

Introduction of Bio-Robotics and Human-Mechatronics Laboratory

Bio-Robotics and Human-Mechatronics Laboratory

Graduate School of Information, Production and Systems, Waseda University

<http://www.waseda.jp/sem-matsumaru/>



Takafumi MATSUMARU

<http://www.f.waseda.jp/matsumaru/>
matsumaru@waseda.jp

Outline

□ Introduction

- Biographical Information
- BR&HM Laboratory

□ Past subjects

- HFAMRO: friendly amusng mobile robot
- IDAT: image-projective desktop arm trainer
- Touch Interaction
- Calligraphy-Stroke Learning Support System
- Mobile robot companion
- RDB-D Visual SLAM

□ Recent subjects

- Interactive Aerial Projection of 3D Hologram Object
- Pedestrian Navigation Robotic System
- Reinforcement Learning in Manipulator Control
- Real-time Remote Projection of 3D Human Image
- Short Range Finger Pointing Interface using Depth Camera
- Brand-Wise Random Picking of 500ml Plastic Bottle using RGB Image

□ Closing remarks

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Biographical Information



Ichiro Kato
1926-1994

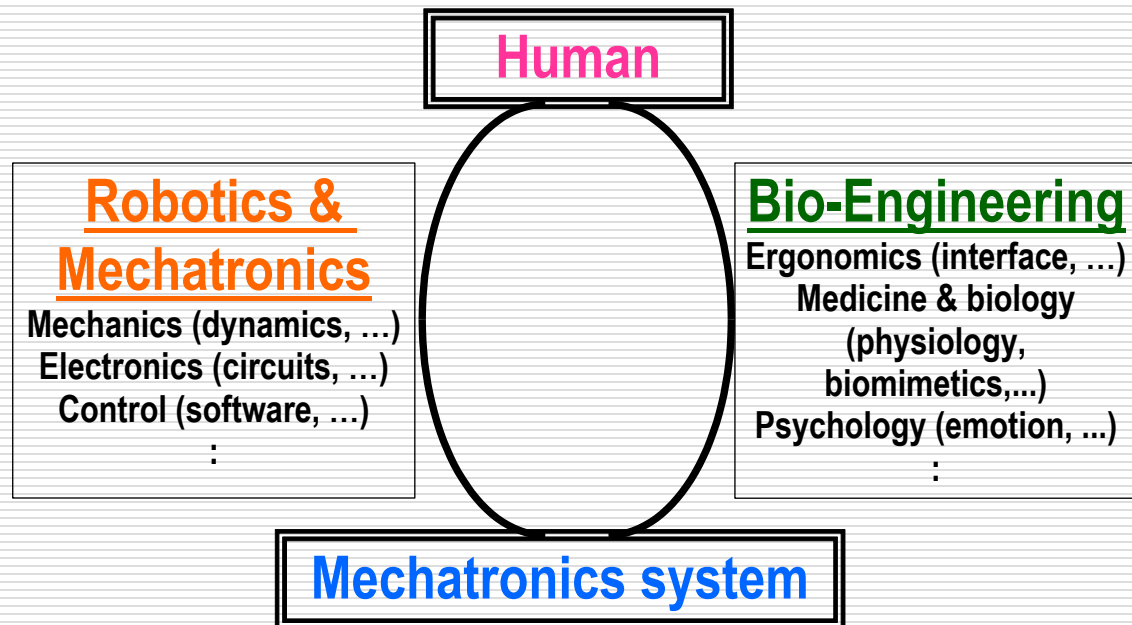
- **1985 B.S., Mechanical Engineering, Waseda University**
“Development of articulated manipulator aiming at force control”
(Supervised by late Prof. I.Kato)
- **1987 M.S., Mechanical Engineering, Waseda University**
“Basic theory of multi d.o.f. compliance control on articulated manipulator”
(Supervised by late Prof. I.Kato)
- **1987-99 Corporate Research & Development Center, Toshiba Corporation**
 - Research on robots for specialized operations
 - Developing mechatronics systems using robotic technologies
- **1998 Ph.D., Mechanical Engineering, Waseda University**
“Research on structure and control of working robot in a narrow space”
(supervised by Prof. S.Sugano)
- **1999-2010 Associated Professor, Shizuoka University**
 - Education and Research on Bio-Robotics and Human-Mechatronics
 - Invited Professor (2003). LSC - CNRS, Evry France, Visiting Fellow (2002). Shizuoka Industrial Research Institute, Shizuoka Japan, etc.
- **2010- Professor, Waseda University**
 - Research and Education on Bio-Robotics and Human-Mechatronics

TOSHIBA
Leading Innovation



Bio-Robotics and Human-Mechatronics Laboratory

- ❑ Various themes between **human** and **mechatronics systems** (robots and other systems)
- ❑ To make mechanical systems more **friendly / useful** for users
- ❑ Developing **new** functions and producing **real-world** systems
- ❑ **Integrating** various knowledge and technologies **into systems** (selection / combination are based on engineering sense)
- ❑ Work on elemental technologies by ourselves if desired



Better interaction / relationship between human and robots

Bio-Robotics and Human-Mechatronics Laboratory

□ Career after graduation

■ Domestic companies

- Seiko Epson Corp.
- Ascent Robotics Inc.
- KCM Corp.
- Nachi-Fujikoshi Corp.

■ Oversee companies

- IDEALSEE [Sichuan, China]
- Hangzhou Hikvision Digital Technology Co.,Ltd. [China]
- HuaXia Bank [Beijing, China]
- Huawei Technologies Co.,Ltd. [Shenzhen, China]
- CT (Computer Technology) Asia Co.,Ltd. [Thailand]
- China Mobile Ltd.
- Da-Jiang Innovations Science and Technology Co.,Ltd. [China]
- Shanghai Mitsubishi Elevator Co.,Ltd. [China]
- Perfect World Co.,Ltd.

■ Foreign university

- Universitas Pendidikan Indonesia [Bandung, Indonesia]
- State University of Malang [Malang, Indonesia]



中国移动通信
CHINA MOBILE



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Interactive Aerial Projection of 3D Hologram Object

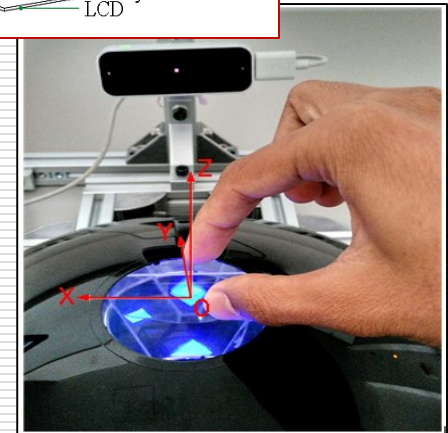
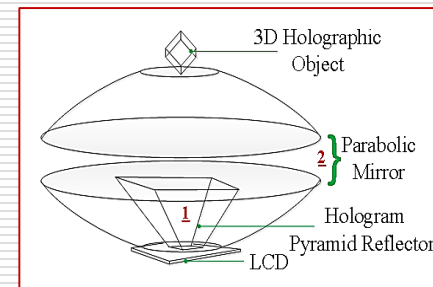
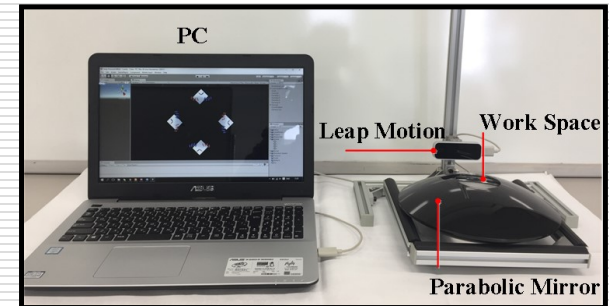
□ Target/purpose

- Interactive interface of 3D holographic object image
- “*Remote operation*” of robotic systems



□ 3DAHII, three-dimensional aerial holographic image interface

- Reconstruction and aerial projection of 3D object image
 - Pyramid-holography
 - Parabolic reflector
- Interactive instruction
 - Direct/real-time interaction with 3D object image
 - Operating procedure
 - Reaction function
 - End-tip control of robot manipulator



3DAHII [2017.11] (03:18)

3DAHII@iREX2017
[2017.12] (00:13)

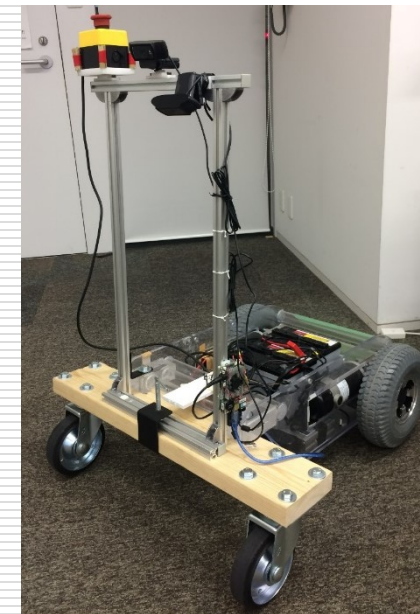
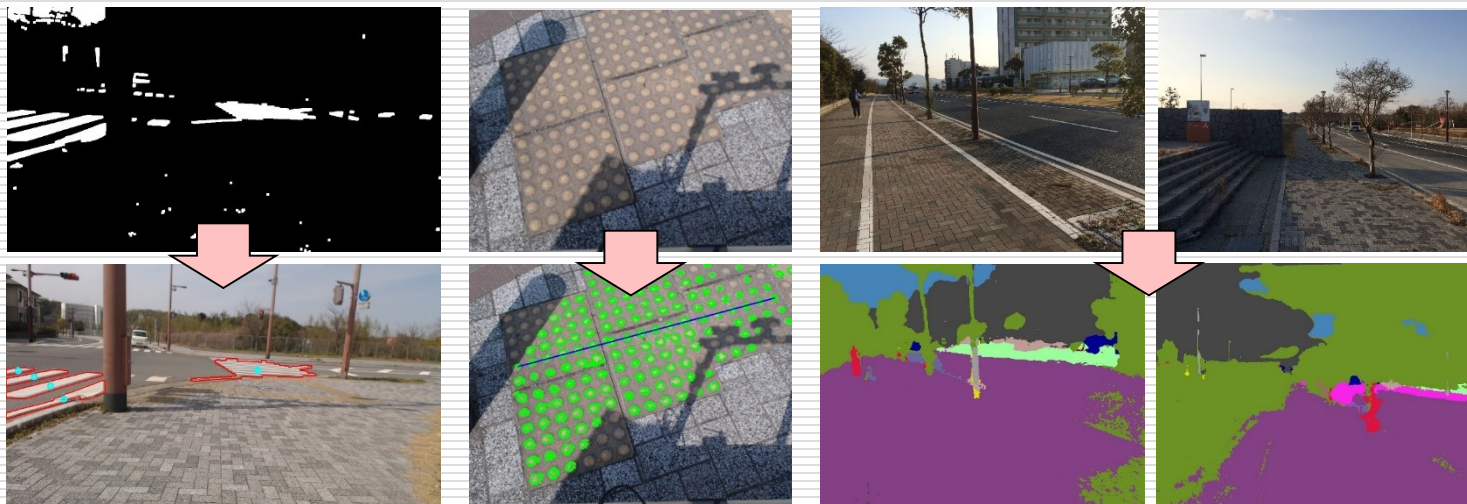
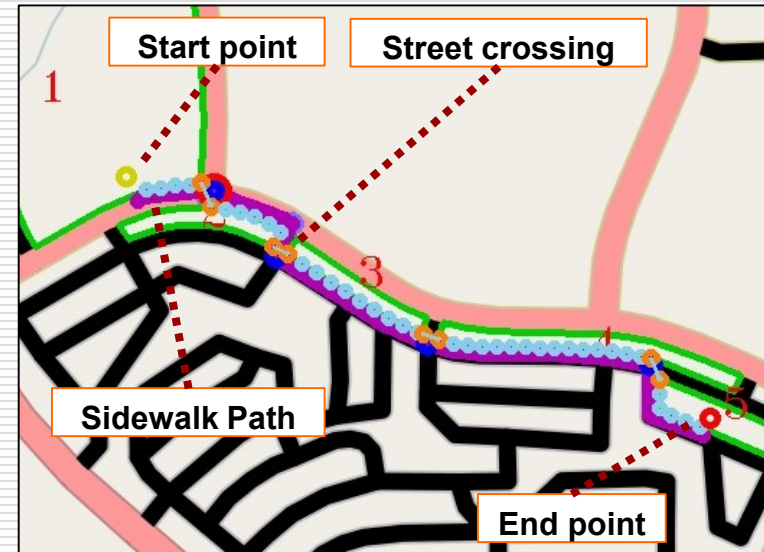
Pedestrian Navigation Robotic System

□ How to make mobile robots navigate in semi-structured outdoor environments

- Without pre-driving recording (i.e. SLAM)
- Using network-provided maps (i.e. OpenStreetMaps)
- Contextual awareness for navigation (vision, location)

□ Pedestrian path planning

- Build upon internet map processing approach
- Image processing on 2D maps to infer
 - City blocks, Street crossings, Sidewalk path



Reinforcement Learning in Manipulator Control

□ Reinforcement learning (RL)

■ Policy

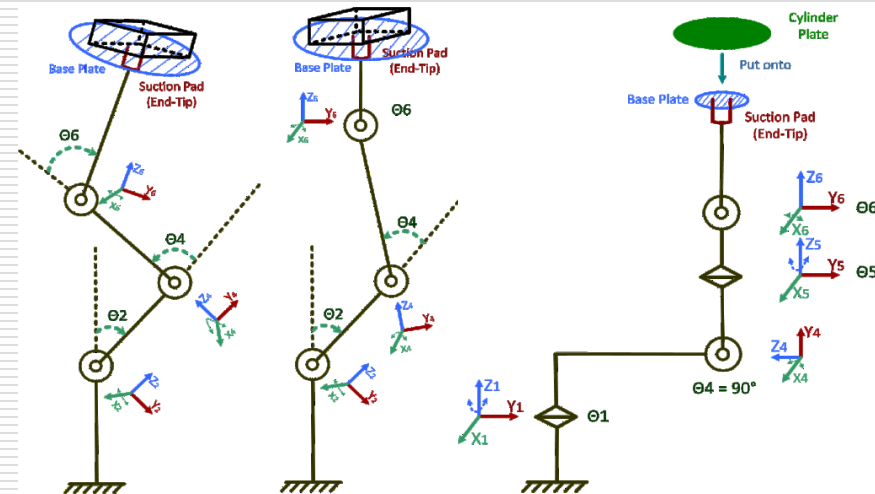
- S: environment and agent States
- A: Action of agent
- R: Reward

■ Example data

- Supervised learning
- Unsupervised learning

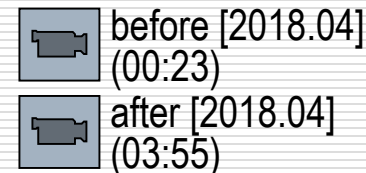
□ Deep RL

- Discrete action space (DAS) approach
 - Deep Q-Network (DQN) algorithm
- Continuous action space (CAS) approach
 - Stochastic CAS (SCAS)
 - Proximal policy optimization (PPO) algorithm
 - Deterministic CAS (DCAS)
 - Deep deterministic policy gradients (DDPG) algorithm



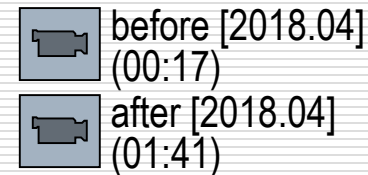
(1) Object balancing

- Joint position



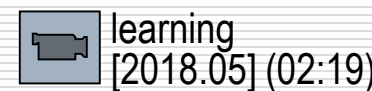
(2) Object balancing

- Joint pos/spd



(3) Object catching

- Joint pos/spd



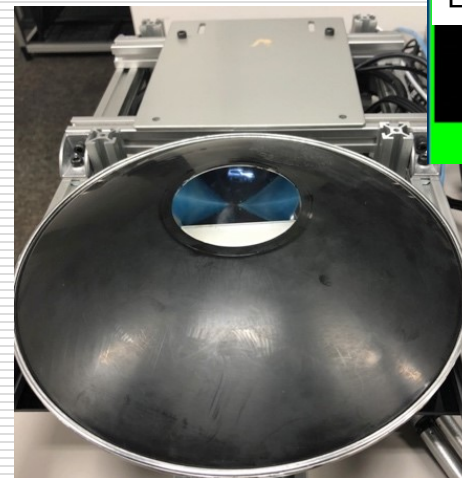
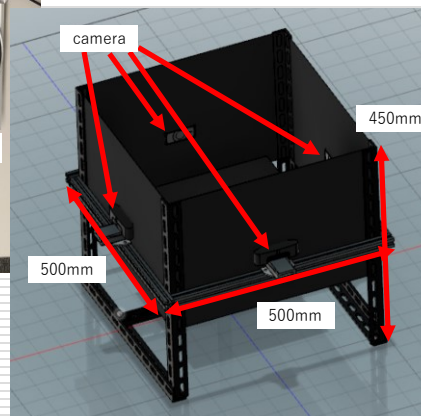
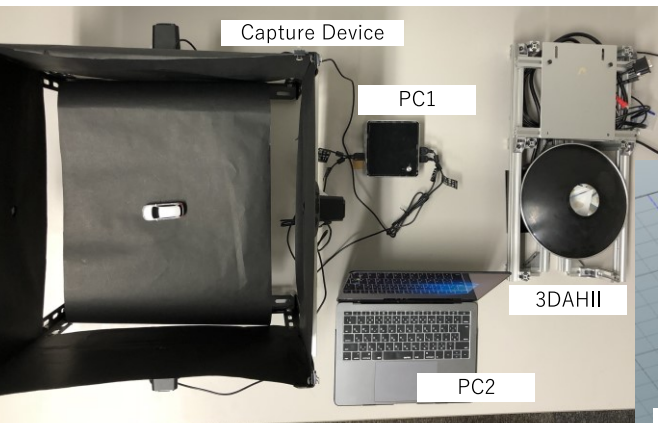
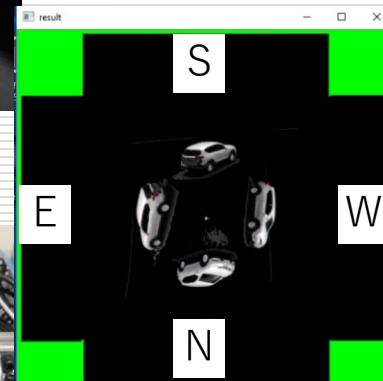
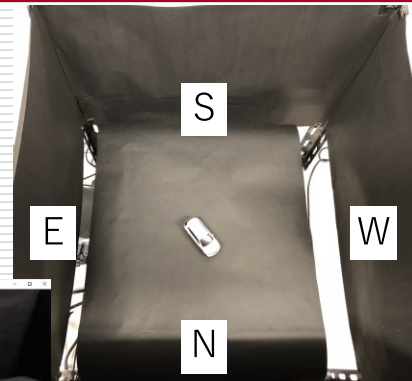
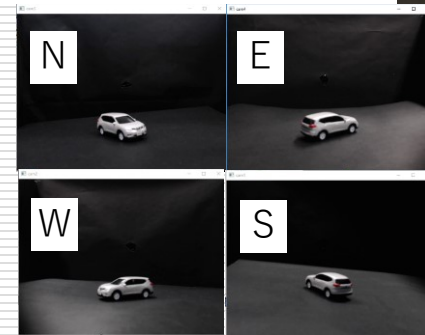
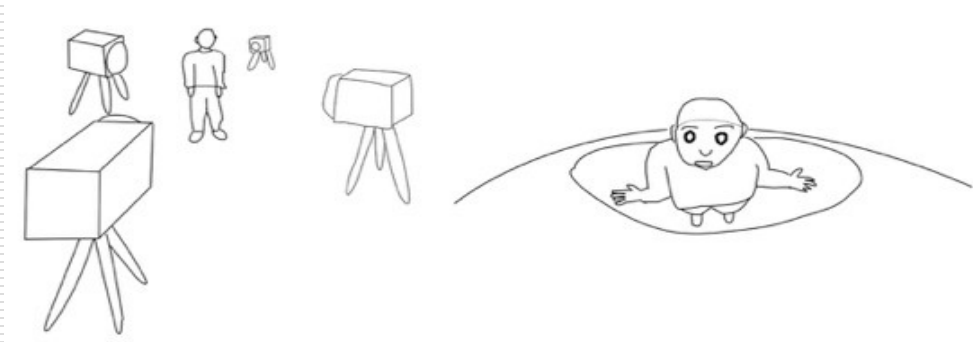
ROS



Real-time Remote Projection of 3D Human Image

Real-time remote projection of 3D human image

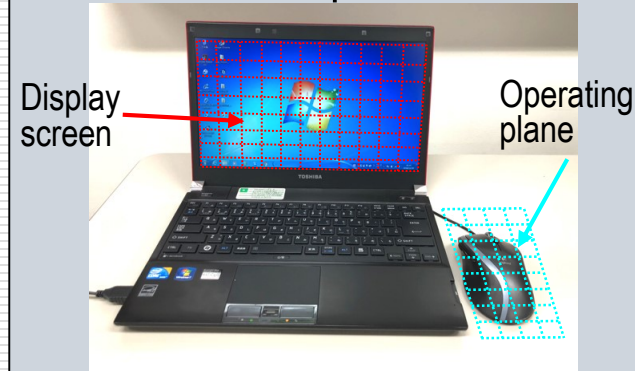
- Image capturing
- Image processing



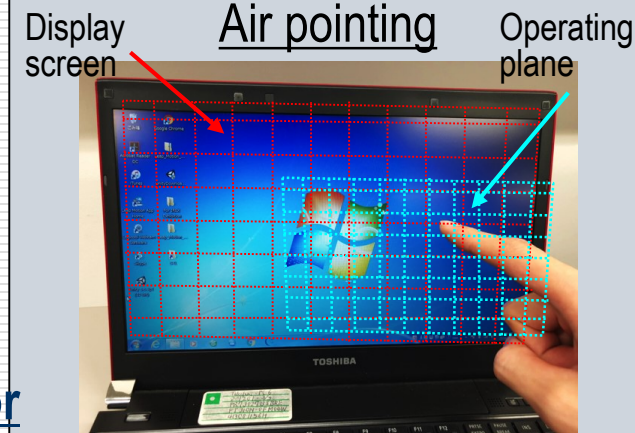
Short Range Finger Pointing Interface using Depth Camera

- ❑ Switch frequently between typing and cursor placing in tasks
 - Web browsing, Editing spread sheet and documents, Coding
- ❑ Cursor placing using finger gesture
 - No need of physically-interactive devices
 - Easy finger operation
 - ❑ Familiar with sign language
 - Finger pointing is facing to display screen
 - ❑ Intuitive
- ❑ Approach
 - a) Ergonomic use of 3D space -- Posture
 - ❑ Hand putting on desk
 - b) Recognition accuracy of finger in near range -- Sensor
 - ❑ Realsense SR300
 - c) Real time operation -- Processing
 - ❑ Accurate measurement of fingertip, Fast response

Mouse operation



Air pointing



Work space



Brand-Wise Random Picking of 500ml Plastic Bottle using RGB Image

□ 500ml Plastic Bottles

■ Condition

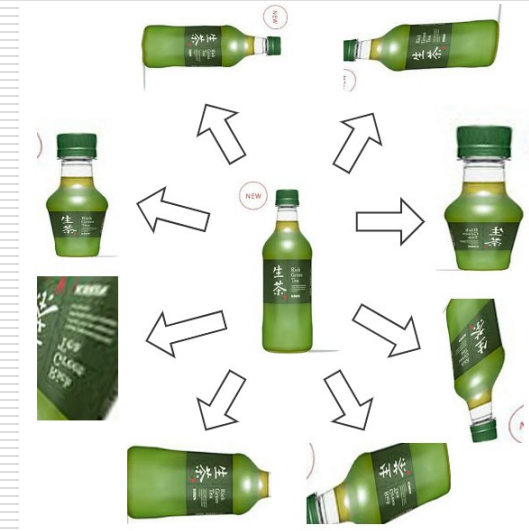
- Dry
- In water
- In water with ice

■ Sensor

- RGB camera

■ Procedure

- Segmentation
- Brand recognition
 - Masked Image
 - ROI image
 - Mask R-CNN + Inception V3



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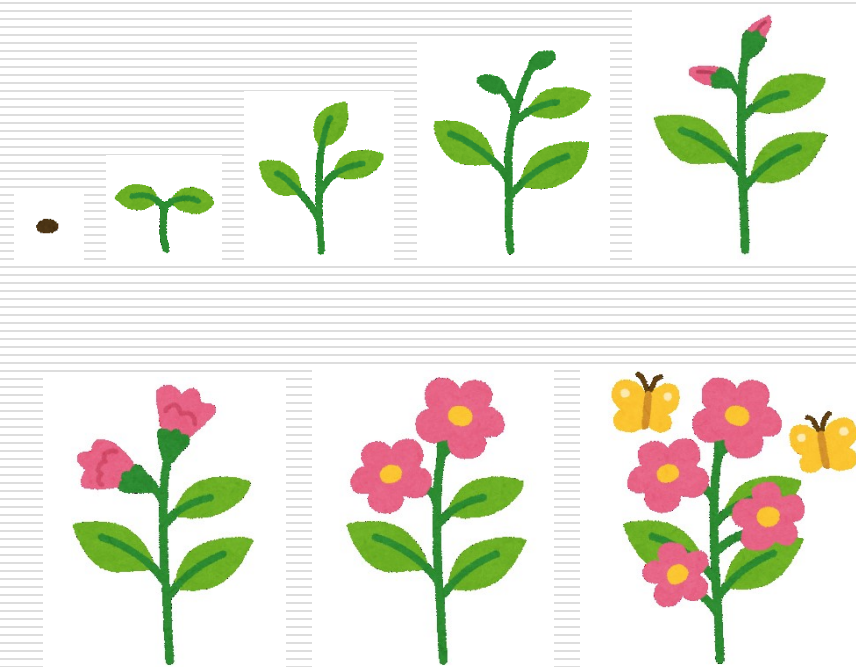
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□ Closing remarks

Message

- Let's grow up together
developing a new field at the
meeting ground for people
who have a new way of
thinking and extraordinary
abilities regardless of areas
or aspects.
- 領域や分野にとらわれない
新しい考え方や, 高い能力
をもった人々が集う場で,
新しい分野を開拓しながら,
一緒に成長しましょう.



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