6/Sep/2018

Tomato Harvesting Robot

Robotics Promotion Office
Manufacturing Innovation Division
Panasonic Corporation

Environment
- Destruction of nature
- Global warming
- Abnormal weather

Medical
- Nursing
- Public health
- Incurable disease

Resource
- Lack of resource
- Lack of water
- Atomic power plant

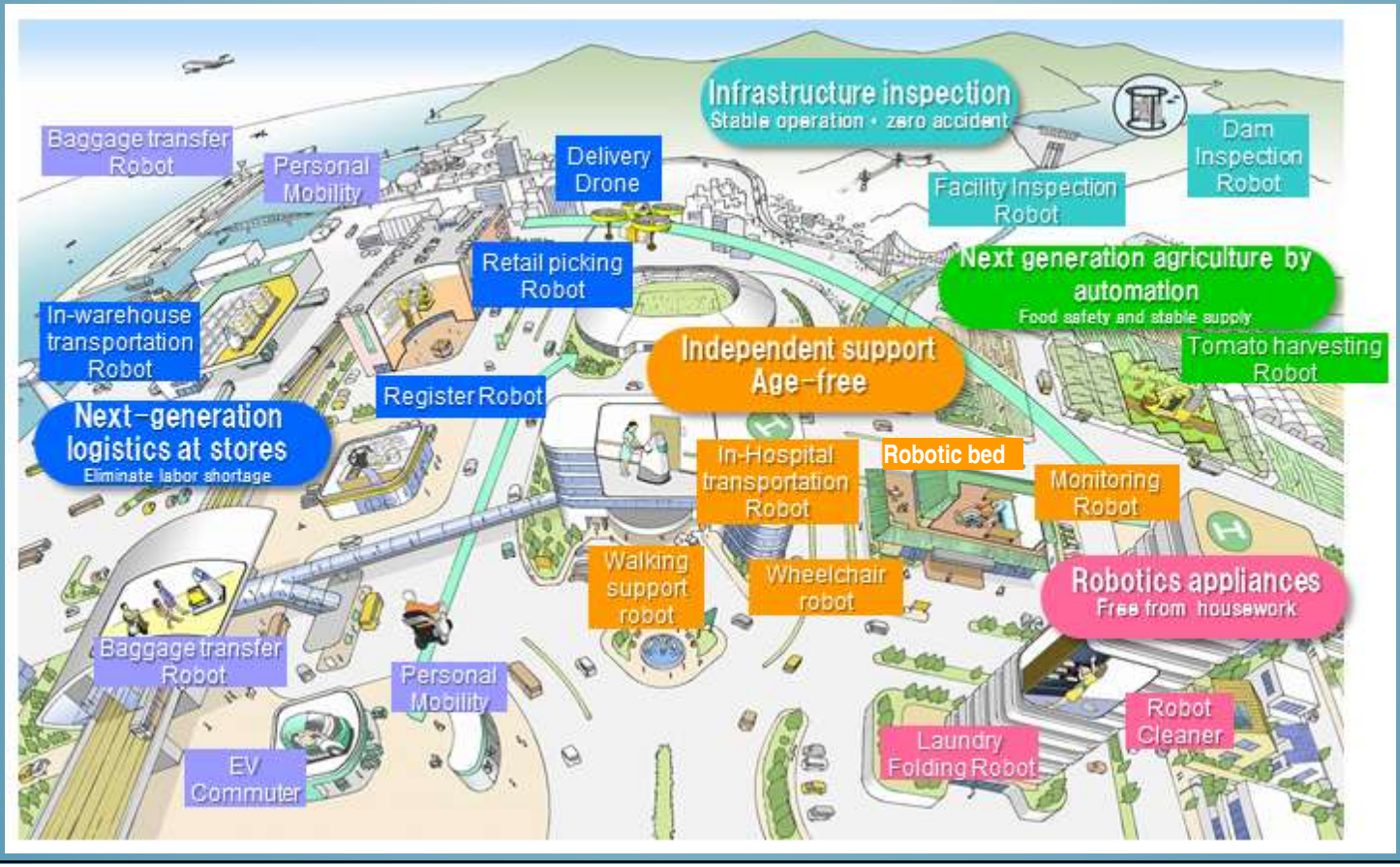
Labor issues
- Labor shortage
- Long working hours
- Unemployment rate

Food issues
- Safety of food
- Hunger
- Decrease of Farmer

Trying to solve these social problems
by utilizing robotics technology!

The World with Robotics Developed by Panasonic

Robotics that stay close to people's lives.



ROBOT TECHNOLOGY OF PANASONIC

HOSPI : Autonomous delivery robot.

ROBOT TECHNOLOGY OF PANASONIC

Automatic cell culture system : automatic cell culture and passage.

Technologies of Panasonic

Mass production technology | Robotics technology | ICT/ Communication technology | Control technology | Sensing technology | Air conditioning technology

Smart agriculture

① Useful for stable production and productivity improvement

Passive house type farming systems

Plant factory system

Next generation barn system

② Useful for labor saving

Tomato harvesting robot

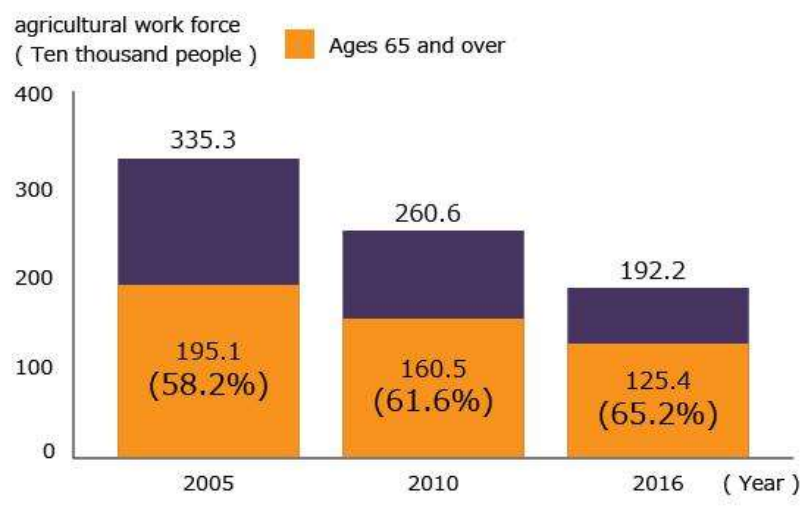
Power assist suits

③ Useful for data storage and Technology tradition

Integrated environmental control system

Farming support

In agriculture, worker shortage is big problem.



In Japan

To solve social problem that the number of labor is decreasing in future by using robot technology.

To make innovation in agriculture.

To create an opportunity of making robot business which uses AI technology.

Introducing technologies of robots to tomato harvesting robot.

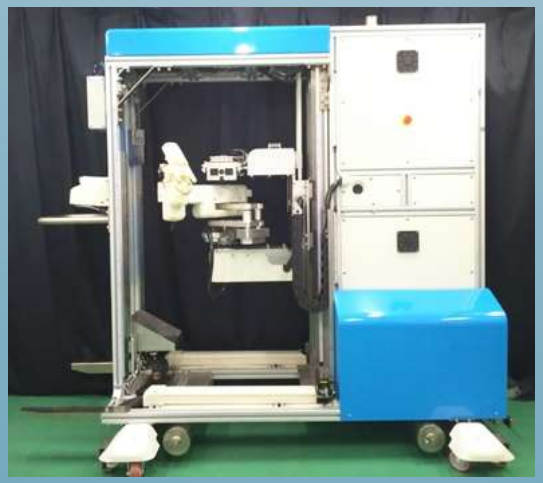
Sensing

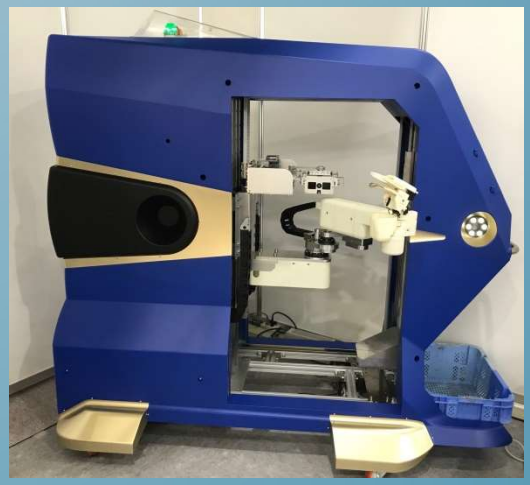
Autonomous move

Manipulation

Artificial intelligence

Agriculture robot





TOMATO HARVESTING ROBOT GENERATION 1

TOMATO HARVESTING ROBOT GENERATION 2

TOMATO HARVESTING ROBOT GENERATION 3

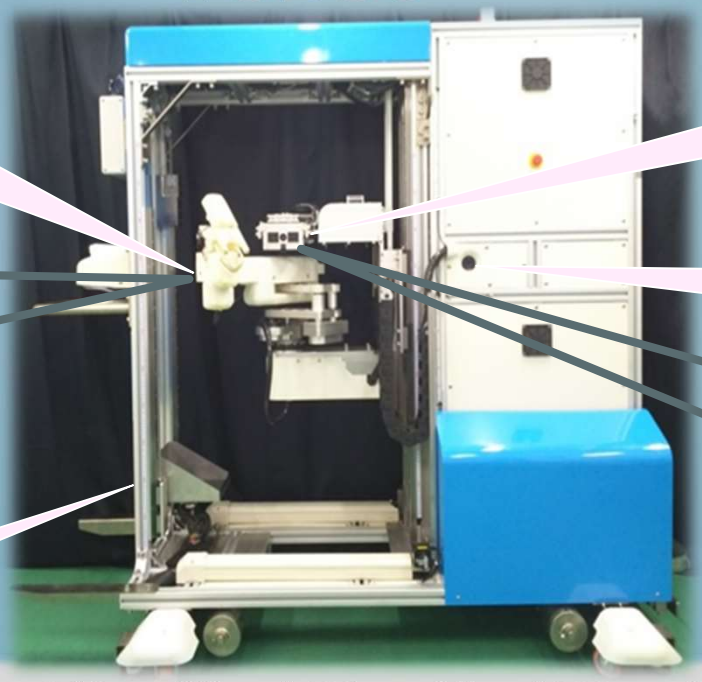
Design of tomato harvesting robot

Robot arm :reaching to tomato fruit

Robot hand (End effector) :Picking tomato

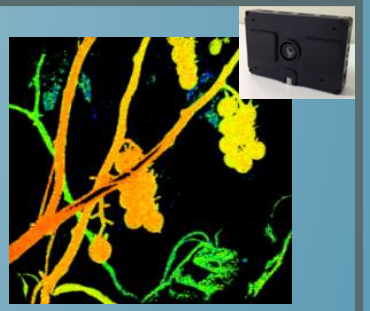
Manipulation preventing the scratches of the fruits

Basket :Transferring tomato fruit to the basket



TOF sensor: Detecting distance and color of tomato.

Color camera : Searching cluster of tomatoes.



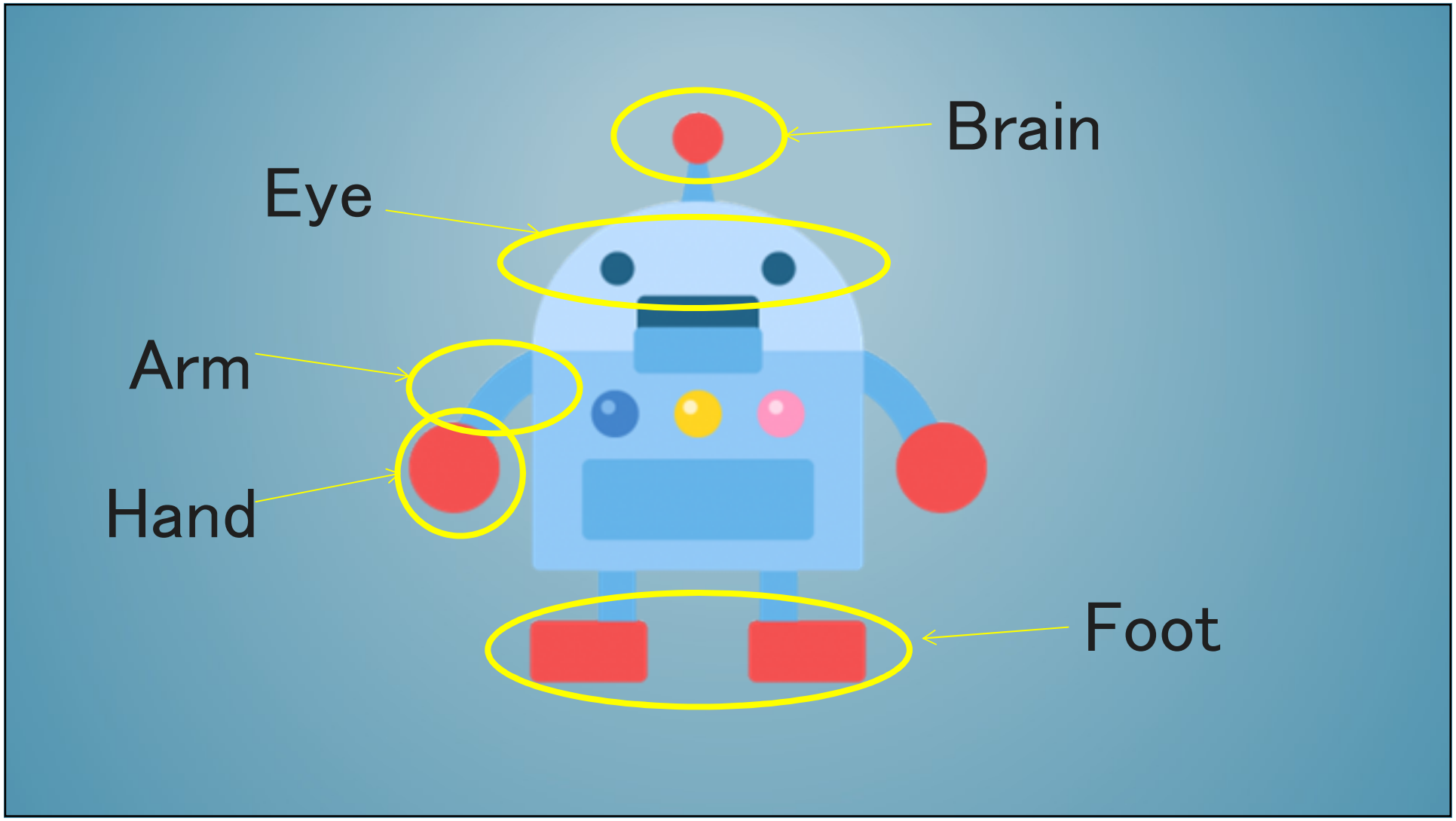
3D recognition using distance and image sensors(TOF sensor)

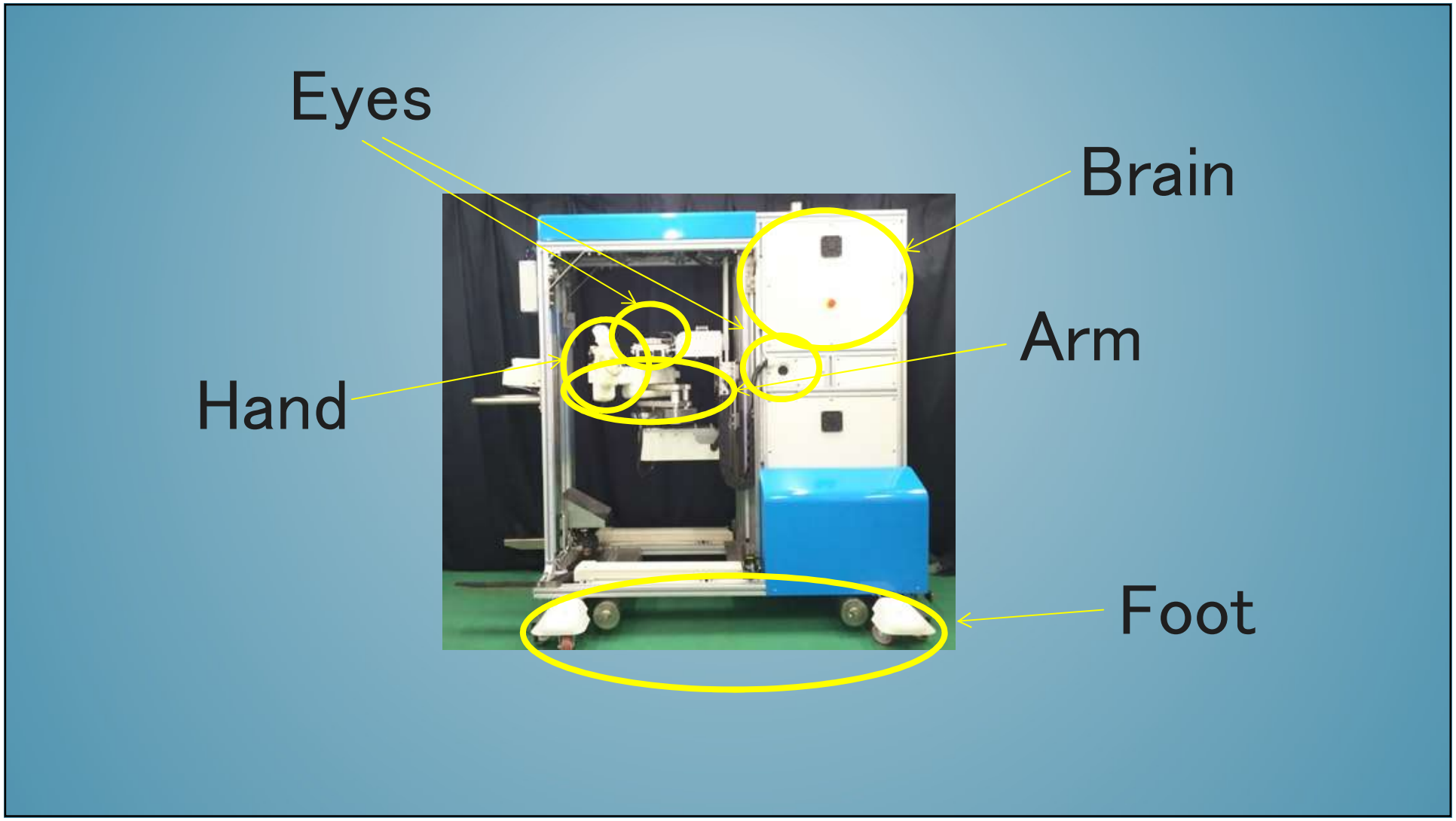
Size : 950mm(W) × 1600mm(D) × 1800mm(H)

Weight : 150kg

Continuous moving time : 4hour ※depending on situation

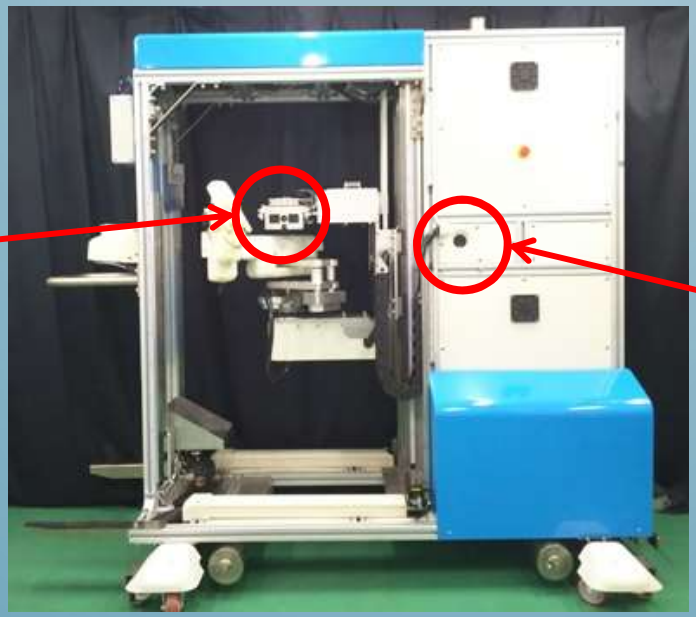
Moving speed : max 30cm/sec


Brain
Eye
Arm
Hand
Foot


Eyes
Brain
Arm
Hand
Foot

Eye

Direction of movement

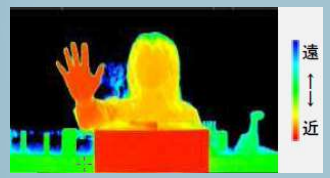


For measuring color of fruits and detecting accurate location of the fruits.

For finding bulk of tomato which has ripe fruits.

Eye

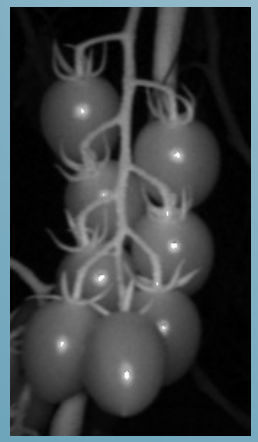
For measuring color of fruits and detecting accurate location of the fruits, TOF (time of flight) sensor is adopted.



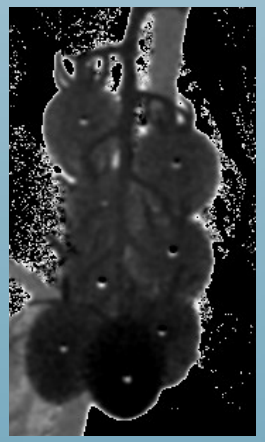
＜TOF-sensor（Panasonic)＞

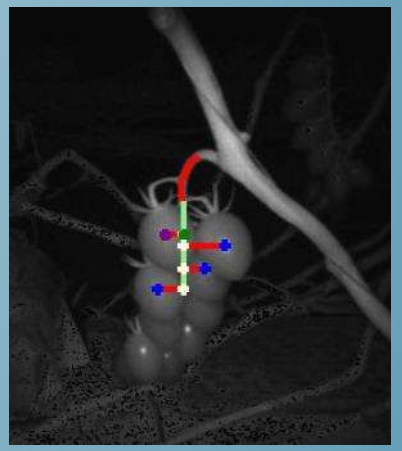
Color image

IR image



Depth data

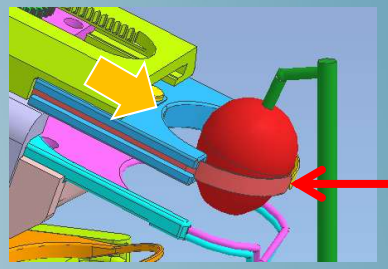




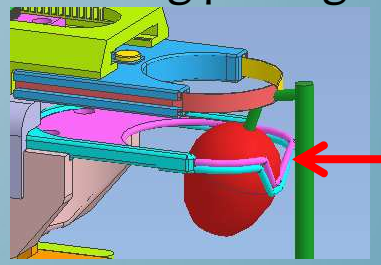
Recognizing color of tomato fruits and location of tomato fruits.

Hand

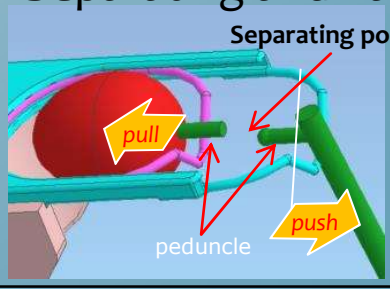
1. Pulling tomato



2. Inserting picking ring



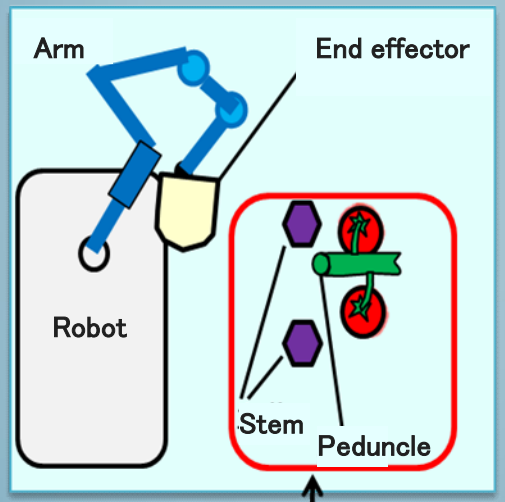
3. Separating and harvesting



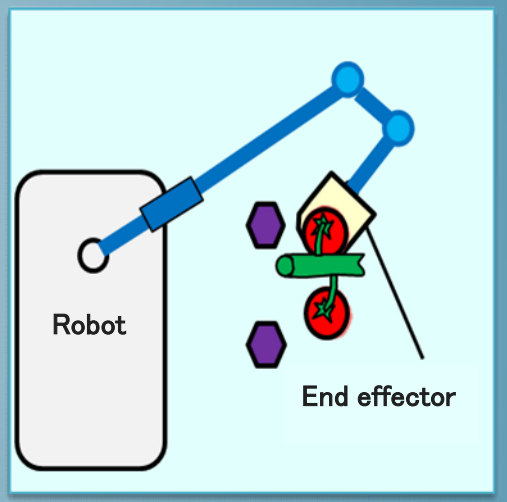
Arm

Robot calculates the route of arm
which can prevent crashing with other objects.

Sensing data



Making cross-section map of fruits, peduncle, and other obstacles.



Calculating the route which can prevent crashing with other objects.

Detection

Location of fruits
Location of peduncle
Location of obstacles

Map creation

Cross-section map

Route search

Using reverse kinema

Foot

For running on rail

Autonomous moving on rail

Foot

For running on concrete
(outside of row)

No autonomous moving

Brain

Recognizing tomato fruits by utilizing AI technology.

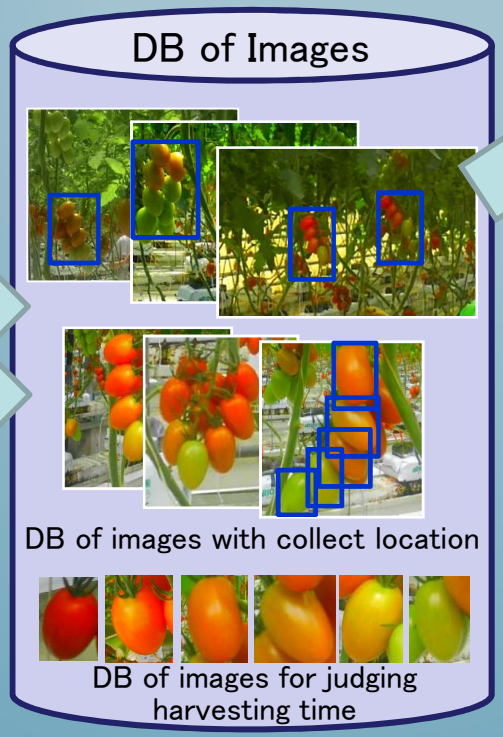
Collection of learning data

Collecting images for control of sensor

Collecting images for control of robot arm

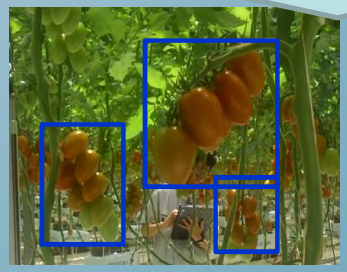
Annotation: Teaching collect information by human

Construction of Image database for learning

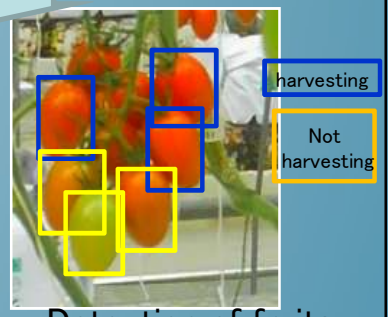


AI: Recognition of tomato by deep learning

Learning for detection of cluster and fruits.
Suitable of neural network and parameter.



Detection of tomato cluster



Detection of fruits
Judgement of harvesting time.

Installing AI to robot

ROBOT NEVER COMPLAINS

We need rest.
Tired……
I want to go back to home.
….
….

Keep on working without complaining

CHALLENGES TO COMMERCIALIZE

1. To improve the performance (picking rate, continuous moving time)
2. To ensure safety in the situation where human and robot co-exist.
3. To develop the function of transfer between rows.
4. To reduce the cost of robot. (To make farms earn money!)
5. To operate this robot stably.(Recovery from short time breakdown)

TO MAKE FARM PROFITABLE

The cost to harvest one tomato by robot

<

The cost to harvest one tomato by human

Cost reduction

Improve Performance level

Improving success rate of picking.

Dropping tomatoes makes a loss for farm.

Hand is pulling stem and stopping.

RECOVERY FROM TROUBLE

No recovery system

Engineer has to wake up earlier,,,

FOR OTHER VEGETABLES

considering utilization of technology of tomato harvesting robot to other vegetables.

FOR OTHER VEGETABLES

Eye ⇒Same vision system is utilized

Hand ⇒New hand has to be developed

Arm ⇒Same arm is utilized

Foot ⇒Depending on situation of land

Brain ⇒Same system is utilized
We need data for learning

To make better world by robotics technology is our destination.

Introducing tomato harvesting robot to farm is first step toward our goal.

Please pay attention to our robot technology and new world which our technology will realize!