Social Service Robots in Public and Private Environments

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Abstract: - Research on service robots especially for health care or home assistant has been in growing interest during last decades. New solutions are needed to assist elderly people and personnel working in elderly houses or in hospitals. Demographic change as the population is aging will affect in other service domains as well. In the current paper, we describe a scalable service robot system designed for elderly people in private home environments but also for visitors in public environments in restaurants and expos. The designed system is consisting of Robosoft's Kompai service robot with a service menu with multimodal interaction methods.

Key-Words: - Social robots, service robotics, human-robot interaction, multimodal user interfaces, elderly services, smart restaurants

1 Introduction

In this paper, we will describe a scalable service robot system designed for different user groups in private and public environments. One of the most promising research fields in service robotics is wellness and entertainment for elderly people. The number of elderly people is increasing dramatically in next decades in the world, especially in EU, USA and Japan. According to the most recent UN population projections, Europe will really be the Old Continent as it is often called: according to the Demography Report 2010 [1] the share of the population aged 65 or over is projected to increase from 17.4% in 2010 to 30.0 % in 2060. The proportion of those aged 80 or over is growing faster than any other segment of the population. Figure 1 presents these trends in EU area: the population pyramid is widening upwards as the population is aging dramatically. Demographics dependency ratio describes the number of children and elderly people per 100 persons in working age. According to the same Demography Report 2010 [1] the old age dependency ratio (population aged 65 or over in relation to that aged 20-64) is estimated to more than double from 28.4 % in 2010 to 58.5% in 2060. In 2020, The total age dependency ratio (calculated as the ratio of children and young people aged under 19 and older people aged 65 or over to the population aged 20-64) is expected to rise from 63.2% in 2010 to 95.5 % in 2060. The result is that there will be almost one person of working age for every dependent person aged under 19 or over 65 years in the EU-27.

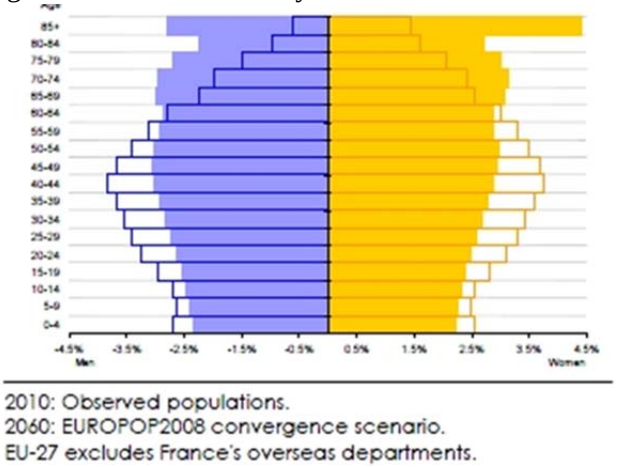

Figure 1. Upwards growing population pyramid in EU-27 counties.

The situation in Finland is one of the worst in EU area; in fact Finland will have the oldest population in EU-27, measured in terms of the old-age dependency ratio [1]. Figure 2 shows how the

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demographic dependency ratio is developing in Finland during the next few decades [2]. In Figure 2 the age limit for children is different than in the Demography Report 2010 [1]; children are defined in this graph as young people aged under 15.

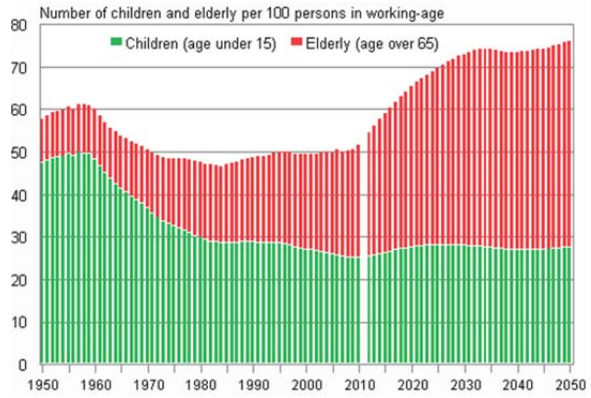

Figure 2. Demographic dependency ratio in Finland in 1950–2010 and projection for 2011–2050

To cope with this problem in the future, new solutions are needed to assist elderly people and personnel working in elderly houses or in hospitals. Service robots as co-workers can bring one way to help the burden of overcrowded personnel. Actually, this burden of overcrowding may become a challenge also in other service domains because of the demographic change reported above. Therefore in this paper, we describe a scalable service robot system designed for elderly people in private home environments but also for visitors in public environments in restaurants and expos.

2 State-of-the-art in Social Robots

2.1 Service Robots

International Federation of Robots (IFR) defines service robots as follows*: A service robot is a robot which operates semi- or fully autonomously to perform services useful to the well-being of humans and equipment, excluding manufacturing operation* (http://www.ifr.org/service-robots/). Service robots assist people in their daily lives at work, home and leisure. They can also be used as part of assistance to handicapped and elderly. The IFR lists the application fields for service robots include cleaning & housekeeping, edutainment, humanoids, humanitarian demining, rehabilitation, inspection agriculture & harvesting, lawn mowers, surveillance, medical applications, mining applications, construction, automatic refilling, guides & office, fire fighters, picking & palletizing, food industry, and search & rescue (www.ifr.org).

Bill Gates argued in 2007 that personal service robots will be in the next few decades the same kind of large business area as personal computers in the last 30 years[9]. Gates also reminds that people did not believe in the 1980s that personal computers could come to homes around the world.

Dautenhahn et al. [3] were testing robots as a human companion for the home. Test group consisted of 28 adults and most of them saw the potential role as being an assistant, machine or servant. Few wanted a robot companion to be a friend. Household tasks were preferred to caretaking tasks of children or animals.

2.2 Social Robots

Social robots include various robot types which are able to communicate with humans or other robots. According to Feil-Seifer & Mataric [10] social robots can be categorized to assistive robots, socially interactive robots and socially assistive robots. ***Assistive robotics*** (AR) has largely referred to robots which can assist people with physical disabilities through physical interaction. Fong, Nourbakhsh & Dautenhahn [4] have proposed the term ***socially interactive robots*** (SIR) to describe robots for which social interaction plays a key role. Socially interactive robots operate as partners, peers or assistants, which means that they need to exhibit a certain degree of adaptability and flexibility to drive the interaction with a wide range of humans. Feil-Seifer & Mataric [10] have introduced the definition of **socially assistive robotics** (SAR) as the intersection of assistive robotics (AR) and socially interactive robotics (SIR) defined by Fong et al. [4]. SAR shares with assistive robotics the goal to provide assistance to human users, but it specifies that the assistance is through social interaction.

2.3 Social Service Robots in Wellness

Research on service robots for health care or home assistant has been in growing interest during last decades [3-10]. Some research groups have made intensive work for years and achieved respectable results. Fraunhofer IPA in Stuttgart has made three generations of robotic home assistant Care-O-bot since 1998 [5].

The latest version Care-O-bot 3 is equipped with the latest state-of-art industrial components: omnidirectional drives, range and image sensors for object learning and detection real-time 3D supervision of environment, a 7 degree-of-freedom redundant manipulator and a dexterous three finger gripper. All this is integrated as a user-friendly designed product [5]. Neobotix

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(http://www.neobotix-roboter.de/) and GPS Gesellschaft für Produktionssysteme GmbH (http://www.gps-stuttgart.de/) are currently selling service robots whose technology is in many ways based on research and development carried out in Care-O-bot research projects.

University Of California Los Angeles (UCLA) and Imperial College London have been developing health care robots together with InTouch Health company (www.intouchhealth.com). InTouch Health's latest RP-7 uses state-of art technology for a remote presence robot which can be used for example in remote patient care, hospital capacity management, training and collaboration. RP-7 robot does not include manipulating ability. In 2008 these Intouch Health's I See You robots were reported to be used also in Canada for real-time remote communication and treatment for patients having neurological disorders such as Parkinson's disease. In 2009 InTouch Health has reported new applications in Ireland and USA.

The father of industrial robots, Joe Engelberger, is one of the main persons behind Transitions Research Corporation and Help Mate Robotics, pioneer companies which introduced service robots for hospitals already twenty years ago in USA. To date, nearly 100 Pyxis HelpMate units have been sold to hospitals within the United States [11].

The University of Nice at Sophia Antipolis (UNSA) has been developing remote monitoring of fragile persons at home in their Gerhome project and mobile service robots for hospital use through the ROBODOMO project. UNSA has been collaborating with the French research institutes CSTB and INRIA, Stanford Research Institute in the USA, and the French company Robosoft (www.robosoft.com) which introduced the Kompai robot in March 2010 to assist elderly and disabled people and others who need special care.

Many companies have sophisticated products which can be used when developing a robot co-worker for elderly houses. Barrett Technology Inc. (www.barrett.com) has developed an advanced robotic arm which has been tested also in many health care applications.

2.4 Social Service Robots in Restaurants

Service robots have widely been studied in guidance for years. For example the first version of Care-O-bot was designed for navigating safely in public indoor environments with ability for communicating, guiding or entertaining people [5]. In Japan, Fujitsu introduced the first in 2007 their service robot called enon for the visitor's in the Kyotara Nishimura Museum on a permanent basis [12].

In restaurant environment, service robots are becoming more common as well. A new Japanese Hajime robot restaurant in Thailand was open April 2010 with a robotic waiter-staff of totally four robots. Hajime [13] is a robot themed restaurant which is dressed like a samurai. Customers sit at booths on either side of a long aisle. At each booth is a touch-screen-very user friendly upon which customers place the orders. When the meal is ready the legless robot wheels down to the kitchen and brings and serves food to customers.

FU-RO restaurant robot [14], in turn, is a practical restaurant robot with hands-on experience. This was released in June, 2010 from Future Robot Co. Ltd - a South Korean robotics company. Its service was implemented to make possible interacting between robot and customers through specialized HRI service technology by Future Robot Co. Ltd. The company has various selections of robot such as greeting robot at an entrance, waiting time robot which provides entertain-ments, order guide robot for guidance, taking order, and payment robot to help customers pay after meals and so on.

In December, 2010, the Dalu Hotpot Robot Restaurant [15] in China has unveiled seven mechanical custom built robot servers with some that resemble the classic automatons from 1950s science fiction, and others that are basical-ly wheeled tables.

Furthermore, KAIST restaurant robot [16] - the restaurant service robot platform (2006-2008) from Korean Advanced Institute of Science and Technology aimed to develop emotionally interactive service robot in the restaurant service area using emotional human-robot interaction technologies which have been researched in the research group. KAIST robot has features such as:

- Mobile robot platform with robust stability and high mobility in the service area.
- Path recognition and planning via points in the service area
- Restaurant service integrated software system from registering guests to controlling robot
- Restaurant service by robot such as menu ordering and beverage service
- Human recognition, tracking, and human's intention recognition for situation assessment

3 CENTRIA's Social Robot Pilots

3.1 Pilot for Elderly People

CENTRIA's interactive service robot Kaveri introduced in this paper is developed using the Kompai platform. CENTRIA has previously carried out application-oriented research including mobile robotics, human-robot interaction, geographical information systems, RFID and wireless sensor networks, and safety issues [17, 18, 19].

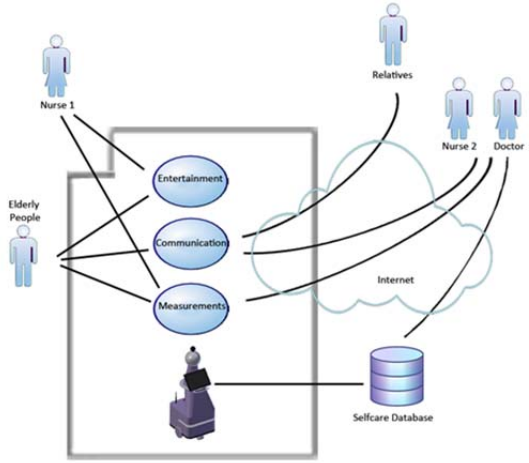

Figure 3. CENTRIA's social robot with use cases

In this study we used an interactive service robot, which is a complex mechatronics piece of equipment wherein many sensors and actuators are integrated with a mobile robot control system; the interaction is based on voice recognition and voice synthesis together with an interactive multi-touch screen. This interactive robot, called Kaveri, is based on Robosoft's Kompai platform, to which we added some wireless sensors, multi-language solutions (including Finnish) for multi-touch screen software and for voice recognition, and voice synthesis.

We have developed the national language-based user interface with voice recognition and synthesis together with a multi-touch screen and tested it first in laboratory conditions. We have also had our first experiences with elderly users, and the results are promising. Our development team includes a manager of an elderly house who has provided important information on what types of functions are needed for interactive service robots to assist nursing personnel in facilities for the elderly. Guiding tasks in museums and in tourist and shopping centers are another direction where interactive service robots have been already used and which have promising opportunities in the future. We have made our first interactive service robot demonstrations in guiding tasks at tourist centers and restaurants; these possibilities will be examined more in the future.

Figure 4. CENTRIA's service robot and one of the test subjects in the pilot project (Yleisradio 2011).

Based on the first experiences of elderly users, we plan to extend service robot systems to senior care systems such as ArctiCare in the future. In fact, we have already installed an ArctiCare test system in our laboratory. A combination of these systems could be utilized for different kinds of alarm services. Currently, our service robot is able to open Skype phone calls between the user and a nurse. In critical circumstances, the robot could open a connection automatically based on a wrist-held alarm button (Fig.4, right).

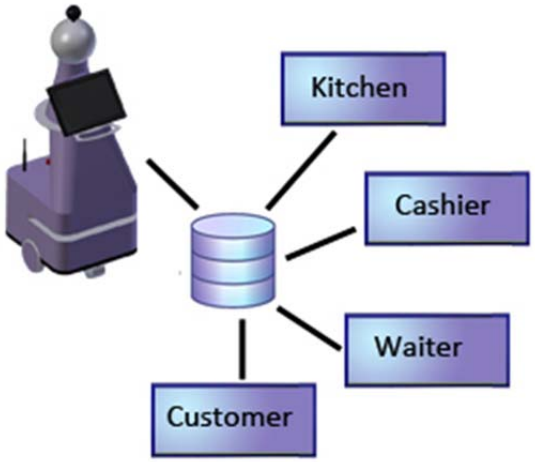

Figure 5. CENTRIA's service robot as a part of a restaurant system.

3.2 Pilot for Restaurant Visitors

CENTRIA has built up a restaurant system which is consisting of five applications and two different device types. The purpose of this system is to simplify and speed up ordering in restaurants, and help the restaurant employees' work. Applications are used on table-computers or desktop computers equipped with touchscreens. The system covers the whole order process of a restaurant from the customer's application to the kitchen's and cashiers' applications. The customer and the butler will be using software that runs on Android tablets. The

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system also includes a server which has the restaurant's menu in a database and all the information related to ordering logic. The devices are connected to a private and secured WLAN network. The menu can be created with desktop application specifically made for this.

Social Service Robot in Restaurant

When the restaurant has been scanned with the sensors the robot can be given a voice command to move to as predefined location in the restaurant. Different kinds of voice commands can be taught to the robot. The voice commands can then be used to move the robot or to interact with other software on the robot. The robot also has a tray so it can be used for delivering food to a table.

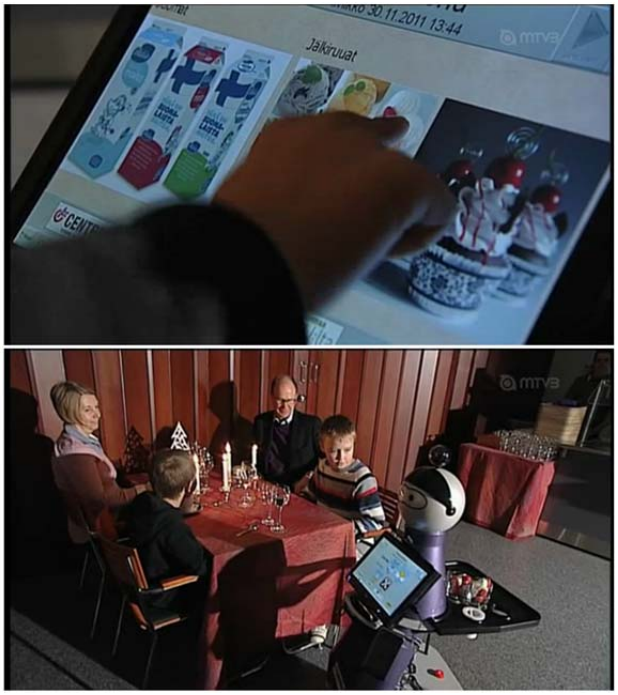

Figure 6. Service robot with children's menu (above) and with a tray for bringing dessert (below).

The robot's touchscreen has a service menu application which contains different applications for restaurant customers. The service menu has information (weather, news) and entertainment like videos and games. We also aim to develop a children's menu in the service menu. The children's menu will consist of pictures of the foods so children will find it easy to browse. The service menu also has Skype-calling.

The service robot has been developed from RoboSoft's Kompai-robot by adding Finnish voice recognition and creating a touchscreen application for restaurants. Our goal has been to develop the user interface of the robot and add games and services that can be connected to the Smart Menu – system or provide tourism information.

First experiences with restaurant visitors have been promising. We have cooperated with a consultant who has worked years in various positions in restaurant service management. Service robots can be used as a part of restaurant system for introducing restaurant supply, entertaining visitors, and collecting feedback. Service menu and navigation of the robot has been tested in two Finnish restaurants. Based on waiter and butler evaluation service robots can rather be utilizing in entertainment than in waiter services even that Kompai robot is now able to carry some food articles for the visitors. The developed system consisting of five applications and two different device types with a service robot is an interesting research prototype. We will continue in the near future testing this system in long-term experiments for example in areas of computer-supported cooperative work (CSCW).

4 Conclusion

Social robots are coming into our lives both in public and private environments. In this paper we presented our experiences both from public nad private social robotics pilots. Our experiences support that service robots can be used at home for various assisting, monitoring and guiding tasks, mainly for the elderly or disabled persons. One area where service robots also have excellent business potential is in guiding or monitoring tasks at public places such as museums, tourist centers and restaurants.

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