Robotic Services for Super-Aging Society
- Service Development with Cloud Networked Robotics Technologies -

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OUTLINE

1. Robotic Services
2. Ubiquitous Network Robots (UNR) Platform for Life Support
3. Toward Innovation
4. Conclusion
1. Robotic Services
Robot has three functions

1. Sensation
   Seeing, hearing, being touched

2. Actuation
   Moving, gesturing, talking delivering goods

3. Intelligent Control
   Communicating with other robots, sensor networks, smartphones, etc.
However,

Stand-alone robots are not enough for continuously and seamlessly supporting daily activity like Ambient Assisted Living.
Field Experimentations by ATR (2002-2013)

- **School (2002)**
- **Science museum (2004-2005)**
- **Station (2006)**
- **Tour guide (2010)**
- **Day-care center (2009)**
- **Shopping mall (2009)**
Robotic services for AAL (Field Experimentation in 2009-2013)

Life support research project in Ministry of Internal Affairs and Communications in Japan ATR, NTT, Hitachi, Toshiba, and NEC in 2009-2013
Three Types of Robots with UNR Platform

Visible-type
- Physical Robot, Geminoid, WheelChair
- User Interface: Broaden to Elderly
- Price: competitive to bike or vehicle, (or hobby)

Virtual-type
- ICT Infrastructure (Cloud and Ubiquitous Computing & Wireless Communication,...)
- iPhone, iPad, DS-3D, ...
- User Interface: easy-to-use & inevitable utility in daily use
- Price: Reasonable

Unconscious-type
- RF-ID, Camera, LRF,...
- Location Precision: 3m→5cm accuracy
- Price: gradually decreasing
Cloud Networked Robotics

Koji Kamei, Shuichi Nishio, and Norihiro Hagita, Advanced Telecommunications Research Institute International (ATR)
Miki Sato, DENSO Corporation

Abstract

This article proposes a new field of research called Cloud Networked Robotics, which tackles the issues for supporting daily activity, especially for the elderly and the disabled, throughout various locations in a continuously and seamlessly manner by abstracting robotic devices and providing a means for utilizing them as a cloud of robots. With recent advances in robotic development environments and in integrated multi-robot systems, robots are acquiring richer functionalities and robotic systems are becoming much easier to develop. However, such stand-alone robotic services are not enough for continuously and seamlessly supporting daily activity. We examine the requirements in typical daily supporting services through example scenarios that target senior citizens and the disabled. Based on these requirements, we discuss the key research issues in cloud network robotics. As a case study, a field experiment in a shopping mall shows how our proposed prototype infrastructure of cloud networked robotics enables multi-location robotic services for life support.

Special Issue on Machine and Robotic Networking

http://dx.doi.org/10.1109/MNET.2012.6201213
Why we need robotic services?

→ Professor Obi has already introduced it.
Examples of Robotic Services
Shopping support service for elderly wheelchair users

(March, 2011)
Shopping support service for elderly wheelchair users (March, 2011)
http://networked-robots.cs.umn.edu/
Robotic Service Coordination with Smartphone (January, 2013)

Available icons on several robotic services will be displayed on smartphone with no input.
User can select service icons as she/he likes

Depending on Locations, Users, and Robots

Available services are popped out on smartphone

Location 1

Shopping Support

Touring Support

Location 2

Health care advice
2. Ubiquitous Network Robot Platform
Conventional Style of Service Application Programming

Example: Find a person and approach the person

Service App. 1
- find face
  - guest name face position
  - face recognition
  - wheel control

Service App. 2
- find tag
  - tag ID tag position
  - RFID tag Detection
  - leg control

Implementation-dependent functions called from service applications and their return values

Implementation layer (hardware layer)

Application program and robot implementation are tightly coupled

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Proposed Service Application Programming Style

Ubiquitous Network Robot Platform Layer

Implementation-independent functions and their return values in common message type

Implementations are invisible from outside

Standard APIs enhance the reusability of application programs

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Ubiquitous Network Robot Platform

- separates the developments of robots and robotic service applications.

- connects various service applications to appropriate robots in a variety of places.

- permits service applications to share their own data between each other.

http://www.irc.atr.jp/std/UNR-Platform.html
UNR-PF for coordinating multiple robotic services (Consent from ITU-T, SG16, Q25(IoT), March 2013)

An robot component may be used for many service applications

Service Application Layer

UNR-PF Layer

Robot Component Layer

*UNR-PF: Ubiquitous Network Robot Platform
UNR-PF for coordinating multiple robotic services
(Consent from ITU-T, SG16, Q25(IoT), March 2013)

A service application may be available for several robot components (smartphones, humanoid robots, and wheelchairs)

*UNR-PF: Ubiquitous Network Robot Platform*
Map Registry
Standardized as CityGML in OGC* (2012)

APITA Shopping Center in Kyoto

Universal City walk in Osaka

* OGC: Open Geospatial Consortium

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# Robot Registry

<table>
<thead>
<tr>
<th></th>
<th>Robovie-II</th>
<th>Wheel chair robot</th>
<th>ApriPetit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td>Humanoid with wheels</td>
<td>Wheel chair</td>
<td>Humanoid with no movement</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Speech func.</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Personal mobility</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Identify users</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Secure Criterion</strong></td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>
# User Registry

<table>
<thead>
<tr>
<th>User Name</th>
<th>Attribute</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>User 1</td>
<td>Elderly</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>User 2</td>
<td>Elderly with cane</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td>No Pedometer</td>
</tr>
</tbody>
</table>

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Standardization Map

- Sensor Network
- ISO/TC 211
- GIS
- Indoor Map
- CityGML
- OGC
- GeoSMS
- IndoorGML
- Robotics components
- RTC
- ISO191XX series
- Robotic Localization Service (RLS)
- Robotic Interaction Service (RoIS)
- OMG
- Device
- IEEE
- Map data
- Glossary/ontology
- ISO/TC 184
- Personal Care
- Industry Safety
- Safety of households
- ORiN
- Industrial Robots
- Service Robots
- Vocabulary
- Safety Life Cycle
- IEC/TC 61
- Electrical Appliances
- Multimedia
- Sensor Network
- Network
- UNR Platform
- ITU-T SG16
- DDC4RTC
- Distributed System
- Service Robots

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3. Toward Innovation
Current work for Robotic Services

By Prof. Paolo Dario from SSSA, Italy

- Scientific and Technological Challenges
- System Reliability and Standardization
- Insurance and legal issues
- Collaboration with local administrations
- Design service & Evaluation tests
- User Acceptance
- End-User Analysis & Education
- Cross fertilization: academics and industry
- Cost Performance
Future work for Creating Market of Robotic Services

By Prof. Paolo Dario from SSSA, Italy

- Scientific and Technological Challenges
- System Reliability and Standardization
- Insurance and legal issues
- Collaboration with local administrations
- Design service & Evaluation tests
- User Acceptance
- End-User Analysis & Education
- Cross fertilization: academics and industry
- Cost Performance
Innovation Ecosystems for disseminating New Tech-Seeds

• Building platform, or ecosystem, for research, development, fund raising and marketing.
Global Innovation Base

[Osaka Innovation Hub] in Grand Front Osaka

Osaka Innovation Hub was established in Umekita area at the end of April, 2013.

Major facilities and shops in Knowledge Capital

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Osaka Innovation Hub

**Collaboration Area** (150㎡)
- Capacity: 40～60 (seats)
- Equipment: 5 tables, 60 chairs, 5 white boards, 1 LCD Projector, 3D-Printer, Laser Cutter

**Workshop Area** (90㎡)
- Capacity: 36～45 (seats)
- Equipment: 18 tables, 36 chairs, 3 wireless microphone, 50 inch touch panel LCD Display, etc.

**Meeting Room** (35 ㎡)
- Capacity: 10～15 (seats)
- Equipment: 2 tables, 10 chairs, 2 white boards, etc.

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Supporting Program for Innovative Projects (supported by Osaka City)

Hack! Creating Innovative Projects
Ex. Mono-App. Hackathon,
Lean Launch-pad,
Assistive Tech. Idea WS, etc.

191 events in FY2013

Match! Making and matching Communities
Ex. Silicon Valley Tour

Disseminate! Disseminate the projects to the world!
Ex. International Conf.
Business pitch con.
Ex. Assistive Technology Hackathon

ぼくたちが変える、新しい福祉のカタチ

Assistive Technology Innovation Workshop

【全4回】
平成25年10月6日(日)、10月20日(日)、11月10日(日)、12月1日(日)
各回14:00～16:00（受付開始13:30）
Future Trends in Multi- & Many-Robot Systems In Japan (MEXT* Research Projects)

* MEXT: Ministry of Education, Culture, Sports, Science and Technology in Japan

Research Area
Intelligent Information Processing Systems
Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration

Program Officer: Norihiro Hagita (ATR)
Budget for each PI: 1.5 M US$ to 5 M US$
Period: 5.5 years
Call 1 (due date): June 10th, 2014
Call 2 in 2015, and Call 3 in 2016.
Conclusion

- Robotic service coordination based on UNR platform for AAL were introduced.
- MIC in Japan, task-force on super-ageing society, focuses on creating new business and market in AAL
- Let’s use Osaka Innovation Hub and start innovative business: Lower price, Faster implementation and Various Excellent services for AAL services