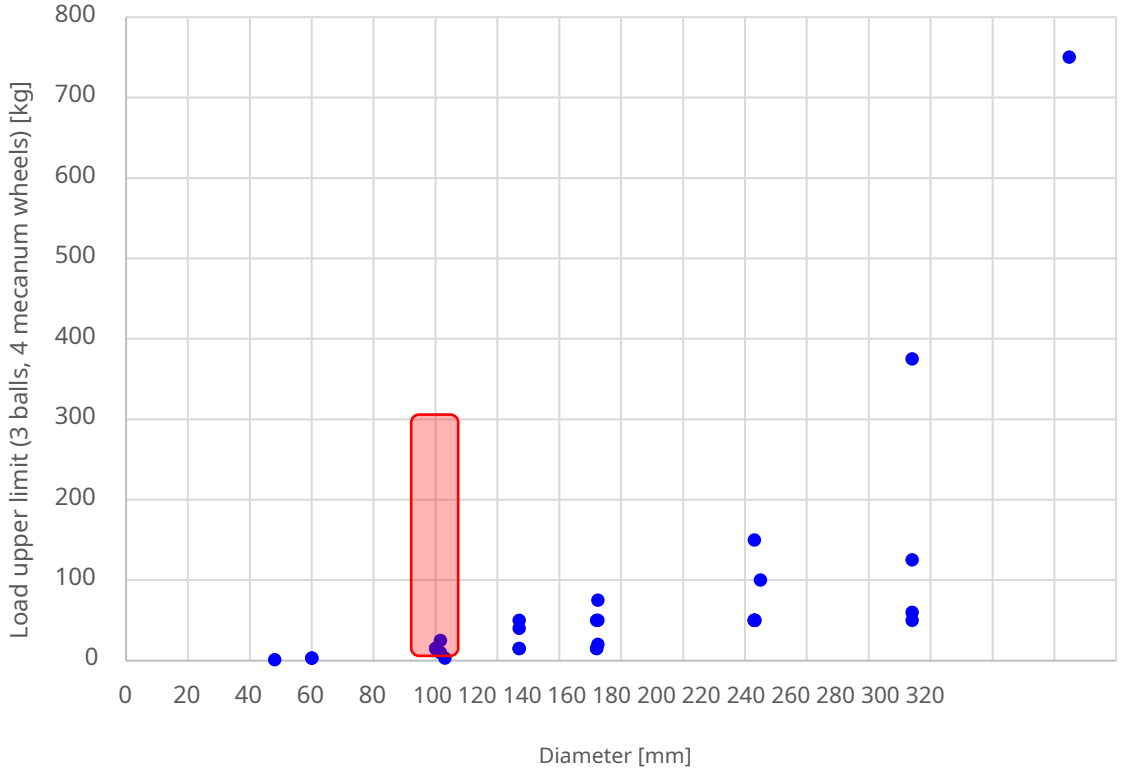
  2020.6 Intellectual property office NEXPAT

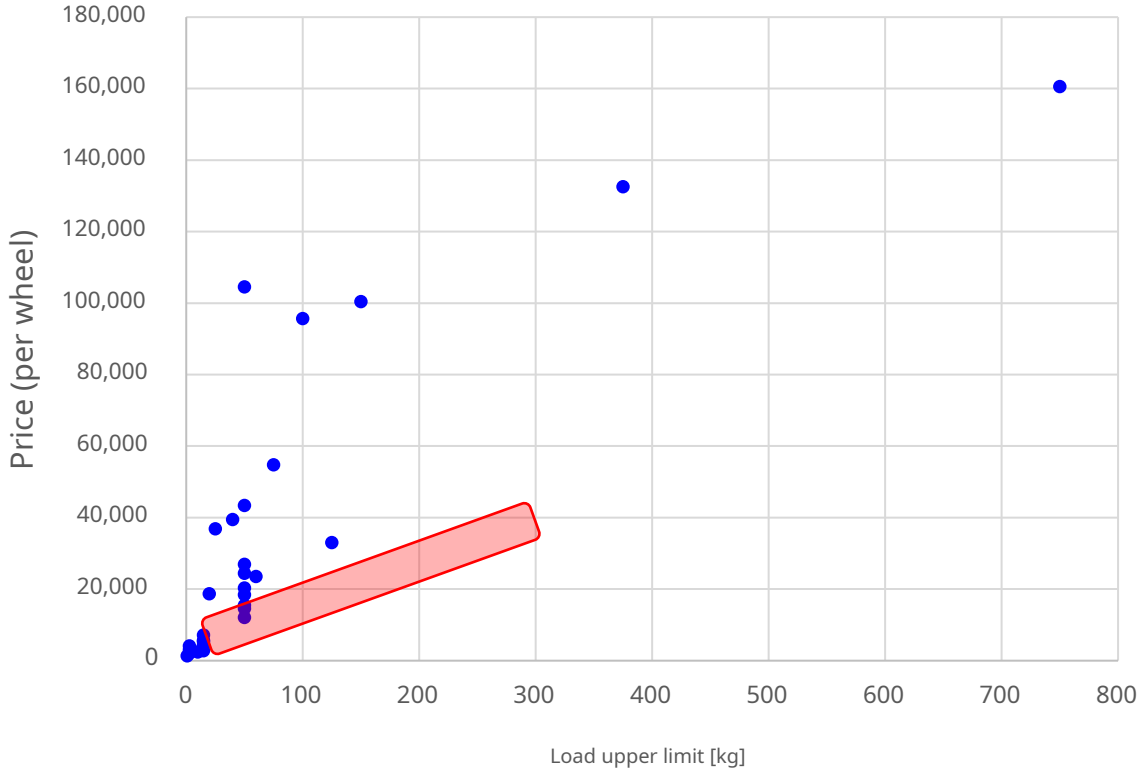
  2021.3 AI patent simulation system

There are no similar patents, and there is a high probability of success.

Comparison with existing technology:

Ball drive mechanism (Φ100mm) - mecanum wheels

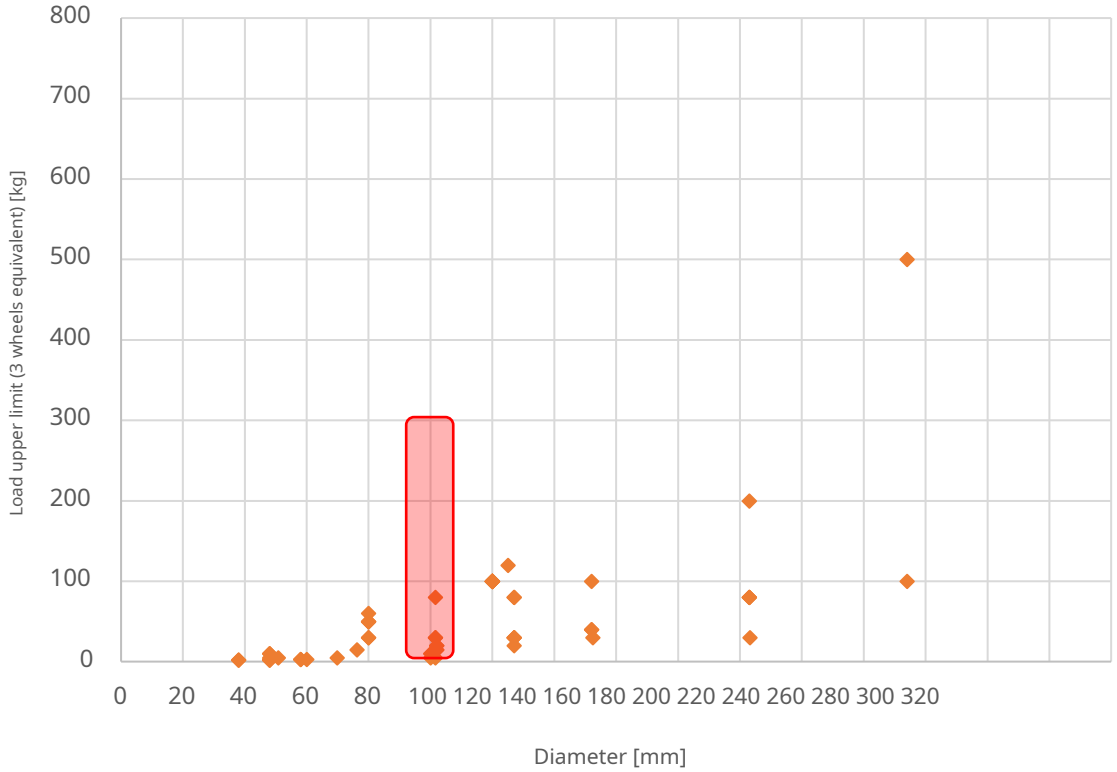


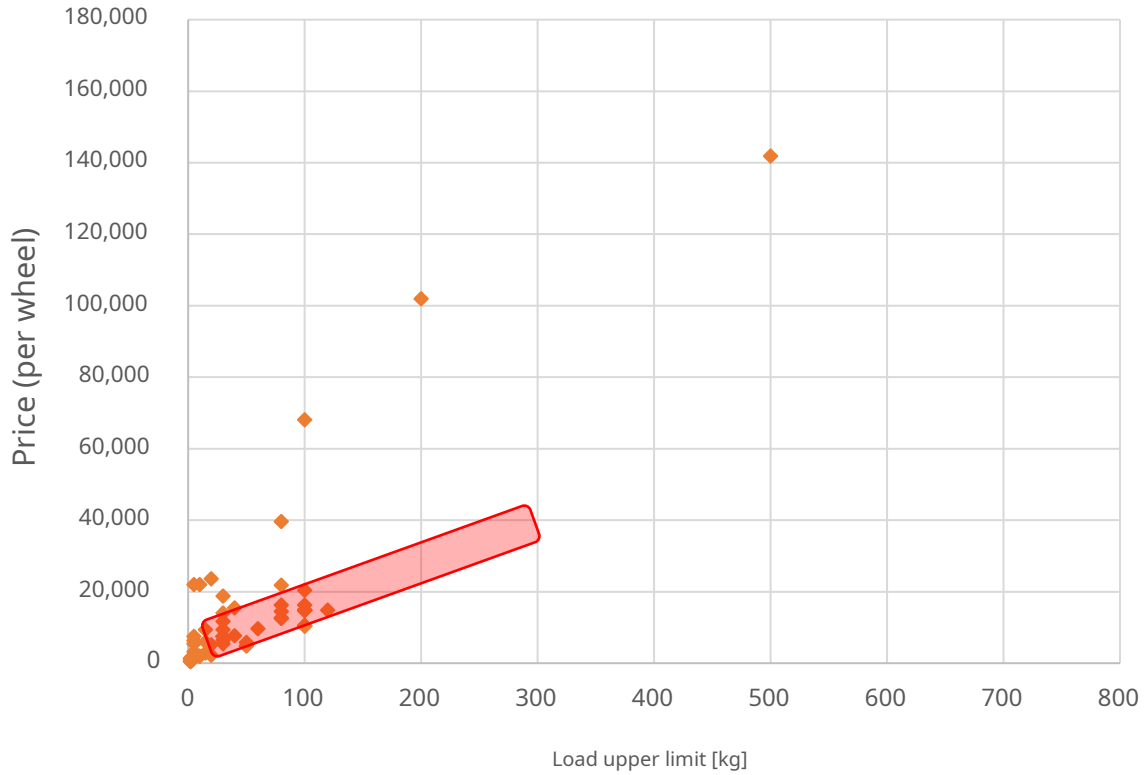


Mecanum wheels (30 products)

Comparison with existing technology:

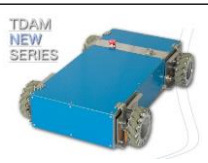
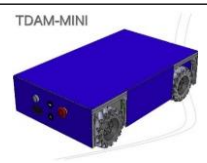
Ball drive mechanism (Φ100mm) - Omniwheel

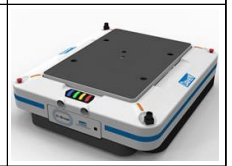




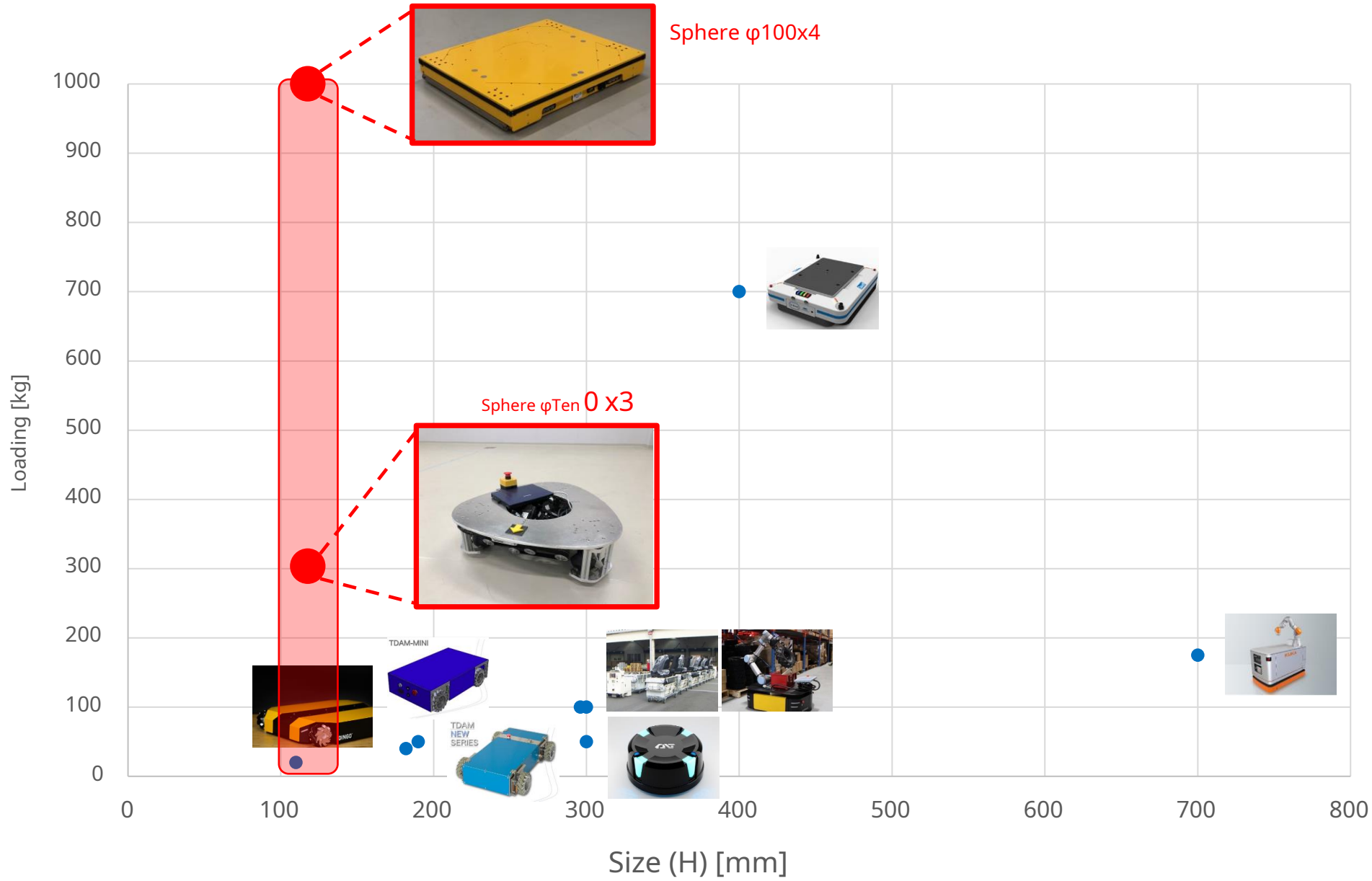
Omniwheel (65 products)

Application example of omnidirectional movement mechanism (free roller system)

Maker	KUKA				Tosa Electronics		HILLTOP	Clearpath Robotics	
Name/model	KMP 1500	omniMove	Triple Lift	KMR iiwa	TDAM NEW	TDAM MINI	Smart Factory Transporter	DINGO	Ridgeback
exterior									
kinds	automated guided vehicle				automated guided vehicle		automated guided vehicle	automated guided vehicle	
Drive/steering	mecanum wheels				mecanum wheels		mecanum wheels	mecanum wheels	mecanum wheels
Size (L×W×**H**) [mm]	2000×800×**470**	5560×2800×**650**	5708×2208×**750-8000**	1190×720×**700**(trolley)	730×513×**190**	699×408×**182**	500×600×**300**	551x517x**110**	960x793x**296**
Mass [kg]	711	9,000	10,000	Trolley:375	50	35	-		
Loading/towing mass [kg]	**1,500**	**90,000**	**1,000**	**Arms: 7, 14 / Trolley: 175**	**50**	**40**	**100**	**20**	**100**
Maximum speed [m/min]	60	50	48	67	47	36	60	8	66
Position accuracy [mm]	±5	±5	±5	Arm: ±0.1 / Dolly: ±1	-	-	-		
position control	SLAM, laser, wheel scanner				grid		-	LiDAR, ultrasound, IMU, wheel encoder	
Introduction market	Factory/warehouse (indoor)				Factories/warehouses (indoors), hospitals		Factory/warehouse (indoor)	Factories/warehouses (indoors), hospitals	
Features	Industry 4.0 In line with tomation Adjust	The above figures are for the maximum (10 types of fully hydraulic telescopic systems) connection (maximum 30m), Synchronous operation possible	Stepless with Linder adjustable	Equipped with a small manipulator, Movable range 0.8~0.82m, No protective fence required	Can be operated by controller		With suspension, rear With foot mechanism	LiDER and manipulator can be installed as options	

Maker	Toyota Industries	TAKUMI	DAIHEN
Name/model	AiR	ANT	AiTran700
exterior			
kinds	automated guided vehicle		automated guided vehicle
Drive/steering	omni wheel	omni wheel	omni wheel
Size (L×W×**H**) [mm]	Diameter 640 x height 1100	655×655×**300**	1230x1480x**400**
Mass [kg]	-	70	
Loading/towing mass [kg]	40	50	700
Maximum speed [m/min]	-	60	40
Position accuracy [mm]	-	±10	±100
position control	SLAM	pulse, gyro	guideless
Introduction market	Factory/warehouse (indoor), hospital, outdoor	Factory/warehouse (indoor)	
Features	option Sending/tracking/cleaning/picking can be changed to	Jointly developed with Kyushu Institute of Technology	By camera sensing High precision positioning (± 20mm)

Comparison with adoption examples (free method): Overall height and load capacity

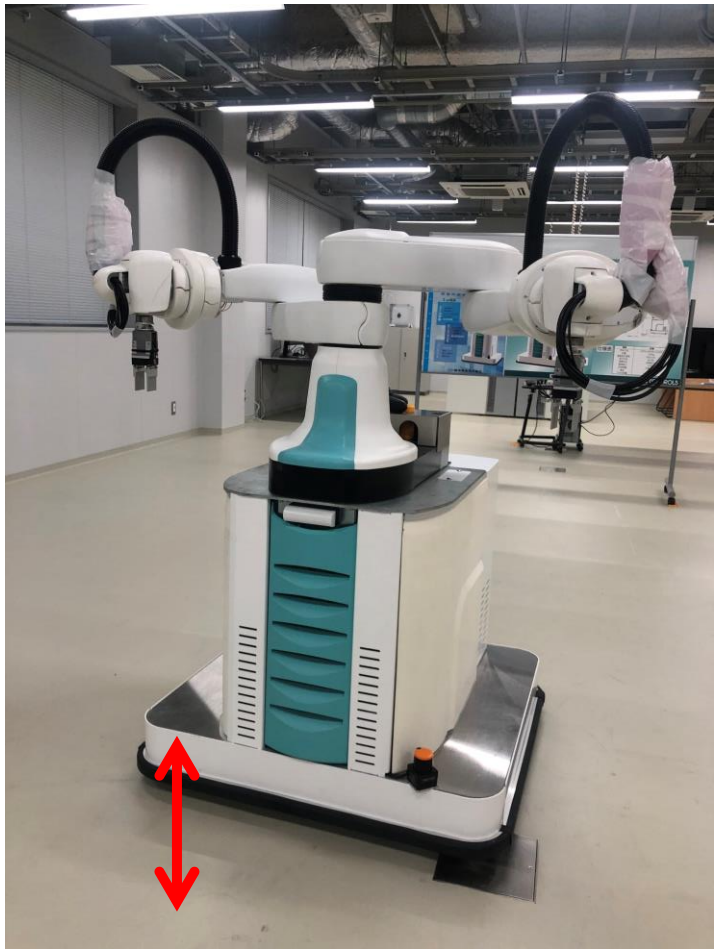


AGV manufacturer: Co., Ltd.

Collaboration with Luz

*AGV: Automatic guided vehicle

Taking advantage of the site needs of "low floor and running performance", it can be used in all directions without changing the arm height.

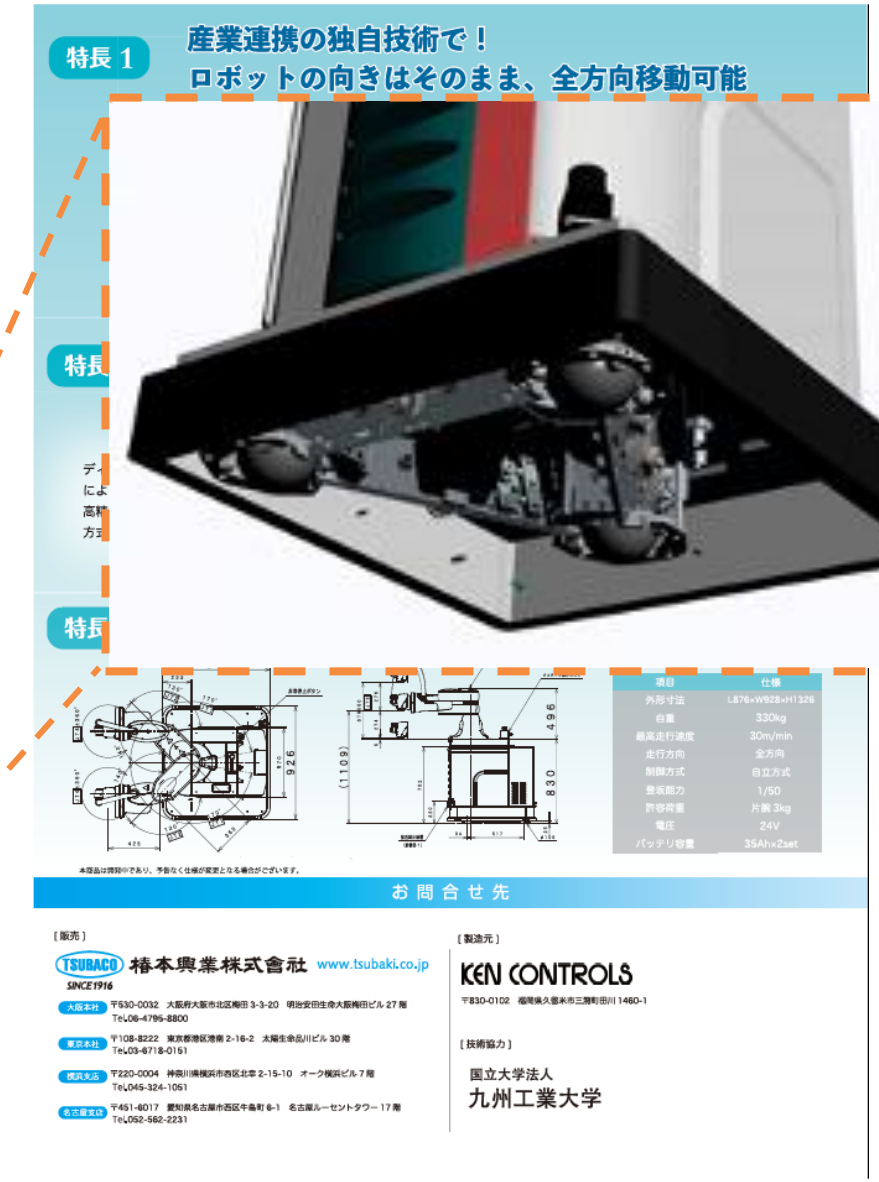


river

Collaborative robot that moves around Realization (Φ100mm x 3)

Exhibition exhibition (Robodex, 2020): duAro2 implementation model

Tsubakimoto Kogyo – Ken Controls

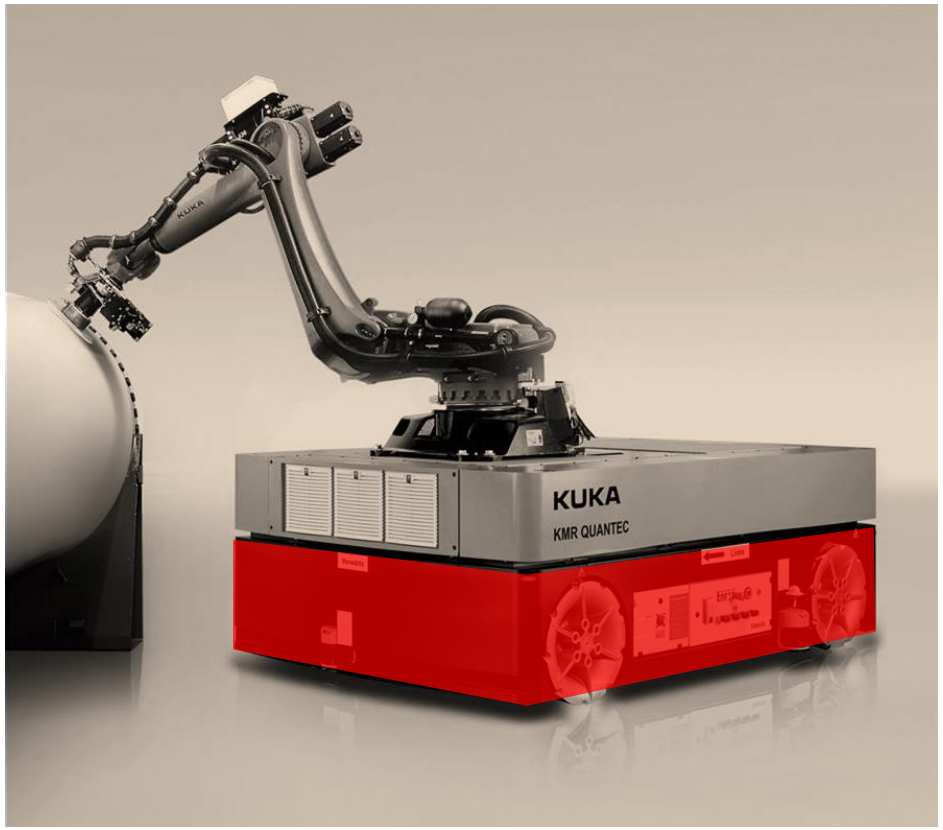


Construction industry needs: Further lower floors + load capacity

low floorRealization of transport vehicle (Φ100mm x 4), expected load capacity:1tons

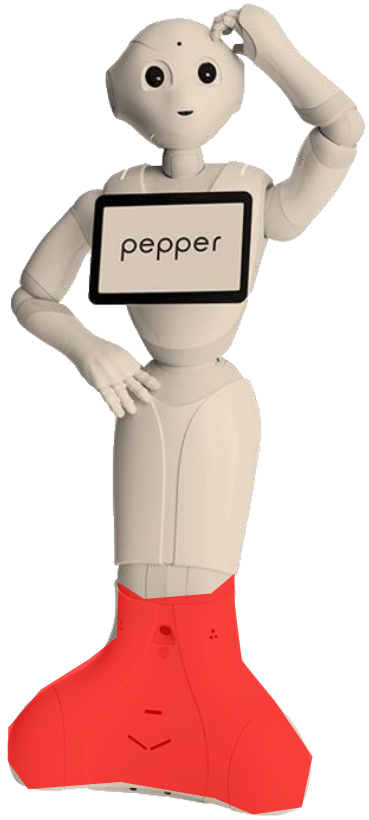
Market potential of omnidirectional movement mechanism

k



collaborative robot

automated guided vehicle



service