Session on 5G Access/Core Network

Smart Networked Robotics toward 5G Access/Core Network

Makuhari Messe, International Convention Complex
Room 105

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1. 5G Application Fields
2. Robotic City Services
3. History of Field Experimentations in ATR
4. Current MIC R&D Projects related to 5G
   - Smart Networked Robotics -

This research was partly supported by the Ministry of Internal Affairs and Communications
5G Application Fields

- **Transportation**
  - More efficient and safer
  - Navigation
  - Autonomous driving

- **Healthcare**
  - Remote medical examination

- **Disaster Relief**
  - Prediction
  - Robustness to disaster

- **Education**
  - Distance learning
  - Virtual experience

- **Richer Contents**
  - Multiuser UHD teleconference
  - Purchase enriched video, music, book

- **House**
  - Home security

- **Consumer Electronics**
  - Remote control

- **Safety and Lifeline System**
  - Collision avoidance
  - Rescue (Distress, Accident, etc.)

5G will enhance the socio-economic satisfaction

From ARIB 2020 and Beyond Ad Hoc Group White Paper (2014/10/08)
www.arib.or.jp/english/20bah-wp-100.pdf
Robotic City Services on 5G Application Fields

- Transportation
  Safer, more efficient and comfortable navigation for autonomous personal mobility

- Health care
  Facilitating social participation in human populated environment

- Safety and lifeline system
  Collision avoidance between wheelchairs, and between wheelchairs and pedestrians
1. Smart Networked Robotics
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.
Robotic Services

systems, devices, and robots with three functions: **sensation, actuation and control**

City becomes robotic city when city has these three functions.
What is Network Robot System?

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

**Agent-type**
- iPhone, iPad, Pokemon GO...
- User Interface: easy-to-use & inevitable utility in daily use
- Price: Reasonable

**Ambient Intelligence-type**
- RF-ID, Camera, LRF, ...
- Location Precision: 3m → 5cm accuracy
- Price: gradually decreasing

**ICT Infrastructure**
- Cloud and Edge Computing & 5G Wireless Communication,...
Three-layer Architecture in UNR-PF

An robot component may be used for several service applications.
Standardization on UNR-PF

- **F.USN-NRP (UNR-PF)**

- **RoIS**: Robotic Interaction Service @OMG
- **RLS**: Robotic Localization Service @OMG
- **City GML**: City Geography Markup Language @OGC
- **Indoor GML**: Indoor Geography Markup Language @OGC
- **F.USN-NRP (UNR-PF)** ITU-T: Ubiquitous Sensor Network application and services for network robot platform @ITU-T
### Service Functions Provided by Smart Networked Robotics

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<th>Before/After</th>
<th>Social Impact</th>
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<td><strong>1. Location</strong></td>
<td><strong>Care/Prevention</strong></td>
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<tr>
<td>Single ⇒ Multiple</td>
<td>Job creation</td>
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<td><strong>2. Operation</strong></td>
<td>Social Participation</td>
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<tr>
<td>Single ⇒ Cooperative &amp; collaborative</td>
<td>Local creation</td>
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<td><strong>3. Information</strong></td>
<td>Medical services</td>
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<td>Individual ⇒ Sharing</td>
<td>Market creation</td>
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<td><strong>4. Teleoperation</strong></td>
<td>Educaion</td>
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<td>Single robot ⇒ Teleoperation for multi-robots</td>
<td>Art /Science</td>
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<td><strong>5. Human Interface</strong></td>
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<td>Talking/Gesture ⇒ BMI, Biometrics</td>
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<td><strong>6. Knowledge</strong></td>
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<td>Stationary ⇒ Dynamic and Experience Sharing</td>
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**Multi-locations**

- BMI
- Ambient Intelligence

**Social Impact**

- Care/Prevention
- Job creation
- Social Participation
- Local creation
- Medical services
- Market creation
- Educaion
- Art /Science
3. History of Field Experimentations in ATR
Field Experimentations by ATR (2002-2009)

2001  2002  2003  2004  2005  2006  2007  2008  2009

- School (2002)
- Science museum (2004-2005)
- Shopping mall (2007)
- Station (2006)
- Universal Citywalk in Osaka (2008-2009)
- ASIMO
- FP6: DustBot (SSSA)
Field Experimentations by ATR (2002-2009)

- School (2002)
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ASIMO
FP6: DustBot (SSSA)
Collaboration with FP6 at Universal Citywalk in Osaka (2008-2009)

Universal Citywalk in Osaka

FP6: Dustbot Project in SSSA, Pisa, Italy

Peccioli testing: new road signs

‘Attention. Area subject to robotic testing. Yellow lane used by robots’.

‘Attention. Robot crossing. Yellow lane used by robots’.
Field Experimentations by ATR (2009-2015)

- **Shopping mall (2009-2013)**
- **Day-care center (2009)**
- **Tour guide (2010)**
- **Science museum (2013)**
- **Service Coordination in Pararell**
  - **Touring support**
  - **Shopping support**
- **Nursing home (2014)**
  - **Wandering and Watching Supports**
Shopping support service for elderly wheelchair users (March, 2011)

Area 1: Home
Booking a wheelchair robot Using smartphone in advance

Area 2: West mall
The wheelchair will say hello to the user

Area 3: East mall
Secure shopping support
Robotic services for AAL (Field Experimentation in 2009-2013)

- Shopping support
- Active hearing
- Cloud Networking
- Health care
- Touring support
- Community building support

Life support research project in Ministry of Internal Affairs and Communications in Japan. ATR, NTT, Hitachi, Toshiba, and NEC in 2009-2013
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 seamless 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.


http://dx.doi.org/10.1109/MNET.2012.6201213
4. Current MIC R&D Projects related to 5G
   - Smart Networked Robotics -
 Autonomous Personal Mobility*  
in Smart Networked Robotics  
Safe and comfort riding while passengers riding and talking with the other wheelchairs and/or persons in human populated environments.

*This research project called autonomous personal mobility including robots is supported by the Ministry of Internal affairs and Communications (MIC), Japan, in 2016-2019.
Conclusion

1. Robotic city services will be created in the 5G infrastructure.
2. Not only safer and more efficient services but also more comfortable ones for users/passengers are inevitable in Human Populated Environments.
Thank you for your kind attention