What is identity?

- Who has the Ishiguro’s identity?
- Is it Ishiguro or the Geminoid?

Robot Society
Human-Robot Symbiotic Society

Why Do We Need Humanoid Robots?
- Humans have a brain that recognizes humans.
- The ideal interface for humans is a human.
- Therefore, information media devices, e.g., talking rice cookers, should be at least partially humanlike.
- On the other hand, the very humanlike robots, android robots, are necessary for understanding humans.

Personal Robots
Interactive Communicative Robots

The Future Society
Supported by Humanoids & Androids

Robot and Science
Constructive Science with Intelligent Systems

- Past brain studies have found that human intelligence comprises elements of memory, computation, inference, learning, etc. The challenge is to identify how these elements can be put together for realizing human intelligence.
- The constructive approach will reconstruct robots and androids to model humans, and use such robots and androids to study human macro-level functions.

**Intelligent robotics**

Developing humanoid robots based on knowledge in science

Understanding humans by using the robots

**Cognitive & Neuroscience**

Progress of Robot Technology and Human Science

“Cognitive Science with Robots”

- Voice recognition
- Social relationship
- Image understanding
- Intention/Desire
- Sensor
- Multi-modal integration
- Manipulator
- Embodiment
- Mechanics
- Intelligence
- Meta-level Cognitive functions

Robot Development

- Language teacher robots
- Order-taking robots at restaurants
- Interpreter/Guide robots
- Conversation training robots
- Receptionist/Concierge robots
- Shop keeper robots
- Counseling robots
- Conversational robots for the elderly and children
- Intelligent sensor network
- Self-organizing sensor network

Science and Robot Development

- Total Turing Test
- Companion robots
- Conversational robots for the elderly and children
- Social relationship
- Intellectual integration
- Conception
- Interaction
- Embodiment
- Shop keeper robots
- Language teacher robots
- Order-taking robots at restaurants

Total Turing Test (TTT)

- TTT is to compare between a robot manipulated by human operators and an autonomous robot controlled by developed technology.
- One of the important challenges in intelligent robotics is to pass TTT.
- It evaluates the total human likeness through all of the modalities.
- It evaluates the social acceptance as a member of our society.
Ishiguro has built a new field in robotics: Interaction.

Before that, navigation and manipulation were major topics in robotics. Recently, 10-20% papers at major conferences focus on interaction.

Japanese government expects that the market of interactive robots/service robots, will be bigger than manipulators and it will reach 50 Billion USD in 2035.
Android of a Great Literary Figure

What is human presence?
What is human?

Androids and Human Presence

Androids for Representing Humanlikeness in Artistic Areas

House Mannequin Android

Android as an Idol Singer
What is heart/mind?

- We feel the humanlike hearts/minds of the android, but it is a simple computer program.

Androids with Conversational Functions

- Toward Total Turing Test -

Autonomous Conversational Android

- Big-data approach
  - Collection of simple conversational patterns through the Internet for unlimited topics
  - Chatbots

- Story-based approach
  - Stories presented in graphical models
  - Complex conversation for limited topics
Conversational Autonomous Androids

NTT Laboratories
Osaka University and ATR

- Microphone array by NTT
- Voice recognition by NTT
- Chatbot by NTT
- Android by Osak Univ.
- Lip and head movements by ATR

Chat-Oriented Dialogue System

with NTT

Androidol U

with NTT

Internet TV
Mechanism of Deep Discussion

Toulmin Model of Argument

Harry must be a British subject.
Harry was born in Bermuda.
A man born in Bermuda will be a British subject.

Big-data approach
- Collection of simple conversational patterns through the Internet for unlimited topics
- Chatbots

Story-based approach
- Stories presented in graphical models
- Complex conversation for limited topics

JST ERATO ISHIKURO
Symbiotic Human Robot Interaction Project
2014-2020
mainly with Prof. Kawahara (Kyoto University) Dr. Minato, Dr. Ishii, and NTT
Android with Intensions and Desires

Behavior

Intention

Desire

Speech and gesture recognition
Utterance and behavior generation
Hierarchical models of utterance and behavior generation

Robot Action (Sequential organization × topic, focus)

Closin talk
Talking about myself
Talking about something the other likes
Letting the other talk

Self-esteem
Relationship-building
Values, Opinion, Preference
Talk contents
The other's state such as emotion
Feedback of action

Implementation of Desire Behavior Model

The intention binds the desires and actions to satisfy them.
The action that mostly satisfies the current desires is chosen.

Ex. Sequence beginning with question × which shop to go to buy clothes

ISHIKI System with Prof. Kawahara (Kyoto Univ.)

Interaction Composer

ERICA with Prof. Kawahara (Kyoto Univ.)
How to represent the feeling of presence?
mainly with Prof. Ogawa, Dr. Nishio and Dr. Sumioka

What is conversation?
mainly with Prof. Yoshikawa

Feeling of presence “Sonzaikan”
Geminoid: Teleoperated Android to Transfer Human Presence

Meeting with the Geminoid

Internet
Operator

How do we recognize the robot/android?

Recognition Based on Observation

Recognition Based on Imagination

Robot that Activates User’s Imagination
Telenoid: Teleoperated Robot Based on User’s Imagination

The Minimum Media to Transfer the Human Presence

- It requires two modalities.
- Hugvie: the minimum media.

Relaxing Effect of Hugvie

Talking to an unknown person for 15 min.

Cortisol, the Stress Hormone, Is Reduced with Hugvie.

Scientific Reports, 2013

with Sumioka
Representation with two modalities for activating the imagination

- Voice + Tactile sensation
- Appearance + Tactile sensation
- Smell + Tactile sensation
- Voice + Smell

1st grade children in an elementary school

Conversation

CommU: Communication with Two Robots

Conversation without voice recognition

- If there are two robots, robots do not need to understand the person's utterance.
- The robots talk to each other and bring the person to their conversation.
How to Ignore the Person’s Utterance

Ask the person a question just before switching the subject.

Ask the same question to both another robot and the person.

What Is Conversation?

Robots do not need to recognize the voice.

Shopkeeper android

Conversation by Using Touch-Panel

• Selecting an option is much easier than speaking.
• The visitor coming to the shop does not have many stories.

Touch-Panel

Positive   Positive
Positive   Negative

What Is Conversation?

Robots do not need to recognize the voice.
People do not need to pronounce.
(Choice from options is enough)
Touch-panel conversation

- The computer controls the stories.
- People can adapt to stories by selecting options and hearing the voice.

Story controlled by the computer

Computer voice

Selection by touching

People Start Liking Each Other by Touch-Panel Conversation

How to Connect People

Human-Robot Symbiotic Society

Information/sensor network