ICT-2009-248730

Florence

Multi Purpose Mobile Robot for Ambient Assisted Living

STREP
Contract Nr: 248730

Deliverable: D5.1 State of the Art in AAL Robotic Services

Due date of deliverable: (31-07-2010)
Actual submission date: (29-10-2010)

Start date of Project: 01 February 2010 Duration: 36 months

Responsible WP: Philips

Revision: final

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
M		
m	Public	X
PP	Restricted to other programme participants (including the Commission Service	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	

0 DOCUMENT INFO

0.1 Author

Author	Company	E-mail
Dietwig Lowet	Philips	dietwig.lowet@philips.com
Melvin Isken	OFFIS	melvin.isken@offis.de
Geke Ludden	Novay	geke.ludden@novay.nl
Dirk-Jan van Dijk	Novay	dirk-Jan.vandijk@novay.nl
Anthony Remazeilles	Fatronik	aremazeilles@fatronik.com
Elena Cruz Martin	TID	mecm@tid.es

0.2 Documents history

Document version #	Date	Change
V0.1	03/03/2010	Starting version, template
V0.2	04/07/2010	First complete draft (sent to project internal reviewers)
V0.3	25/07/2010	First set of review comments have been processed.
Sign off	28/07/2010	Signed off version (for approval to PMT members)
V1.0	30/07/2010	Approved Version to be submitted to EU
V1.1	29/07/2010	Resubmitted version to EU

0.3 Document data

Keywords	Robot, elderly AAL, social robotics, tele-care, social connectedness, safety, coaching, collaboration
Editor Address data	Name: Dietwig Lowet Partner: Philips Address: High Tech Campus 34, 5.041, 5656 AE, Eindhoven, The Netherlands Phone: +31 (0)40 27 49 543 Fax: +31 (0)40 27 46 321 E-mail: dietwig.lowet@philips.com
Delivery date	29-10-2010

0.4 Distribution list

Date	Issue	E-mailer
	Consortium members	al_florence_all@natlab.research.philips.com
	Project Officer	Luiz.Santos@ec.europa.eu
	EC Archive	INFSO-ICT-248730@ec.europa.eu

© Florence Public

Table of Contents

© Florence Public

© Florence Public

1 Introduction

This document provides an overview of the state of the art in services that are relevant for the Florence project. In this document, the focus is on the functionality provided by the different products and services and less on the technologies used. The state of the art documents [Dijk2010], [Bargh2010] and [Isken2010] delve deeper into the underlying technologies. The Florence project aims to develop a robotic platform that supports robotic services for elderly in four key service domains:

- *Safety:* use the robot as additional ears and eyes in comfort or safety situations, controlled by service providers or (volunteer) care providers.
- *Social connectedness:* Provide access to social networks, including web2.0 and synchronous communication tools
- *Coaching:* give feedback on specific activities like physical exercises, and advise on activities of daily life.
- *Collaboration:* log care-related activities at home that are shared among professional or volunteer care providers.

Therefore, we have identified the following service domains relevant to Florence:

1. Service robotics
2. Tele-care services for Elderly
3. Services and Products targeted at Safety
4. Services and Products targeted at Social Connectedness
5. Services and Products targeted at Coaching
6. Services and Products targeted at Collaboration

Evidently there is a large overlap between these domains. This and an assignment of the relevant areas to the sections of this document are schematically depicted in Figure 1.

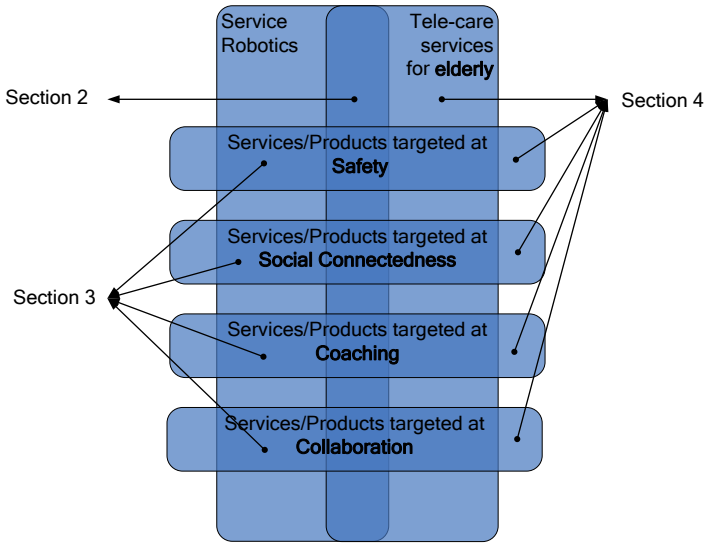

Figure 1 Overview of the relevant area's for the Florence project

Section 2 provides an overview of service robotics providing care for elderly. Section 3 provides an overview of robotics providing services in the one of the service domains targeted by the Florence project i.e.: safety, social connectedness, coaching and collaboration. This includes services that are not targeted at elderly. Section 4 provides an overview of non-robotic services that are relevant for Florence, i.e. tele-care services and for elderly and services in the service domains targeted by Florence, i.e. safety, social connectedness, coaching and collaboration. This includes services that are not targeted at elderly.

© Florence Public

2 Robotics for Elderly

This section provides a description of a number of robot projects aimed to assist elderly. These robots or robot projects for elderly will be described with a focus on the following aspects: the services and functionality they provide, the main human-robot Interaction paradigm being used (e.g. touch screen, physical face, virtual avatar), if available, the results of users tests and, for commercial projects, business model aspects, such as estimated time of market introduction and price, price. Because the number of past and current robotic projects for elderly is so large, we will limit ourselves to the most relevant ones.

In this overview, we excluded the following categories of robots:

- "Household robots": Household robots are being developed to do household chores like doing the dishes, cooking, cleaning the room. We did not include them because they are still too far away from realisation,
- "Pet robots": Pet robots these are robots that mimic a pet. Well-known examples are AIBO [Aibo] from Sony and Paro [Paro].
- Exoskeletons: Exoskeletons are robots that support elderly physically.

Though pet robots and exoskeletons are also used to assist elderly, the services they provide are not in the scope of the Florence project.

2.1 Nursebot

One of the first comprehensive robot projects for elderly was the Nursebot project [Nursebot] at the Carnegie Mellon University. This project started in 1999 and is one of the first large attempts at developing a robot to assist elderly suffering from chronic disorders in their everyday life. A robot, called PEARL, was developed as a research platform to test out a range of services for assisting elderly people, such as:

- *Reminding:* Many elderly patients have to give up independent living because of their forgetfulness. They forget to visit the restroom, to take medicine, to drink, or to see the doctor. The Nursebot project has explored the effectiveness of a robotic reminder, which follows people around (hence cannot get lost).
- *Tele-presence:* Professional care-givers can use the robot to establish a "tele-presence" and interact directly with remote patients. This rationalises doctors' visits. The robot is a platform for tele-presence technology that connects patients with care-givers.
- *Data collection and surveillance:* A range of emergency conditions can be avoided with systematic data collection …

Figure 2 The PEARL robot

The robot interacts through speech, visual display, facial expressions and physical motion [Pineau2002].

The robot has been tested in a nursing home, where the robot autonomously provided reminders and guidance to elderly residents. The user tests showed that elderly have difficulty understanding the robot's synthesized speech [Pineau2002], as well as expressing commands

© Florence Public

that the robot can understand. One of the conclusions of [Pineau2002] was the need for techniques that can cope with individual differences when designing robots for elderly users. Those techniques should exhibit a great range of skills as a result of age-related decline, for example, to adjust to varying walking speeds, voice levels and auditory acuity. A movie of PEARL in action can be found at [NursebotMovie].

2.2 Robocare

The aim of the RoboCare project [RoboCare] (2002-2006) was to explore the added value of an "embodied" companion in an intelligent home. The project was aimed at assisting people *with cognitive impairment* by providing cognitive support to the assisted person. Further, the robot is seen as the main communication channel between the users and the intelligent domestic environment. This project is mainly focussed on detecting patterns of activity of the elderly, providing suggestions, reminding and detecting unusual circumstances that might indicate an emergency. The robot provides an “on-demand” real-time “Question & Answer” service that takes into account the contextual knowledge of the assisted person, for example, “at what time should I take my pill”. The robot also behaves “proactively”, in which the intelligent environment commences interaction guided by its internal reasoning: e.g. approach the assisted person; issue an alarm, issue a warning and suggestions. The “proactive services” provided by the robot are: (1) suggestions and reminders to the elderly and (2) preserve the safeness of the elderly. For example, when a person is lying on the floor in an unusual circumstance, the robot can ask if all is well, and if necessary sound an alarm.

The main interaction modality used in the Robocare project is verbal communication, via an on-screen avatar, as shown in Figure 3. Though also a PDA is used to give commands to the robot, for example, to send the robot to a specific location, relay streaming video from the robot to the DPA and/or stop the robot.

User tests performed by the Robocare project indicated that the safety-related functionality was considered most important by the elderly. Further, the elderly also preferred a version of the robot without an avatar face. The tests also showed that the elderly developed a psychological attachment to the robot. Another result was that elderly with a weaker health condition, showed more negative evaluations of the robot, though they did recognize the practical advantages of having such a device at home. The reason is probably due to the fact that potential problems with the robot, e.g. the robot should crash an object, would have a larger detrimental effect on their life than on the life of an elderly which has less health problems.

More information on the Robocare project and its results can be found at [RobocarePapers] and [RobocareMov].

Figure 3 the RoboCare Robot

2.3 Wakamaru

The Wakamaru robot [Wakamaru] from Mitsubishi has been designed to provide companionship to elderly and disabled people. It provides the following functionality; communication to family members using speech and facial recognition (it is claimed to recognize up to 10 family members and 10,000 words), record information about daily household patterns such as children's athletic activities or school schedules. Wakamaru

© Florence Public

contains an integrated cell phone that is programmed to call emergency dispatchers automatically if a problem occurs with a patient. An embedded Web camera lets doctors and family members keep an eye on the patient. Wakamaru looks for the elderly, if no contact (conversation or touch) is made for a certain period of time. Also if there is a wide difference between the daily life schedule and the schedule he has memorized. Wakamaru can also be tele-operated via the internet to check on the home.

Mitsubishi began selling 100 units of Wakamaru in September 2005 for $14.300 in Japan. Though Mitsubishi has sold a number of these robots, Mitsubishi found out that the technology was not matured enough for the intended functionality and has stopped selling the robot for domestic uses.

Figure 4 the Wakamaru Robot by Mitsubishi

2.4 The u-bot

The u-bot [ubot] was developed to study robots that provide assistance to people at home by the University of Massachusetts between 2005 and 2009. The research on the u-bot focused on the aspect of being able to physically manipulate the environment and in this way helping the elderly (see Figure 5). The u-bot provided the following services:

- *Tele-presence:* Concerned family members can access the unit and visit their elderly parents from any Internet connection, including navigating around the home and looking for the user, who may not hear the ringing phone or may be in need of assistance. Doctors can perform virtual house calls, reducing the need for travel. The arms can be used to perform measurements on the elderly.
- *Emergency handling:* Using an array of sensors u-bot was aimed to recognize human activities, such as walking or sitting. It can also recognize an abnormal visual event, such as a fall, and notify a remote medical caregiver. The remote service provider may ask the client to speak, smile or raise both arms, movements that the robot can demonstrate. If the person is unresponsive, the robot can call 911, alert family and apply a digital stethoscope to a patient, conveying information to an emergency medical technician who is en route
- *Reminding:* remind people to take their medication.
- *Safety:* remove objects and obstacles form highly trafficked parts of the home. However the difficulty is to determine what is an obstacle.

Figure 5 the u-bot robot developed by MIT

© Florence Public

A number of focus groups have been conducted with the u-bot [Deegan2007]. This research showed that the elder focus group participants were very enthusiastic about the use of video technology (e.g. the videophone), as they anticipate future impairment that overrides their own personal concerns about privacy. Preliminary conversations with focus group attendees in informal/open Q&A sessions included enthusiastic support for active agents in the form of small robots that could be deployed in the home. From these conversations, it appears important to expand services beyond the *detect-and-alert* model, to include “effectors” that perform work in the environment and that can interact with the user in a physical way. For example, a mobile manipulator that can take preemptive action to reduce the probability that the user will trip and fall by cleaning up clutter was viewed as an attractive option.

2.5 The CareBot

The CareBot is aimed at helping elderly people to stay longer independent in their home. The services provided by the CareBot are:

- *Tele-presence:* using an on-board web-cam and monitor.
- *Automatic Reminders:* to remind the elderly to take medication or a family visit. The CareBot can keep track of a user's schedule and remind him/her (e.g. grandmother) to feed the cat
- *Companionship:* the CareBot talks to the elderly using AI conversational interaction system. This conversational interaction system can be programmed to be aware of local idioms, local colloquialisms, pet names for family members and answer questions. Grandma may ask on a daily basis like, "What time is my Bingo game?" or "What's my daughter's telephone number?"
- *Automatic Emergency Notification:* The CareBot notifies designated care providers when a potentially harmful event has occurred, such as fall, fire in the home, or simply “been not found by the CareBot for too long”. It responds to calls for help and notifies care providers when any predetermined adverse event occurs.
- *Customization:* The personality of the CareBot can be personalized. The voice’s cadence can be fast or slow. The intonation can be breathy, or abrupt. The response phrases from the CareBot for recognized words and phrases can be colloquial. CareBots also supports multiple personalities.

More information about the CareBot can be found at [GeckoLinks] and [GeckoMovies]. The CareBot from GeckoSystems [GeckoSystems] will be one of the first robots for elderly to be commercially available. The market introduction is planned for the end of 2010. Over the past 10 years, GeckoSystems has spent $6 million for developing its CareBots. Currently, the CareBot is taking part in user field trials and is expected to be available at the end of 2010 for $15.000.

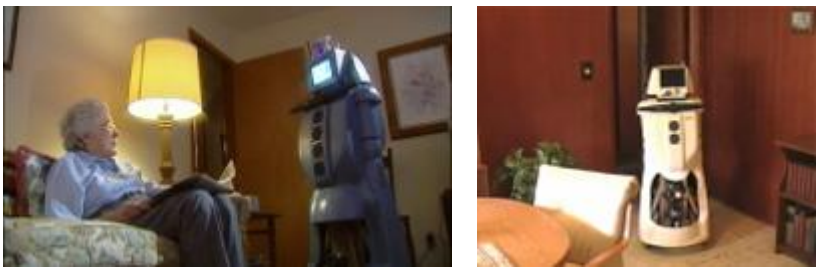

Figure 6 The CareBot robot from GeckoSystems

2.6 Kompaï

In March 2010, Robosoft [Robosoft] announced the Kompaï robot, which is designed to assist dependent persons at home. The Kompaï robot is intended as a development platform for 3rd party developers who would like to implement their own robotic applications for assistance. An

© Florence Public

example is the MobiServ [MobiServ] project that has selected the Kompaï as their robotic platform. Kompaï is a companion-style robot that can speak, understand verbal commands, navigate a home that can remember appointments and make shopping lists. It is able to understand simple orders and give a certain level of response. It knows its position within the house, how to get from one point to another on demand or on its own initiative, and it remains permanently connected to the internet and all its associated services. Its primary means of communication with people is speech, with an additional touch screen that features simple icons. A more detailed specification of the Kompaï robot can be found in [KompaiSpec].

Figure 7 The Kompaï Robot

2.7 Charlie, the Healthbot

Charlie, the "Healthbot", manufactured by the Yujin Robot Company [Yujin] of South Korea is the robotic platform used by the robotics department at the University of Auckland and a South Korean Electronics and Telecommunications Research Institute, to produce robots to care for the elderly. The Healthbot addresses the following concerns [Costley2010]:

- Monitoring vital signs (pulse, blood pressure),
- Locating residents who tend to wander,
- Reminders for medication and
- Detecting falls.
- Mental stimulation: the robot can encourage the elderly to play games, and help them to phone relatives.

Initially, the robot interaction will be based only on a touch screen, see Figure 8, but it is intended to be eventually voice activated.

Figure 8 Charlie, the Health bot

2.8 CompanionAble

The FP7 funded CompanionAble project [Companionable] aims to provide a care environment that supports carers, both family members and therapists, in their daily tasks, by using a strong

© Florence Public

integration intelligent home and the robot. The CompanionAble project aims to provide the following services:

- Intelligent day-time-management.
- Content generation for cognitive stimulation and training.
- Reminder function for medication taking and analysis of acquired data regarding the health status of the care recipient.
- Efficient and natural social communication and care networking by means of audio-visual communication with relatives or care-givers.
- Mobile Person Tracking & Monitoring
- Interactive Communication via Videophone
- Training Delivery
- Alarms Verification

Figure 9 shows the SCITOS A5 robots as used by the companionAble project.

Figure 9 The SCITOS A5 robot used by the CompanionAble project

2.9 Care-O-bot

The Care-O-bot project [Care-O-bot] is a long running project (since 1998) with the goal “to create a robot that enables people that are in need of support and care to live independently and supported in their private homes for a longer time”. The first instantiation of the Care-O-bot, the Care-O-bot I, was a mobile platform with a touch screen, see Figure 10. Its successor, the Care-O-bot II, is additionally equipped with adjustable walking supporters and a manipulator arm. It has the ability to navigate autonomously in indoor environments and execute manipulation tasks. In “direct mode”, the user can move along freely with the robot whereas obstacles are detected and avoided. In “planned mode”, he can specify a target and be lead there by the robotic assistant. The user input (graphical and speech input) is transferred to the task planner and adequate actions to solve the task (sequence of motion and manipulation commands) are created. The walking aid has been tested with elderly users from an assisted living facility and a nursery home.

The latest instantiation of the care-O-bot is the “care-O-bot 3”. The newly designed care-o-bot is deliberately not designed as a humanoid. It can be voice controlled and also recognise and respond to gestures.

© Florence Public


Figure 10 the Care-O-bot II (left) and the Care-O-bot 3 (right)

2.10 Conclusions

Most robots targeted at assisting people in the home are targeted specifically at elderly with the goal of keeping them longer independent. Services offered by these robots included (more or less ordered in order of occurrence): remote video chat and tele-presence, coaching, cognitive assistance: medication reminders and safety.

Though there is a great commonality concerning the intended functionality, only a few robot projects that are targeted at elderly already look at physically manipulating objects in the environment (e.g. care-O-bot 3 and u-bot). This is probably due to that reliable manipulation by robots in uncontrolled environments is still in its infancy such that this technology is still developed independent of a particular service domain.

With respect to human-robot interaction, the robots for elderly can be categorized into two main categories. In one category the robot is aimed to mimic a human personality, in the sense that the robot has been given a human-like head. In particular this seems to have been the trend with the early robotic projects for elderly (1995-2005). Lately, a number of projects concluded that a human-like head raises too high expectations, and they present the robots more as a device, though the robot can still have a personality. In this case, the interaction with the elderly is typically done through a touch-screen and also voice-recognition. Independent of whether a human-like head is used or not, most robots use interaction modalities such as speech in combination with a touch screen.

Most robots for elderly are still in their research phase. One exception is the CareBot from GeckoSystems that is announced to be commercially available in 2010. This is also reflected in that most robotic projects for elderly are still developed by universities or in subsidy research projects. Note that for robots for elderly developed by private companies, it is often difficult to distinguish between “accomplished” and planned functionality.

© Florence Public

3 Robots targeted at one of the Florence service domains

In the previous section, we discussed robots and robotic projects that were aimed at assisting elderly and increasing their independence. In this section, we discuss robots that provide a service in one of the service domains targeted by Florence, i.e. safety, social connectedness, coaching and collaboration. Note that these robots don't need to be targeted at elderly. Similar to the previous section, we discuss these robots from the aspects of which functionality they provide, the human robot interaction, the business model aspects and results from user tests, if available.

3.1 Robots for safety

There are different kinds of robots to target the safety and security domain. Robots support humans in various fields of safety and security. This section mainly deals with such services covering the civilian personal (home) security so other aspects like military (which is also a very large field of activities) are not considered. Since there are few robots targeted especially at safety/security at home, also security robots for public buildings are mentioned.

This section can be clustered into two subsections: robots helping in emergency cases and robots preventing emergency cases.

3.1.1 Guardians Project

The Guardians Project [Guardians] belongs to the first category. The Guardians are a swarm of autonomous robots applied to navigate and search an urban ground. The project's central example is search and rescue in an industrial warehouse in smoke, as proposed by the Fire and Rescue Service of South Yorkshire. The job is time consuming and dangerous; toxics may be released and humans senses can be severely impaired. They get disoriented and may get lost. The robots warn for toxic chemicals, provide and maintain mobile communication links, infer localisation information and assist in searching. These tasks are not limited to industrial warehouses but could also be used in home environments. However, home environments may be more challenging because they are more cluttered than industrial buildings with large floors and few stairs.

The robots navigate autonomously and accompany a human squad-leader. They connect to a wireless ad-hoc network and forward data to the squad-leader as well as the control station. The network is self-organising, adapting to connection failures by modifying its connections from local up to central connections. The autonomous swarm operates in communicative and non-communicative mode. In communicative mode automatic service discovery is applied: the robots find peers to help them.

The wireless network also enables the robots to support a human squad-leader operating within close range. The aim is for flexible and seamless switching between these modes in order to compensate for loss of network signals and to support and safeguard the squad-leader. Several robot platforms are used, off-the-shelf mini-robots as well as middle sized robots. The emphasis in data collection is on toxic plume detection, to enable olfactory-based navigation, allow safe progress for the human squad-leader and to detect plume sources.

The major aim of the project is to develop a swarm of autonomous robots that is able to adequately assist and safeguard a human squad leader. The project organises workshops with end-users (rescue workers and fire-fighters) and the advisory board, to assess the demonstrations and to disseminate research results. The workshops, moreover, aim at exploring additional exploitation of results.

© Florence Public

Figure 11: Guardians Project Robot

3.1.2 Monitoring of Objects

The following systems are commercial systems for surveillance purposes. These systems are used to monitor specific places like homes, buildings or warehouses. Most of the systems work autonomously nearly all of the time. They patrol the area and look for abnormal changes. If they detect suspicious actions they will start an alarm and notify the user.

MOSRO by Robowatch [Mosro] is a surveillance robot. It is used to monitor certain areas (like production sites, public places and so on). It has a radar sensor, infrared sensors and a CCD camera. It can be used as a watchdog, patrolling a defined area. It can be upgraded with different modules such as GSM radio to be able to send text messages to mobile phones. The robot can also be remotely controlled.

Figure 12 - The MOSRO robot Error! Bookmark not defined.

Although the security system at office buildings are almost mechanized, when emergent things happen, it is not enough mechanized to check the emergent site quickly and to react for the first measure. Security robots allow reacting to the emergency quickly and appropriately. Furthermore security robots act as a substitute of guards and saves human guards. Additionally fixed mechanical sensors sometimes produce false alarms and monitoring where emergent things happen by a security robot would be more efficient for the security centre work.

So the basic developing plan was to introduce a self-moving robot into security systems and to develop a security robot with cheaper initial introducing costs.

Especially, Tmsuk has focused on easy installation into security systems without LAN where the robot works by itself. The prototype of T-32 [T32] is controlled by a cellular phone.

© Florence Public

Figure 13 - The T-32 prototype

The **Roborior** [Roborior] is a stylish virtual guard dog that can also be used for keeping in touch/check elderly people. The Roborior looks like a jellyfish, created by Tmsuk. Co and Sonyo Electric. The robot runs on batteries and has wheels to move it around the house. For surveillance it has a digital camera, infrared sensors and videophone capability – to notify its owner or intruders while the owners are away.

Roborior can be controlled with a handset or via mobile phone and can connect with its owner's mobile phone to relay streaming video taken on the robot's digital camera.

The robot is also compatible with third-generation videophones from Japan's top mobile carrier NTT DoCoMo and connects to the TV so you can watch the caller's face on a larger monitor. It hums its own electronic music to signal incoming calls and responds to remote-control commands.

Unlike most virtual guard dog robots Roborior doesn't have a pet-like personality, instead it is a fashionable colour changing floor light designed to be functional and ascetically pleasing.

Figure 14 The Roborior robot

The Roborior system already shows that most of the so called home safety robots are more or less tele-presence robots. More of this kind of robots are also shown in section "Robots for social connectedness". The function of home surveillance can be perfomed by most mobile robotic systems because they have video cameras, motion detection and internet connection. These features are needed for recognize an emergency situation and inform the user.

3.1.3 Conclusions Robots Targeted for Safety

The examples of this subsection show some fields of security where robots are used. Robots can go to places where humans cannot go, see things humans cannot see and react faster than a human can react. The sensors can detect environmental changes long before humans can detect them (if at all, e.g. inodorous gases). So they are designed to help humans where they can't act any more. This enables a better level of safety because it expands the usual tools. In case of elderly people robots can help to compensate lowering of wits. People who have problems with hearing are already totally familiar with hearing aids. So the use of robots to detect environmental changes (heat, fire, smoke, gas) is just the next step. Robots are able to do these tasks and general surveillance tasks without the need to sleep. So people can rely on 24/7-safety provided by the robot. There are still some problems to overcome because robot

© Florence Public

technology has still some problems to deal with (e.g. climbing stairs) but in the future they will become even more helpful. Since most of the safety/security robot systems are still targeted to the industrial domain, this would be a good field for Florence to improve in the home environment. The Florence robot can be used to detect dangerous situations in the home, cause by accidents like fire but also caused by apparently harmless things like obstacles. In combination with the home automation, Florence can be used as burglar detection system, recognize situations like fire or smoke and warn the user. If the user can't react accordingly the robot can contact other help sources like caregivers or relatives.

3.2 Robots for Social Connectedness

In this section, we provide an overview of robots whose main function is that aim to improve communication and social interaction between people. This includes robots that provide an interface to web 2.0 services.

3.2.1 Giraffe Robot

The Giraffe robot of Giraffe Technologies [Giraffe] aims to allow people to virtually visit their family across the Internet and move around their home. It has a camera, display, a speaker and microphone mounted on a base with motorized wheels. A distinguishing aspect of the Giraffe tele-presence robot is that the camera and screen form a "pan-tilt unit" which enables a greater and controllable field of view and the height of the unit is easily adjustable. Giraffe Technologies claims to have developed a patent-pending way of remotely navigating the robot. The company has announced that the robots are will be commercially available 2010. More technical details can be found at [GiraffeTechnical] and the system can be seen in action at [GiraffefMovies].

Figure 15 The Giraffe tele-presence robot

The Giraffe robot is also used in the FP7 ExCITE project [ExCITE] to evaluate user requirements of social interaction that enables embodiment through robotic tele presence. This evaluation is performed in different places in Europe and with a longitudinal perspective. An existing prototype is deployed to the targeted end users, and is refined by tightly involving the users in the development cycles of the prototype throughout the project.

3.2.2 Texas robot

The Texas robot [TexasRobot] is a tele-presence robot under development at Willow Garage [WillowGarage] since 2009. The aim of the project is to understand the technical and social interaction challenges and benefits of robotic tele-presence. The Texas robot is currently aimed at tele-work. It has features such as autonomous docking and sound separation to focus on a single person speaking in noisy environments. Willow Garage has announced that the Texas robot will be commercially available at the end of 2010 at a price point between $7.000 and $15.000. A movie demonstrating the Texas robot can be found at [TexasMovie].

© Florence Public

Figure 16 The Texas tele-presence robot

3.2.3 The QA and QB tele-presence robots

The QB from [Anybots] is a tele-presence robot aimed at tele-work. Remote users can drive the robot around using a browser plug-in. The QB robot can move forward at 3.5mph and is stated to operate a maximum of 8 hours per charge. It's also light (35 lbs) so it can be picked up and moved if the need arises. It is notable that the QB only has a small display to who the remote user. Anybots claims that a small display is sufficient to convey the presence of the remote user to the local user. The QB is the successor the QA research prototype. The QA robot has a laser pointer such that the remote controller can also point to something. It is supposed to correspond directly to where you click on the PC screen and the system stabilizes the laser spot when the robot moves. Anybots has announced that it will bring the QB tele-presence robot onto the market in the fall of 2010 for an expected price of $15,000 USD.

Figure 17 The QA (left) and QB (right) tele-presence robots

3.2.4 VGO

Another tele-presence robot targeted at tele-work is the VGO robot developed by VGO Communications Inc. [VGO]. The robot can be remotely controlled and sensors prevent the robot from bumping into obstacles. The VGO robot also provides automatic docking.

The VGO robot is scheduled for market introduction at the end of 2010 and will be available for an estimated price of $5000 and an annual service contract of $1200.

© Florence Public

Figure 18 The VGO tele-presence robot

3.2.5 The RP-7 Robot

The RP-7 is a telemedicine robot that allows specialist medical professionals to visit remotely hospital patients. The robot's head is a screen which has a video image of the doctor's face as (s)he checks out the patient Additional features on the RP-7 Robot includes autonomously docking and enhanced audio capabilities, which allow the user to focus in on a specific conversation. According to InTouch Health [InTouch], the RP-7 is the first and only FDA-cleared tele-presence robot, which allows direct connection to Class II medical devices. Devices such as electronic stethoscopes, otoscopes and ultrasound can be connected to the Expansion Bay of the Robot, to transmit medical data to the remote physician. The RP-7 Robot uses a patented omni-directional drive system, rolling on three spherical balls rather than wheels, to achieve easier and higher manoeuvrability.

There are currently over 250 systems used globally, most of which are in the United States including UCLA's medical centre and North Shore-Long Island hospital in New York. Hospitals can either buy the RP-7 for around $150.000 or lease the RP-7 remote presence robots for a monthly fee of $6,000.

A large number of movies showing the RP-7 in action are available [RP7Movies].

Figure 19 The RP-7 tele-presence robot used in a hospital

3.2.6 The MeBot

The MeBot [MeBot] from MIT (Massachusetts Institute of Technology) is a semi-autonomous desktop robotic avatar that gives a person a richer way to interact remotely with an audience than is allowed with phone and video conferencing. The robot was designed with an emphasis on being able to convey the non-verbal channels of social communication. It is able to communicate body posture, a wide range of head movement and expressive hand gestures. A movie of the MeBot in action can be found at [MeBotMovie].

© Florence Public

Figure 20 The MeBot

3.2.7 Pingo

Pingo [Pingo], available since 2009, is an interactive electronic playmate that can move around your desk, express moods, respond to voice commands, sing songs, and read aloud e-mail messages, headlines, stock quotes, and weather.

The device connects to its owner's Facebook account via a Facebook application called MyDeskFriend. With this application, the user can give Pingo a new name and customize its personality. After that it can be programmed to read RSS newsfeeds or follow your voice command to send pokes, messages, or Facebook gifts, and so on. It can also follow your fingers around on a desk and is smart enough not to fall off. It has two proximity sensors on the front, three ground sensors on the bottom, and two powered wheels. It also has built-in speakers, a microphone, and eyes that can change colours. The Pingo was introduced in 2009 and costs around $150.

Figure 21 Pingo

3.2.8 Nabaztag

The Nabaztag bunny aims to bridge the virtual world and the real world and to present virtual information in a more tangible way. The Nabaztag can send and receive MP3s and messages that are read out loud as well as perform the following services (by either speaking the information out loud or using indicative lights): weather forecast, stock market report, news headlines, alarm clock, e-mail alerts, RSS-Feeds, MP3-Streams and others. The Nabaztag has a build-in microphone that enables services to be voice activated. The Nabaztag can also read RFID tags, for example to identify and read out books. The Nabaztag is for sale since 2006 and costs around $150.

© Florence Public

Figure 22 The Nabaztag

3.2.9 Conclusions Robots for Social Connectedness

Robots that offer social connectedness related services can be subdivided in two categories:

- *Tele-presence robots:* Robots that provide or at least claim to provide a better tele-video conferencing solution: These are the Giraffe robot, the Texas robot, the QA and QB robots the VGO robot and RP-7. Most of these tele-presence robots are aimed at tele-work. Only the Giraffe robot currently explicitly targets communication between children and their elderly family members. Telemedicine based on tele-presence robots also seems to have great potential as demonstrated by the RP-7 of InTouch Health. The RP-7 is already on the market for a number of years. The other four tele-presence robots discussed in this overview are scheduled to be commercially released at the end of 2010. Note that tele-presence robot can also play an important role in emergence situational handling. If an emergency alarm has been raised, the tele-presence robot can be used by remote care providers to assess the severity of the situation and potentially provide help immediately.
- *"Web 2.0 related robots":* Robots that provide a user friendly or stylish interface to web 2.0 type of services: these robots are also referred to as "ambient consumer electronics". They are not focused on social connectedness, but information from your social network is one part of the information stream these devices provide. Current devices are mainly targeted towards a younger, gadget-loving public. Note that these robots can be considered as lifestyle devices.

3.3 Robots for Coaching

3.3.1 Mamoru

Mamoru [Mamoru] aims to help forgetful elderly find their misplaced pills at medicine time, or simply point out lost slippers. Mamoru has been developed by Tokyo University's IRT Research group. Its main purpose is to be an extra pair of eyes and ears around the house. Its main innovation is its vision system, which can detect objects regardless of rotation, scale, or lighting condition using SIFT (Scale Invariant Feature Transform).

To recognize objects, Mamoru uses a wide-angle camera to keep track of the room, and image recognition software to tell what each object is. Mamoru's eyes have motion detection and pattern matching, such as face and gesture recognition. He also has a 16-channel microphone for listening to your nervous murmurs of where the hell did I leave that damned remote? and can respond cheerfully with a speaker port.

To help with dwindling memory, Mamoru has a database which stores the location of objects within a three-dimensional virtual model of your living space. If, for example, you put away your medication in the second from the top drawer of your cupboard, the robot will watch you doing this and store that information in its own memory banks, so you don't have to.

© Florence Public

Figure 23 The Mamoru

The robot is 40cm tall and weighs 3.8kg. It has only 4 degrees of freedom, neck x2, 2 arms x1, which allows its head to look around, and flap its simple, penguin-like limbs.

3.3.2 Taizo

The Taizo [Taizo] robot, developed by the Japanese National Institute of Advanced Industrial Science and Technology (AIST) is aimed at leading groups of seniors in performing preventative care and rehabilitation exercises. The 70-centimeter tall robot has a friendly appearance designed to motivate elderly people to engage in more physical exercise.

With 26 joints in its body, the 7-kilogram mechanical exercise instructor can demonstrate around 30 different moves for others to imitate. Although Taizo does most of its exercises while sitting in a special chair, it can also stand up to perform some activities. One can see Taizo in action at [TaizoMovie].

AIST has announced plans to sell the Taizo on the market in 2010 for around €6000.

Figure 24 The Taizo performing an exercise

3.3.3 Bandit

The Bandit [Bandit] robot is a robotic personal trainer developed at USC's Viterbi School of Engineering. It was created to examine the influence of virtual social characters on people's motivation to exercise. One group of subjects will work directly with the robot, while another group will work with video of robots. This is a 1-2 year project started at the end of 2009.

Bandit will model the exercises. Bandit is also able to watch users' movements and then mimic them. This is meant to encourage user to put greater effort into training. One can see Bandit in action at [BanditMovie]

© Florence Public

Figure 25 The Bandit Robot

3.3.4 Autom

Autom [Autom] is a weight loss coach, designed to motivate dieters to stick with their diet. Autom has been developed at the Massachusetts Institute of Technology (MIT) and is planned for commercial exploitation in December 2010 by Intuitive Automata. The price of one Autom robot should be between $400 and $500, plus a monthly fee for the service.

Users touch a screen on the robot's torso to choose their weight-loss goals. The robot talks the user through personalized tips based on their current food and exercise routine. The idea is that people who consciously keep track of their food consumption and exercise pattern while dieting have more success. The Autom should assist in keeping track of food and exercise and also encourage the user on a daily basis. One can see Autom in action at [AutomMovie].

Figure 26 Autom Robot old and new design

3.3.5 Conclusions (robots for coaching)

Robots targeted at coaching cover coaching on several topics: finding and remembering, doing exercises and losing weight. Kidd and Breazeal [Kidd2005] claim that for coaching or behavior change, sociable robots offer advantages over on-screen agents or embedded technology. As part of the Florence system, serving as the interface with sensors and actuators in a house, the Florence robot would be able to create a relationship with the user that enables it to address health care goals or behavior changes. Using robots for exercise coaching seems to be an effective way to remember sequences of exercises even for groups with special needs such as Alzheimer's disease patients [Mead2009].

3.4 Robotic Services targeted at Collaboration

3.4.1 A definition of collaborative services

First of all it is important to well understand the meaning we give to collaborative services:

© Florence Public

"Collaboration is a recursive process where two or more people work together in an intersection of common goals […]. Most of the collaboration requires leadership, although the form of leadership can be social within a decentralized and egalitarian group"[1]

A key point of this definition relies onto the involvement of at least two people who share a common goal. In the context of the Florence project, and more especially within the design, implementation and assessment of collaborative services, our objective is to study how we can, through appropriate interaction tools, maximize this perception of a human-human shared action, considering the robotic system as a medium to perform the considered activity (see Figure 27).

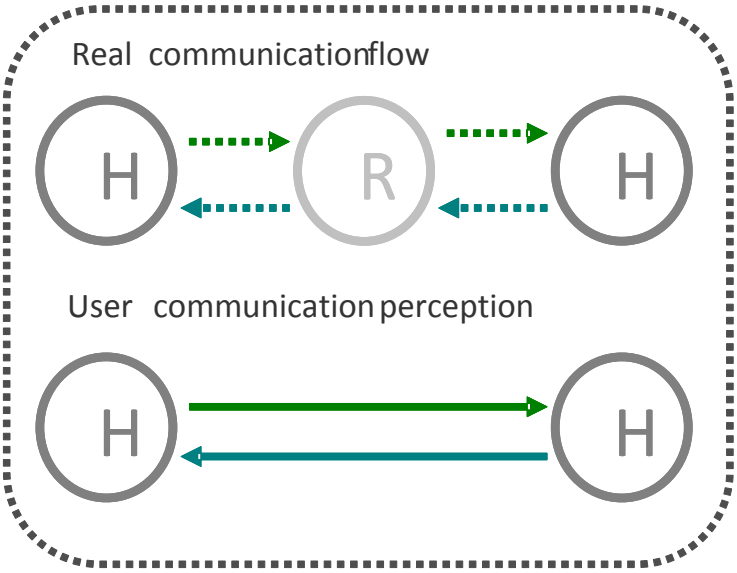

Figure 27: Collaborative services. Even if the robot R is an intermediary medium for the given activity, the objective is to make the person focus onto the interaction with his human partner H so that the robot can be "forgotten" by the user.

3.4.2 Robotic systems providing collaborative services to the person

The most straightforward illustration of a Human-Human Collaboration (HHCo) that is already provided in some robotic systems is the robot-based video conferencing, also called robotic tele-presence systems. Even if these systems are already described within Section 3.2, here we describe another point of view onto the same systems.

Communication is one of the most basic acts of human collaboration happening. In a tele-presence context, the robot provides an intelligent and movable video medium, enabling to establish a remote discussion in between two persons. Most of the projects previously introduced provide this type of collaboration. They are:

- **Companionable** (see Section 2.8),
- **CareBot** (see Section 2.5),
- **Kompaï** (see Section 2.6) and
- **Texas robot** (see Section 3.2.2).

HeadThere (see Sectin 3.2.1) and **InTouch Health** (see Section 3.2.5) are two examples of companies worldly known for their mobile tele-presence systems. The latter is focused onto a use within medical centres, in which the videoconferencing tool and remote control enables specialists to perform remote sessions with their patients. The **Giraffe system** from HeadThere addresses a broader community, and extends the use from the professional area to the

[1] Definition from Wikipedia: http://en.wikipedia.org/wiki/Collaborative

© Florence Public

personal or social one, mentioning possible applications for *tele-visitation*, babysitter supervision and eldercare contacts.

Note that such product cannot be considered as “Skype on wheel”. Indeed, these systems provide a whole architecture and support for making the use as transparent as possible as well. Furthermore, the moving capability enables not only to bring the discussion where the interlocutor needs, but also to give a higher perception of the other interlocutor.

As previously mentioned, the acceptability of such systems relies on the transparent collaboration in between the two humans. The objective of the FP7 **SRS project** [SRS] is precisely to investigate the role of “*Shadow of Robotic System*”, through the study of (among others) intent-based remote control mechanisms, and adaptive autonomic mechanisms to complete higher-level interactions.

The description of the state of the art in robotic systems has presented the different services provided or studied by these robots. Surprisingly, one can note that the services using videoconferencing (for communication, learning or assistance) are the only one implementing a HHCo framework. In almost all the other services provided, the collaboration established is in between the human and the robot, and not between a human and a human *through* the robot. Different domains are addressed by these services. Leisure, or gaming, is one of them. In **CompanionAble**, the person is invited to play to different games realized to stimulate the human cognitive capabilities. The **Robocare** system proposes to the person to play chess. Different studies with the **iCat** have shown that the person got used to play with it, and got attached to it [Breemen2005]. Other studies have demonstrated the importance of the physical system itself, comparing to an avatar onto a pc screen [Pereira2008].

Another example of robotic services involving a human-robot interaction is the teaching and learning. The teaching of physical exercises is illustrated by the **Taizo system** (see Section 3.3.2) that demonstrates different motion the person has to replicate. Nevertheless, this system does not give (so far) any feedback onto the person action, since no monitoring is implemented. **Bandit** is another system demonstrating the interest of using a physical system to involve more the person into the physical exercises (see 3.3.3). Studies have also shown that socially assistive robotics can have a positive impact during a physical rehabilitation procedure. Indeed, such robots have shown a positive acceptance, and contributed to willingness of people to perform the prescribed exercise (significantly more than with just an avatar onto a screen) [Mataric2007].

3.4.3 Conclusion

The notion of collaboration requires at least the joint work of two entities in order to reach a common goal. This concept, or characteristics is clearly present in various activities or services provided by robotic systems; some of them have been cited here, but we can also notice this kind of collaboration in all the different types of services we consider in Florence, *ie* safety, social connectedness and coaching. Nevertheless, real human-human collaboration is only covered within the social connectedness area, with the tele-presence systems. In these systems indeed, the robot is considered as a medium to get a person present within a remote place. In this sense, these systems perfectly apply to the definition of collaborative services we presented on Figure 24. It is interesting to notice that, so far, the human-human collaborative services through a robot have not been envisioned for other applications than social connectedness. This is one of our objectives to study how the design of activities centred onto collaboration between humans could not only provide useful services but also improve the acceptance of the robot itself as a medium of collaboration.

© Florence Public

4 Services in the Florence service domains

In the previous sections, we have provided an overview of robotic services that are relevant for Florence. In this section, we provide an overview is provided of non-robotic products and services that are relevant for Florence. This includes telecare services for elderly and products and services in the four key areas of Florence: safety, social connectedness, coaching services and collaboration.

4.1 Products and Services for Safety

Safety is a major concern of people's well-being. Only when feeling safe people are able to develop their own way of life. So the market for safety products is very big. This starts with simple devices of self-defence (like pepper spray) and goes to complete house surveillance and observation systems.

In this case we concentrate on safety services for elderly. This includes special services which take care of the special needs of elderly. The most important factor is the decreasing sensitivity of people's wits. Elderly can't see and hear as well as before and are also getting slower in movement (decreasing mobility). Different services are established for this target group. The elderly and their relatives are able to get information and contact data at these sites. Some of them are mentioned here.

4.1.1 General Services

Different countries have set up homepages with information for elderly persons and their relatives. On these pages, help and advice is offered for elderly people. Age UK [AgeUK] is the UK's largest charity working with and for older people. They created a website about aging topics, help and advice for elderly. Information is categorized in sections like "Money matters", "Health and wellbeing" or "Travel and lifestyle". Concerning the services targeted at safety they created the topic "Home and care" which gives advice in a lot of aspects of safety security and related topics.

The same goes for **At Home Solutions**[2], which cares about "enhancing the lives of seniors". They provide individualized safety assessments, medication reminders and some additional services to supply and support elderly people.

There are some websites caring about safety for elderly, like **elderlysafety.com**[3] which provide basic articles about safety issues, where elderly or their relatives can get tips about different safety aspects. The International Association of Certified Home Inspectors (InterNACHI) provides checklists[4] to find safety risks at home.

4.1.2 Medical Alarm Sensors

Medical alarm sensors include motion alarm sensors, alarm pads, alarm belts, bed sensor alarms, fall protection mats. This list is by far not exhausted. The market of alarm sensors and medical alarm sensors is very broad and the boundaries often overlap. Some of them are mentioned in more detail in the next paragraphs.

4.1.3 Fall detection

Increased age leads to decreased mobility in most cases. This results in a higher risk of falls. Falls are a dangerous as people often can't get up any more and need immediate help. So there are systems in development which try to solve the decreased mobility on the one hand and try to react to falls appropriately (call emergency etc.). One of these projects is **SensAction-AAL** [SensAction] which is a EU FP6 funded project. "The goal of the

[2] http://www.athomesolutionsllc.com/index.html
[3] http://elderlysafety.com
[4] http://www.nachi.org/elderlysafety.htm

© Florence Public

SENSACTION-AAL project is to assist older people in maintaining independent mobility and daily life activities and prevent injuries by introducing smart body fixed sensor-based technology that allows medical professionals to initiate interventions in the home environment." The project develops a "smart wearable system", that is capable of measuring different types of data (e.g. acceleration) for mobility analysis. Based on these data falls shall be detected and reacted. This is an example for technical fall detection, but there are also products to prevent the elderly from falling. This begins with the already well known "Rollator" which is a walking assistance (walking frame), the "**Giddy-Up Stick**" [GiddyUpStick] which helps elderly getting up from a chair to "**Sure-Step Cushioned Bath Mats"** [SureStep] that prevent from slippery flagging in the bathroom and cushion the impact of the fall. Another fall detection system is mentioned at the end of this section.

4.1.4 Safety Buttons / Panic Buttons / Medical Alert Systems

The panic button (or unit transmitter) is a small and portable device that can be worn as a neck pendant, a wristband, or belt clip. In the event of an emergency, all that is required is for the person to press the panic button to call for help. The loud sound projected by personal alarms, bring attention to any sort of situation you might encounter.

There are a variety of personal medical alarm systems. They include the button safety GPS cell phone, home personal medical alarm system, telephone emergency personal medical alarm and panic button system.

Figure 28 personal security alarm

Other types of personal medical alarm systems are the panic button and personal medical alarm auto telephone dialler and the mobile emergency medical alarm cell phone. There is also the Guardian medical alarm wireless phone, secure watch *medical alert* system, wander alert and alarm system, home emergency personal medical alarm system and the table top *medical alert* alarm system.

A personal alarm establishes communication directly through the main unit that acts as both a loudspeaker and a microphone. If the injured person is in another room or far from the main unit, all they have to do is speak out loudly in order to be heard [PersonalAlarm].

The **Sergesa Televida service** [Sergesa] is a teleassistance service tailored for elders and provided by a private company in Spain. The service not only covers emergency situations, but also aims to provide safety, peace of mind and social interaction to elders and dependent people.

© Florence Public

Figure 29 Pictures of the Sergesa service, accessible via a pendant and base station

The system is based on a pendant that can be worn by the elders the whole day. Each time the user needs attention pushes a red button in the pendant and is contacted by a call centre. The professional caregiver in the call centre has information about the particular needs and profile of the user, as well as some additional information, in order to provide immediate help or support. Besides, the system in the home of the elders offers:

- A base station with a set of pre-programmable buttons, so he/she can contact relatives and friends in a easier way.
- Integration of home automation systems: movement and falls detection, fire, gas, smoke.

The **Medial Mobile service** is based in a bracelet called 'Columba' [MedMobile] and aims to minimize the impact of the memory loss and disorientation events related to Alzheimer's disease. The Columba bracelet integrates mobile communications, a smart system to raise alerts and GPS-based localisation. The system is offered in Spain in coordination with Telefonica as telco operator and Eulen as social services provider.

The cost of the bracelet is 199€, whilst the monthly fee of the system is 49€.

Figure 30 Columba bracelet

4.1.5 Gas detection

Natural gas is one of the safest forms of energy used today; this is why it is used in households. However it is possible to cause problems through mistakes such as forgetting to light a gas ring or a natural cause like a pilot light blowing out. This becomes a bigger problem where there are confused, elderly, or infirm people who may be less aware of what is going on around them. People with a reduced or absent sense of smell may not be able to smell the odorant in gas and some people may not be able to rely on or use the normally provided gas appliance controls and safety features.

To overcome this problem, gas detectors can be used to reduce the risk of explosions etc. There are simple gas detectors that produce an acoustic signal or more advanced ones that shut the gas supply if a leak is detected. A lot of systems are available at the market.

4.1.6 Burglar detection

Burglar alarm systems are also a very broad field with a complete industry around it. There are various systems available. A lot of organizations suggest installing burglar alarm systems in houses of elderly because they are a target group of victims. Often they don't hear or see well enough and keep money and valuables at home.

© Florence Public

4.1.7 Complete System

An example for a system that includes a lot of the mentioned aspects is the "**Brickhouse Alert Home**" system [BrickHouse]. This system includes an intruder alarm, "no activity alert", call for help button, fall alert, and some more functions.

Figure 31 the alert tele-assist system of BrickHouse

The BrickHouse Alert system consist of two parts: BrickHouse Alert Tele-Assist (a home console), and BrickHouse Alert Mobile GPS (a GPS mobile watch). Combined, these two personal emergency response systems (PERS) give you the best protection available whether in your home or anywhere in the world. The home console with personal pendant works within 2500 feet for total home protection. In case of emergency, connect with a trained professional who can dispatch help, whether it is emergency response workers such as firemen or ambulance, or friends, family, or neighbours.

4.1.8 Conclusion

From the listings above it can be seen that products and services for safety are numerous. Some of these systems are rather new, some have been well-established. These devices can be further extended by robots. With very precise sensors they can detect sources of danger like fire, gases and the like. With their observation capabilities they are able to function as burglar alarm systems with much more intelligence then common devices. The mentioned systems are kind of isolated with no more intelligence than needed for the specific task. The Florence robot will be capable of combining much more information to be able to determine the current situation much more precise. For example if the elderly looses the fall detection sensor and it falls to the ground, the sensor will cause an alert. In contrast to the sensor, the robot can do some video recognition and conclude that the person is still standing and has just lost the sensor.

So the safety services can be improved by combining different modalities of information retrieval to make the decisions even more precise.

4.2 Social Connected Services

The last few years have seen a strong growth of the number of services that target to improve the social connectedness of people. Notable examples are Facebook, Twitter, YouTube. These "social services" can be subdivided into the following categories, each category focusing on different user needs, see also Figure 32:

- "*Sharing content*": this category of services allows people to share pictures, short movies, blogs etc. Well know examples here are Flickr, YouTube, Blogger etc. The main drive here for people to participate seems to be "self-expression"; people have a personal view on all kind of topics or are creative and want to show the results of their creativity to the world.
- *"Sharing experiences"*: People also want to feel real-time connected with their family and close friends. This can be provided by services like presence information, instant messaging, video chat, Picture Apart Together, Gaming Apart Together etc.

© Florence Public

- "*Social networking services*": A third category of services allows people to extend their social network, finding like-minded people and making new friends. Well-known examples here are MySpace and Facebook.

To illustrate the importance of social networking services, note that since beginning of 2010, Facebook gets more page clicks per day than Google.

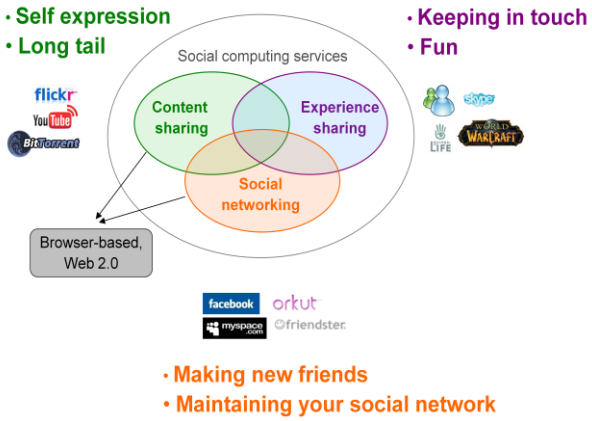

Figure 32 Overview of different types of community-based services and the main consumer needs they address.

4.2.1 Novatouch

The Novatouch [Novatouch] service aims to provide elderly an easy to use interface to a number of functionality traditionally only available through a PC. This functionality includes: video conferencing, e-mail, web browsing, agenda, games and music.

The service cost 139 Euro. This is only for the software for one device (PC, tablet PC etc). There is also a maintenance service that costs 60 euro's per year.

Figure 33 Screenshots of the Novatouch service aimed at elderly

4.2.2 Pal4

PAL4 (Personal Assistant for Living) [PAL4] is a Dutch service platform targeted at elderly. The PAL4 services are accessible through a touch screen, TV and PC. PAL4 is primarily intended to bring elderly and people who need tele-care in contact with the professional care providers and with family and friends via a video call solution. In addition, PAL4 also offers lifestyle services like games, puzzles and information about activities, hobbies, information related to healthy living and diseases. PAL4 is offered as a subscription service for €14.95.

© Florence Public

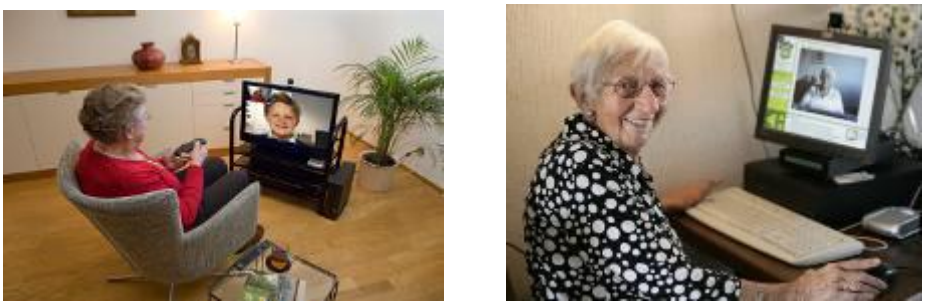

Figure 34 Screenshots of the PAL4 service

4.2.3 VieDome

VieDome [VieDome] is a service platform that is primarily intended to provide video communication based services between elderly and family and friends and professional care providers. The services can be accessed through a PC, a TV (via a set-top box) or a touch screen. Examples of services offered by the VieDome service platform are:

- "Video call with family and friends
- *"Good morning / Good evening service"*: every morning of every evening a professional care provider calls in to check whether everything is all right
- *"Supervised Medication intake"*: some patients need supervised medication intake. The VieDome system allows professional care givers to call in with a video call to check whether the elderly has taken his/her pills.
- *"Front office"*: every day there is one hour service where people can call in to ask for all kind of advise.

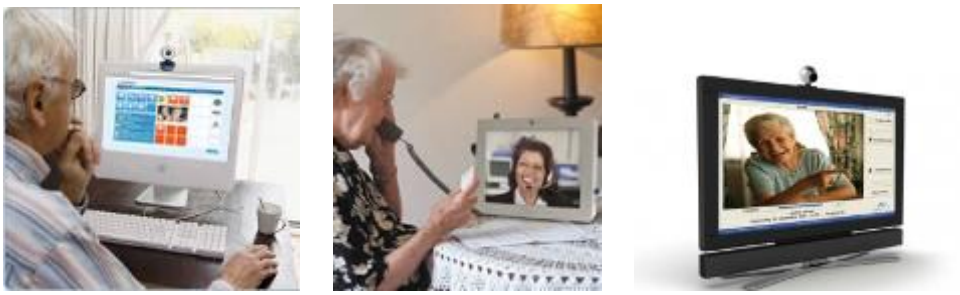

Figure 35 Picture of the VieDome TV service, accessible via a PC, a Touch-Screen or a TV.

4.3 Coaching services

Elderly often have to deal with health and wellbeing related problems like obesity, diabetes, heart and vessel diseases and problems with moving (stiffness, losing balance). For some part, these health and wellbeing issues can be prevented or lessened if people are willing and capable of changing their behavior or lifestyle. As simple as it sounds, for many people it is a real challenge to change their daily habits. Discipline and long term motivation are necessary to effectively change a 'bad habit' or a lifestyle. In coaching on behavior change, or, persuading people to change, computer systems have several advantages over human coaches. B.J. Fogg [Fogg2003] describes these in his book on Persuasive Technology. Computers are determined, they can process large amounts of data, can compare different sets of data, can influence via multiple modalities, can be with people longer and in many places and they provide anonymity.

Therefore, computer systems can be effectively used as coaches for people. This does not mean that a computer system, can completely take over from human coaches. But they can assist throughout daily life in monitoring health aspects and in continuously motivating people to change.

© Florence Public

This section provides an overview of coaching services (often in combination with devices) that are relevant for elderly people. Coaching for elderly is relevant in different domains. We will describe each domain and give examples of existing services within the domain.

4.3.1 Coaching on fitness

Coaching on fitness can be aimed at specific problems that elderly face, such as losing balance, fear to fall, recovery after injury, or at keeping a general level of health by taking regularly exercise.

4.3.1.1 Gaming

One way of encouraging people to exercise regularly is by means of videogames. "**Exergaming**" is a term used for videogames that are also a form of exercise. Exergaming originated in the early 1980s already [Atari1983] when companies, like **RacerMate** [RacerMate] and **Concept 2** [Concept2], experimented with attaching bicycle and rowing fitness machines to a computer system. Initially aimed at professional and use in fitness centres exergaming suddenly became popular in 1998 with the introduction of **Dance Dance Revolution** [DDR] by Konami, where the user has to move his feet in a pattern to the rhythm of a song. With the introduction of the **Nintendo Wii** [Wii] in 2006 and especially the Wii balance board in 2008 there are now numerous fitness coaching videogames available for the home user.

One such videogame is **Wii Fit** [WiiFit]. Wii Fit has over 40 different activities including hula hoop, push ups, ski jump and other exercises. Exercises are divided into four categories: yoga, strength, aerobics and balance. Wii Fit will maintain a history of the results and encourages the user to keep playing by giving them "Fit Credits" if they perform well. Fit Credits can again be used to unlock new activities.

Figure 25. Wii fit and balance board.

While Wii Fit is still marketed as a traditional videogame, where the main object is having fun and no so much a good workout, there's also a plethora of more serious workout coaching games. For instance, "**Gold's Gym: Cardio Workout**" [GoldGym] for the Wii or "**Yourself!Fitness**" [Yourself!Fitness] for the Playstation 2 which offers a personal trainer experience. Users are assisted in performing shadow boxing routines and other activities like sit-ups. The effectiveness of using game consoles like the Wii fit is a topic of discussion [Owens, 2009]

4.3.1.2 DirectLife

Another combination of device and service aimed at exercising regularly is Philips **DirectLife**. DirectLife is an activity program, consisting of 12 week activity plans that provide all the assistance you need to set and achieve realistic activity goals. This is done by showing you how regular activities such as walking around the supermarket contribute to your daily target. It doesn't take long before you have a better understanding of which activities have a positive impact and better motivation to keep on track.

© Florence Public

Figure 26 Philips DirectLife

There are several initiatives similar to DirectLife: **BodyMedia FIT** [BodyMedia] and **Fitbit** [Fitbit]

4.3.2 Coaching on food intake/ keeping track of weight

There are several mobile and online applications that help people to monitor their daily food intake. These services are mostly aimed at keeping track of weight by plotting calories burned against calories eaten. Often, users have to manually put in weight data. Alternatively, a connected scale such as the Withings [Withings] could do this.

Figure 27 Withings scale

Examples of the applications to monitor food intake are: **Tap & Track** (application for iphone) and **The Daily Plate** (online). In most cases, these services do not yet implement real coaching elements like giving advice on food intake or motivating people to eat less or differently. They merely monitor what a person eats.

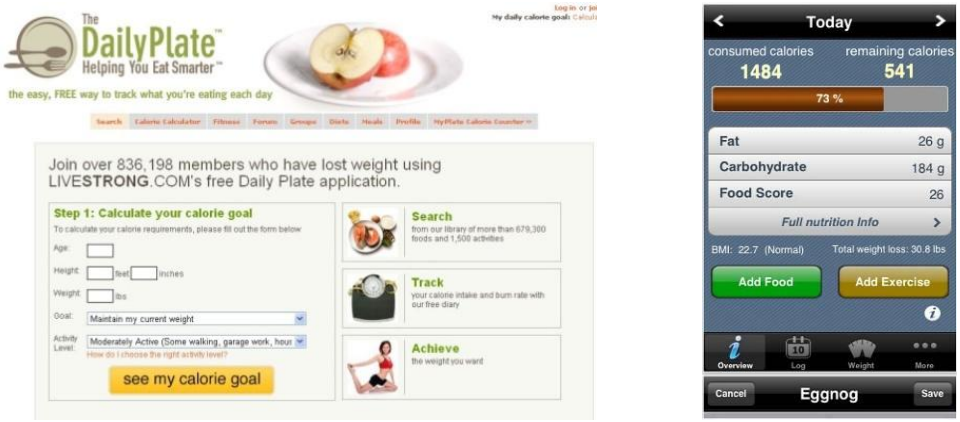

Figure 28. Examples of services that monitor food intake.

Several researchers have studied the effectiveness of using interactive online or multimedia programs to influence weight loss [Tate2007] [Irvine2004].

© Florence Public

4.3.3 Coaching in care

Coaching services in care can be aimed at specific diseases or at general care. Philips **Motiva** [Motiva], for example, is aimed at people with chronic conditions. A medicine box that reminds people to take their medicine is also aimed at more than one conditions. But the glucose meter that Bayer developed in cooperation with Nintendo is specifically designed to assist children with diabetes.

Philips Motiva connects people with chronic conditions such as (Chronic) Heart Failure, Diabetes Mellitus, and Chronic Obstructive Pulmonary Disease (COPD), to their healthcare providers - via the home television and a broadband internet connection.

The Sananet **health buddy** [HealthBuddy] is also aimed at coaching people with a chronic disease, it can keep track of medically relevant data, and is an interface between interactive coaching services, dialogies and patients. In this way, it helps people to deal with their chronic disease.

Figure 29. Sananet health buddy

The **Pico** telemedicine-box is an example of a service that gives a medication reminder. It is produced by Vitaphone and works with pre-packaged medication on a pouch roll in order to improve medication adherence and reduce the chances of making mistakes in medication provisioning to an absolute minimum. The medication pouch roll is rolled up on a cartridge that is installed in the Pico.

The patient is notified by the Pico by means of sound and light that medication is to be taken from the Pico. Taking the medication pouch from the Pico is monitored. When the client is too late according to a pre-defined schedule he/she is notified by a phone announcement to take the forgotten medication pouch. When the client is unreachable and persists in not taking the medication from the Pico, a care giver (e.g., family member, etc.) is requested by means of e-mail or SMS to help the client.

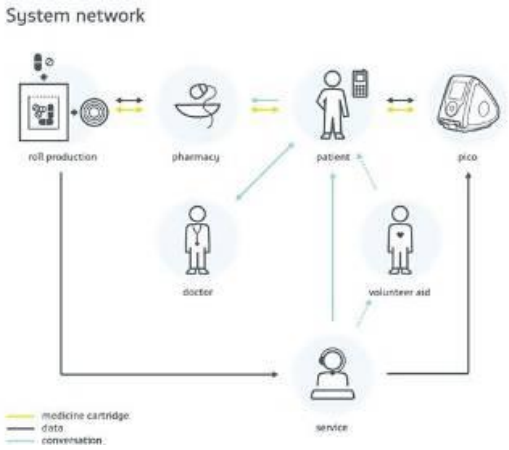

Figure 29 System network of Pico telemedicine reminder and box with medication.

With the Pico the chances of missing a medication intake moment is significantly reduced and the client is assisted in actually taking his/her medication in time. This means an enormous improvement in medication adherence which will result in a better quality of life for the client.

© Florence Public

The Bayer **Didget** [Didget] is developed for children with diabetes. As such, it is not a service for elderly people but is interesting nevertheless because it demonstrates a innovative approach to coaching. Bayer and Nintendo have thought of a way to stimulate the target group (children in their case) to follow health beneficial lifestyle and behavior. The Didget is a blood glucose meter that plugs into a Nintendo DS gaming system to reward children for consistent testing. Having a meter that motivates children to test and provides easy accuracy is a simple win.

Figure 30. Bayer Didget.

4.3.4 Conclusions Coaching Services

There is a multitude of coaching services available online, as mobile application or in combination with a device. Several studies have shown that adding a social aspect to an automatic coaching service results in a higher level of compliance of users to the advice being given [Connely2006]. Not many of the existing product service combinations are specifically aimed at elderly people, the problems they face, the way they would like to interact with services and devices and the motivation they seek to change their lifestyle and or behaviour. These are the main challenges for Florence in this domain. Nevertheless, the examples shown here show the multitude of opportunities that coaching using computer systems give.

4.4 Collaboration Services

As we will see in this section, collaborative activities involving at least two humans are much more present in non-robotic products or systems (with respect to what has been identified within the robotic systems in Section 1.). Once more, we want here to highlight the fact that the collaborative aspect of a service is not an objective *per se,* like safety, coaching or social connectedness. It corresponds better to an attribute of a service, characterizing the way this service is provided. Therefore, the products described here may also be associated to some of the other types of services we want to investigate within Florence. Nevertheless, the point of view we take here is more focused onto the way the service is provided, and more precisely onto the characteristics of the collaboration in between two or more humans. In this sense, we have gathered the different system depending on the spatial location of the participants involved, and depending on the temporal synchronization of these partners.

4.4.1 Collaboration with respect to person location

Products and service can be categorized depending on the location of the persons involved. The gaming domain is a good example in which the human partners are likely to play together within the same place. The most evident illustration is the **Wii** console provided by Nintendo [Wii]. With their wireless controller Wii Remote that is able to detect movements in 3D, users only need to move their body as if they were actually doing the given actions. The shift from a joystick-based control (which can be complicate with all the buttons to handle) to a motion-based control has clearly augmented the acceptability of the console, especially within population that were not “addicted” to console gaming. Furthermore, the focus onto the usability, rather than onto the sophistication of the image rendering, demonstrates that Nintendo tried to enlarge consequently their public. Studies have even considered the positive impact for elderly, forced through gaming to perform some physical interactions. The collaborative aspect is relies here in the fact that people can play simultaneously, collaborating

© Florence Public

thus in a leisure activity. Note that, like other gaming platforms, the console enables to play with remote partners, but this opportunity may be mainly used by more regular users.

The use of tangible interaction has also been studied as a way to increase the understandability of the user interface. In [Gronbaek2007], the **iGameFloor** was proposed as a novel interactive platform involving multiple co-located users in a collaborative game environment in school environment. The interactive floor used as the prototype platform is a $12m^2$ glass surface with bottom projection and camera-based tracking of limbs (e.g. foot, hand, and knee) contact points. The iGameFloor platform supports tracking of limb points for more than 10 users at the same time. Several gaming application were proposed, such as the well-known Pong, or the iFloorQuest that is similar to Trivial Pursuit.

Figure 36: the iGameFloor platform

During this study, it has been observed that players were helping each others, in order to increase their common score. The possibility of creating their own game (with their own questions) was also appreciated by the players. Generally speaking the use of such interaction tool was very well received by the young players. If we can interpolate that tangible interaction could also lead to good results with elderly too, such large scale multi user collaboration (up to 10 users) may be far too ambitious for the Florence system. Furthermore, a large numbers of users increases the complexity of the developed system and may make the interaction flow understanding difficult.

The collocation of partners within collaborative activities is the core issue addressed by the Steelcase **Media:Scape** product [MediaScape], in which the physical environment is adapted to optimize the collaboration for teaching and learning services. This tool (see Figure 28) that can be configured to best fit to the collaborative situation (sitting down in an office space, standing up in a lounge, etc.) Physical collaboration boosting spaces arise from the merging of furniture and technology. The technology behind the Steelcase Media:Scape is not very complex; the system is designed for a “walk-up and connect” experience allowing for the users to easily share in a bigger screen what they have on their laptops.

Figure 37 Media:Scape solution for improving collaborative activities

The knowledge sharing is an important issue for companies, and it justifies the production of different solutions to improve it. If the adaptation of the environment is a solution (like in the previous example), the development of appropriate physical tools is also extensively studied. As an example, the Brainstorm system from **FLUIDUM** is a knowledge generating and exchanging tool based on a shared digital desktop [Fluidum]. Large displays and several

© Florence Public

physical-world-metaphors facilitate communication and enrich the knowledge generation process by providing electronic features like copying, remote sharing, saving, instant transmission, etc.

Figure 38 The FLUIDUM tool

Another option to improve the collaboration in between persons located in the same place is to extend classical media that are already well accepted by the persons. This is the case of white board that are frequently used in company and schools. Digital boards like the one that **3M™ [3MTM]** commercializes, propose to extend the classical whiteboard with some multimedia capabilities, through digital annotation, and simple access to the associated computer.

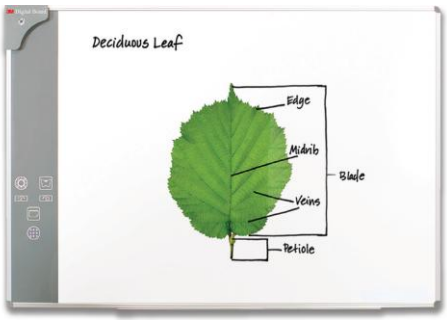

Figure 39 3M Digital board

One can note here that such system is not limited to collaboration in between collocated persons, Indeed, this solution enables to realize remote collaboration in between different sites equipped with the similar digital board, in a synchronous or asynchronous way.

The Distance separation is a key component within the work of [Vetere2009], in which the authors study the intergenerational gaming, in between grandparents and grandchildren. Their Collage system relies onto a shared display, through the use of a mobile phone camera and a touch screen for synchronization. The systems consisted in sharing some photos with the remote partner, commenting and spatially rearranging them through the shared desktop. Among the different conclusions of this work, it is mentioned that through this activity, grandparents and grandchildren were having some daily interactions, “playing” with their photos (by moving them onto the screen). Grandparents and grandchildren collaborated not only to communicate everyday events, but also to keep track of family events, creating a historic database of the family. The use of the camera to take pictures and do the text messaging was also found intuitive in both age groups.

© Florence Public

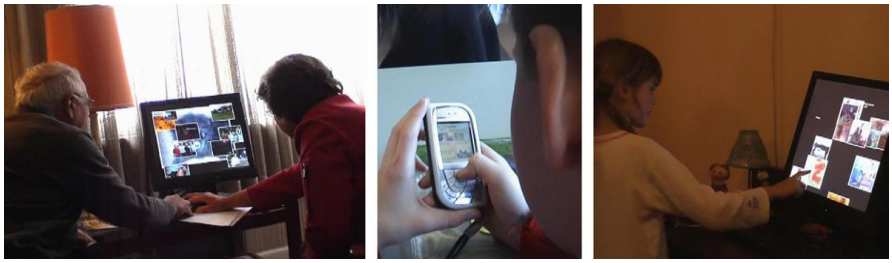

Figure 40 Illustration of the Collage system

4.4.2 Collaboration with respect to the temporal aspect

If most of the previously mentioned system supposed that the person are acting and collaborating at the same time, other collaboration tools do not require this temporal synchronization. The asynchronous aspect of collaborative activities is indeed present in a large part of the web-based products, mainly within the context of teaching and learning applications. Web 2.0 technologies, social networks, blogs and wikis, have opened a wide spectrum of digital tools that may be used to promote collaboration. If most of the so far developed solutions have been directed to the young aged target group, more tools are being developed for collaborative environment in workspace, like **IBM Lotus collaboration Suite** [Lotus] or The Microsoft's solution for Collaboration. **Nuvvo** [Nuvvo], created by Savvica Inc., aims at being the World's online education destination. It offers a different approach to teaching and learning online through networked communities focusing on a specific subject. Anyone can create a community, share a lesson, have a discussion, create a test, share an opinion and hold an online tutoring session at no cost. Elderly people are also engaged in informal training, which would need other conceptual structures in such a workspace like Nuvvo. In any case, these tools should not only give a framework but make the person develop appropriate abilities [Callahan, 2008], in order to attain a foreseen success.

We can also consider that systems providing centralized information to the individual are asynchronous in the sense that the time of the information definition is not necessarily similar to the time of access to this information. More than a physical collaboration in between a group of persons, the collaboration relies on the sharing of information, for care matters or teaching objectives. The **Bettie elderly social network** [Bettie], previously known as Jive, is an example of care system. It provides an intuitive communication space for elderly, as well as a way to keep up to date with local services and information This system is based on a touch-screen and physical character cards that can be placed on it. The limited functionality helps achieve simplicity in the understanding and ease of use. There are experiences in which groups of neighbours have coordinated themselves to look after the safety of the neighbourhood. Collaboration allows individuals to aim at higher goals as a group than those they would achieve individually.

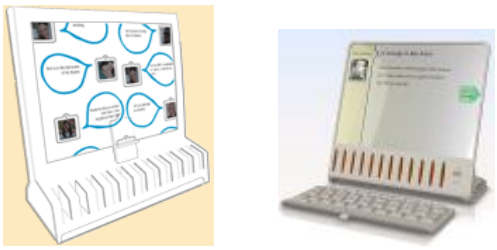

Figure 41: Jive and Bettie communication tools

Collaborative care is an example in which not only healthcare costs are brought down but also the quality of the care provided is higher. The tendency is to have a patient centred care where doctors, nurses and informal or formal caregivers may contribute. Intel created a website, **Connecting for Care [IntelCare]**, with a goal to connect and assist the more than 50 million caregivers in the United States. This online community is targeted to family caregivers, nurses,

© Florence Public

social workers and others to share information and provide emotional support, filling a void in today's healthcare system.

Banco del Tiempo San Javier (Time Bank, San Javier) is a chore exchange site in which people exchange activities on the basis of time [BancoDelTiempo]. The variety of activities one can volunteer for and request is very wide: assistance at home, home repair, transport and help in displacements, etc. This system promotes community cooperative services and solidarity among the people, improving the overall community health and the quality of life of the people in it.

In the continuity of teaching an learning tools, some systems target the sharing of knowledge in between person. As an example, knowledge and experience sharing is a key component of the ***Mutual help groups*** (GAM, Grupos de Ayuda Mutual) with very successful results [GAM]. Mutual help groups offer people a physical space in which they can decide what action to do and how to share the result. There is a link among all participants, either a common shared goal (e.g: to diet) or a common circumstance (e.g.: Alzheimer patients' caregivers). In these groups, the people are preparing the collaboration within the same environment, and therefore are acting at the same moment.

4.4.3 Conclusion

If the definition of collaboration clearly highlights the need of at least two entities, it does not specify the type of these entities. The literature has shown that the use of robotic systems enables to realize some efficient human-robot collaboration, within different domains. The videoconferencing is a straightforward example of human-human collaborations for applications on teaching and learning, assistance, and knowledge sharing. The study of the different robotic systems and their related applications also demonstrates that this service of social connectedness is the only one providing an explicit collaboration in between two humans through a robot, and not a collaboration in between a person and a robot, Through the products available onto the market, it has also been shown the gaming activity, focusing on cognitive or physical engagement, is a good example of an application using a human-human collaboration. Naturally, we have also noticed a similar type of collaboration within the professional world, in which several tools have been proposed to compensate the distance and asynchronous availability of the involved partners. Figure 42 sums up the different characteristics of such collaborative activities. An important point to note here is that a collaborative activity can not be considered as a domain of services; as the figure shows, collaborative services can address domains equivalent to the services we are to investigate within Florence. The collaborative services can be considered as a transversal characterization, in which the interaction in between two entities is the key-point.

Within the collaborative services that we will provide, we would like to concentrate onto services involving two persons. This would enable to study if such HHCo makes the robot acceptance easier when it is presented as a tool or medium for interaction, and not the as the agent with which the person has to interact. Indeed, the acceptability of interactive robots, as an explicit partner of the communication is a complex issue, and that relies on various items like the personality of the robot, its appearance, interaction media, [Fong2003]. That is why, like the Wii system has proven to be a good medium to engage people in shared activities, we would like to see if the use of a robotics system with a similar implication, as a tool, could facilitate the involvement of people for interacting with other people, while improving the human attitude towards the robot.

As a complement, we can mention that this study highlights some activities that already benefit from human-human collaboration. These activities could thus be considered as possible frameworks for scenario in Florence. The first type of activities encountered is naturally gaming, like we have seen with the Wii or iGameFloor. The development of intergenerational game may also be a key to get the person more involved, being happy to have a common activity with his/her grandchildren. Another type of activity in which the notion of collaboration is also important is group work. In this context, it could be interesting to study how a robotic platform could be a tool to improve the communication and the information sharing in between all the persons taking care of the person. An open-question is here to see what would be the benefit to

© Florence Public

realize such operations through a mobile platform, with respect to the use of a classical computer.

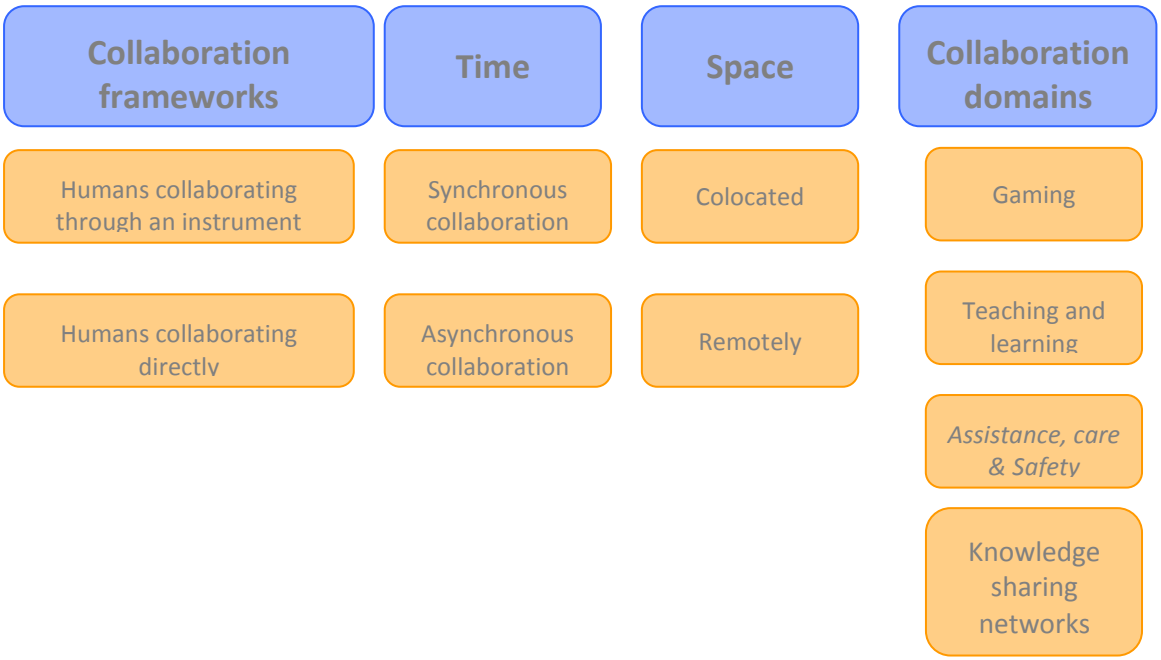

Figure 42: Characteristics of collaborative activities

© Florence Public

5 Conclusions

In this document, we have provided an overview of services and products that are relevant for the Florence project. This includes both and non-robotic services for elderly, robotic services for safety, coaching and social connectedness.

We found many projects that aim to use robots to keep elderly longer independent. Most of these robots offer a similar set of services: tele-presence, alarm detection and emergence intervention, activity monitoring, coaching and medication reminders. Most of these projects are still in the research phase. Only the CareBot from GeckoSystems is announced to come to the market in the short term. The robots for elderly fall into two categories with respect to the human-robot interaction model: robots which are human-like with a head and robots more as a device e.g. with touch screen. Most robots for elderly use voice recognition and synthesis for interaction with the user. Research has been done at which approach is better, but the results are not conclusive. Robots with a human-like head can have a stronger impact on users. However the drawback is that the human-like head triggers unrealistic expectations from the robot.

From the state-of-the art overview, it appears that robotic tele-presence is one of the most interesting and realistic robotic services for elderly in the short term. Robotic tele-presence can address strong elderly needs, such as safety in the case of emergency handling and social connectedness, and is feasible with current technology. A number of tele-presence robots are already on the market (e.g. the RP-7 from InTouch Health) and the last few months, four companies, namely HeadThere (with the Giraffe robot), Willow Garage (with the Texas robot), Anybots (with the QB robot) and VGO, have announced to introduce a tele-presence robot to the market at the end of 2010. These robots are mainly targeted at tele-work. Currently, only the Giraffe robot from HeadThere also explicitly targets elderly people at home.

Another conclusion is there are many (non-robotic) tele-care services developed and deployed aimed at assisting elderly at home, and keeping them longer independent, for example the PAL4 and VieDome service platforms. These telecare service platforms are often developed by local or regional care organizations with technology provided by local technology companies and funded by local governments.

© Florence Public

6 REFERENCES

[Alboul2010] Lyuba Alboul, Jacques Penders, Joan Saez-Pons and Leo Nomdedeu; *Heterogeneous multi-agent system behavior for robotic application*; To appear in Handbook for Robotics: Emerging Robotics and Sensors Technology for Humanitarian De-mining and Risky Interventions. Editors: Prof. Maki K. Habib and Prof. Yvan Baudoin; 2010.

[Bargh2010] Bargh, M; *State of the Art in Monitoring and Decision Making;* Florence project Deliverable D3.1; 2010.

[Breemen2005] Breemen van, A., Yan, X. and Meerbeek, B.; *iCat: an animated user-interface robot with personality*; International Conference on Autonomous Agents and Multi-agent Systems, AAMAS, Utrecht, Netherlands; 2005.

[Cesta2007] Cesta, A., Cortellessa, G., Pecora, F., and Rasconi, R.; *Supporting Interaction in the RoboCare Intelligent Assistive Environment"*; In Proceedings of AAAI Spring Symposium on Interaction Challenges for Intelligent Assistants); 2007.

[Cesta2007] Cesta, A., Cortellessa, G., Giuliani, M.V., Pecora, F., Scopelliti, M., and Tiberio, L.; *Psychological implications of domestic assistive technology for the elderly*; In PsychNology Journal, 5(3):229-252; 2007.

[Costey2010] Nigel Costley, *Robots & Respite*; The Magazine of Technical Enterprise, Volume 11 Issue 1 (Jan/.Feb 2010); 2010.
(This article can be downloaded at https://wiki.auckland.ac.nz/download/attachments/23332598/Robot+and+Respite-+e.nz+magazine.pdf)

[Deegan2007] Deegan, P. Grupen, R., Hanson, A., Horrell, E., Ou, S., Riseman, E., Sen, S., Thibodeau, B., Williams, A., Xie, D.*; Mobile Manipulators for Assisted Living in Residential Settings,* Autonomous Robots; Special Issue; 2007.

[Dijk2010] Van Dijk, D; *State of the Art of Multi-Purpose Robots and Privacy-Aware AAL Home Systems and Services*; Florence project Deliverable D2.1; 2010.

[Fong2003] Fong, T., Nourbakhsh, I. and Dautenhahn, K. *A survey of socially interactive robots*; Robotics and Autonomous Systems, 42, pages 143-146; 2003.

[Gronbaek2007] K. Gronbaek, O. Iversen, K. Kortbek, K. Nielsen and L. Aagaard; *iGameFloor – a platform for co-located collaborative games;* International Conference on Advances in computer Entertainement; Salzburg, Austria, pages 64-71; 2009.

[Hans2002] Hans, M.; Graf, B.; Schraft, R.D; *Robotic home assistant Care-O-bot: past-present-future;* In proceedings of IEEE ROMAN '02, pp. 380-385; 2002.

[Isken2010] Isken, M; State of the art in Human-Robotic Interaction; Florence Project Deliverable D4.1; 2010.

[Irvine2004] Irvine A.B., Ary D.V., Grove, D.A., Gilfillan-Morton, L.; *The effectiveness of an interactive multimedia program to influence eating habits;* Health Education Research, pp.290—305; 2004.

[Kidd2005] Cory D. Kidd and C. Breazeal; *Designing a sociable robot system for weight maintenance;* Proceedings of Ubicomp, Tokyo, Japan; 2005.

[Kojima2008] Mitsuharu Kojima, Shota Shirayama, Ryusuke Ueki, Yoshinao Sodeyama, Satoru Tokutsu, Tomoaki Yoshikai, Kei Okada, Masayuki Inaba; *An Active*

© Florence Public

Stereo Vision Head System with Wide View Angle and High Eyesight to Take Care of Human; in Proceedings of the 9th SICE System Integration Division Annual Conference, pp.219—220; 2008.

[Mataric2007] Mataric, M., Eriksson, J. Feil-Seifer, D. and Winstein, C.; *Socially assistive robotics for post-stroke rehabilitation;* Journal of NeuroEngineering and Rehabilitation 4:5; February 2007.

[Mead2009] Ross Mead and Maja J. Mataric; *The power of suggestion: Teaching sequences through assistive robot motions;* Proceedings of HRI 2009, March 11-13, La Jolla, California, USA, pp. 317--318.

[Naghsh2010] A. Naghsh, J. Saez-Pons, J. Penders , J. Gancet, E Motard, L. Nomdedeu, J. Sales, E. Cervera, R. Marin, P. Sanz, R. Sebastia; *Remote and in-situ multirobot interaction for firefighters interventions under smoke condition;* Submitted to the Second IFAC Symposium on Telematics Applications (TA 2010), Timișoara, Romania, October 5–8; 2010.

[Owens2009] University of Mississippi (2009, December 25); Wii Fit may not help families get fit; Accessed through http://www.sciencedaily.com/releases/2009/12/091218125110.htm.

[Penders2009] Penders, J. and Alboul, L. and Witkowski, U. and Naghsh, A. and Saez-Pons, J. and Herbrechtsmeier, S. and El-Habbel, M.*; GUARDIANS final report part 1 (draft): a robot swarm assisting a human fire fighter* (http://shura.shu.ac.uk/1089/1/FinalReportPart1.pdf). In Sheffield Hallam University Research Archive;2009.

[Pereira2008] Pereira, A., Martinho, C., Leite, I. and Paiva, A.; *iCat, the chess player: the influene of embodiment in the enjoyment of a game;* International Conference on Autonomous Agents and Multiagent Systems, AAMAS, Estoril, Portugal; May 2008.

[Pineau2002] Joelle Pineau Michael , Michael Montemerlo , Martha Pollack , Nicholas Roy , Sebastian Thrun; *Towards robotic assistants in nursing homes: Challenges and results;* Robotics and Autonomous Systems; Vol. 42, No. 3 - 4, 2003, pp. 271 – 281; 2003.

[Reiser2009] Reiser, U. ; Connette, C. ; Fischer, J. ; Kubacki, J. ; Bubeck, A. ; Weisshardt, F. ; Jacobs, T. ; Parlitz, C. ; Hagele, M. ; Verl, A.; *Care-O-bot® 3 - creating a product vision for service robot applications by integrating design and technology;* Intelligent Robots and Systems, IROS 2009. IEEE/RSJ International Conference on Robotic Systems; 2009.

[Reiser2009] Reiser, Ulrich; Parlitz, Christopher; Klein, Peter: *Care-O-bot® 3 - Vision of a robot butler. In: Beyond Gray Droids: Domestic Robot Design for the 21st Century*; Workshop in Cambridge, UK on 1 September 2009 at HCI 2009. Cambridge, UK, 2009.

[Sodeyama2008] Yoshinao Sodeyama, Mitsuharu Kojima, Ryusuke Ueki, Shota Shirayama, Tomoaki Yoshikai, Kei Okada, Masayuki Inaba; *Design and Development of an Information Management Robot for Aged Persons;* in Proceedings of the 9th SICE System Integration Division Annual Conference, pp.1035--1036, 2008.

Tate2007] Tate, D.F., Wing, R.R. and Winett, R.A.; Using internet technology to deliver a behavioural weight loss program; JAMA 2007; 285, pp. 1172—1177; 2007.

© Florence Public

[Ueki2008] Ryusuke Ueki, Shota Shirayama, Mitsuharu Kojima, Yoshinao Sodeyama, Tomoaki Yoshikai, Kei Okada, Masayuki Inaba; *Recognition of human hand motion and its resultant movement of objects using desktop robot*; in Proceedings of the 9th SICE System Integration Division Annual Conference, pp.1037—1038; 2008.

[Vetere2009] F. Vetere, H. Davis, M. Gibbs and S. Howard; *The Magic Box and Collage: responding to the challenge of distributed intergenerational play*; Journal of Human-Computer Studies, pages 165-178; 2009.

Weblinks, last visited in July 2010:

[3MTM] http://solutions.3m.com/wps/portal/3M/en_US/Meetings/Home/ProductsAndServices/Product_Catalog/Digital_Board/
[Aibo] http://support.sony-europe.com/aibo/
[AgeUK] http://www.ageuk.org.uk
[Anybots] http://anybots.com/
[Atari1983] http://www.atarimagazines.com/v2n6/newproducts.html .
[Autom] http://intuitiveautomata.com
[AutomMovie] http://vimeo.com/6354266
http://smallbusiness.uk.reuters.com/2010/01/06/video-autom-robot-provides-diet-help/
[Bandit] http://viterbi.usc.edu/news/news/2009/a-cres-socially.htm
[BanditMovie] http://www.youtube.com/watch?v=puaeq4jfyDM
[Bettie] http://www.bett.ie/
[BancoDelTiempo] http://bancodeltiempo.sanjavier.es/
[BodyMedia] http://www.bodymedia.com/
[BrickHouse] http://www.brickhousealert.com
[Care-O-Bot] http://www.care-o-bot.de/english/
[Companionable] http://www.companionable.net/
[Concept2] http://www.concept2.com
[DDR] http://en.wikipedia.org/wiki/Dance_Dance_Revolution
[Didget] http://www.bayerdidget.co.uk
[ElderlyHealth] http://www.info.gov.hk/elderly/english/healthinfo/selfhelptips/safety.htm
[ExCITE] http://babel.isa.uma.es/mapir/index.php/excite-description-article
[Fluidum] http://www.fluidum.org/projects_brainstorm.shtml
[GAM] http://www.acnefi.org/castella/gams.htm
[GeckoLinks] http://www.hoise.com/vmw/08/articles/vmw/LV-VM-09-08-16.html ;
http://www.news-medical.net/news/20091022/GeckoSystems-to-discuss-its-sensor-fusion-based-vision-system.aspx ;
http://www.hoise.com/vmw/08/articles/vmw/LV-VM-09-08-16.html;
http://www.live-pr.com/en/geckosystems-improves-elder-care-robot-r1048423570.htm
[GeckoMovies] http://www.youtube.com/user/geckosystems
[GeckoSystems] http://www.geckosystems.com/
[GiddyUpStick] http://giddyupstick.com
[Giraff] http://www.giraff.org
http://www.headthere.com/
[GiraffMovies] http://www.viddler.com/explore/svonrump/videos/1/ and
http://www.viddler.com/explore/dsandber/videos/4/28.766/
[GiraffTechnical] http://nexus404.com/Blog/2007/03/08/giraffe-robot/
[GoldGym] http://uk.wii.ign.com/objects/143/14301166.html
[Guardians] http://vision.eng.shu.ac.uk/mmvlwiki/index.php/GUARDIANS
[HealthBuddy] http://www.sananet.nl/index.php?url=/het_health_buddy_systeem/health_buddy
[intelCare] http://www.connectingforcare.com/

© Florence Public

[InTouchHealth] http://www.intouchhealth.com/index.html
[Kompai] http://www.robosoft.com/eng/index.php
[KompaiMovie] http://www.youtube.com/watch?v=GciSisi1cMg
[KompaiSpec] http://www.robosoft.com/img/tiny/CP/fichKompaiV100425_ebook.pdf
[Lotus] http://www-01.ibm.com/software/lotus/
[Mamoru] http://www.jsk.t.u-tokyo.ac.jp/research/irt/mamoru.html
[MeBot] http://robotic.media.mit.edu/projects/robots/mebot/mebot.html
[MeBotMovie] http://www.youtube.com/watch?v=aME2aeIzbQo\
[Mediascape] http://www.steelcase.com/en/products/category/workspace/freestanding/media-scape/pages/overview.aspx
[MedMobile] http://info.telefonica.es/ext/accesible/html/home/pdf/alzheimer2.pdf
[MobiServ] http://www.mobiserv.eu/
[Mosro] http://www.robowatch.de/index.php?id=121
[Motiva] http://www.medical.philips.com/main/products/telehealth/Products/motiva.wpd
[Nabaztag] http://www.nabaztag.com/en/index.html
[Novatouch] http://www.novatouch.nl/
[NovatouchMov] http://www.youtube.com/watch?v=097drYY2TNo
[Nursebot] http://www.cs.cmu.edu/~nursebot/
[NursebotMovie] http://www.youtube.com/watch?v=6T8yhouP0l0
[Nuvvo] http://nuvvo.com/
[PAL4] http://www.aveant.nl/aveant?waxtrapp=urlfBsHsPfWfBaGTL
[Paro] http://www.parorobots.com/
[PersonalAlarm] http://medicalalert-devices.com/personal-alarm
[Pingo] http://www.arimaz.com; http://www.mydeskfriend.com
[PingoMovie] http://www.youtube.com/watch?v=Iz-dKasjt2o
[RacerMate] http://www.racermateinc.com
[RobocarePap] http://robocare.istc.cnr.it/pubs.htm
[RobocareMov] http://robocare.istc.cnr.it/videos.htm
[Roborior] http://www.roborior.com/
[Robosoft] http://www.robosoft.com/
[RoboCare] http://robocare.istc.cnr.it/
[RP7Link] http://www.journalpatriot.com/fullstory.asp?id=1980
[RP7Movies] http://www.youtube.com/watch?v=N_pSe2fO92Q ;
http://www.youtube.com/watch?v=Zu5pdicSJ38;
http://www.youtube.com/watch?v=i05DtPZlA_g ;
http://www.youtube.com/watch?v=E9Oj25kWVMw ;
http://www.youtube.com/watch?v=cR4Bicgjk_g ;
http://www.youtube.com/watch?v=BpraGISxAr4
[SafeAtHome] http://www.safeathomechicago.com
[SCITOS A5] http://www.metralabs.com/index.php?option=com_content&view=article&id=3&Itemid=2
[SensAction] http://www.sensaction-aal.eu
[Sergesa] http://www.sergesa.com/ (in Spanish)
[SRS] http://wiki.srs-project.eu/index.php/Main_Page
[SureStep] http://www.vitalitymedical.com/Product/Posey-Sure-Step-Cushioned-Bath-Mat-60224.html
[T32] http://www.tmsuk.co.jp/english
[Taizo] www.generalrobotix.com/product/taizo/
[TaizoMovie] http://www.youtube.com/watch?v=cOBf6DFPrhM ;
http://www.youtube.com/watch?v=06fY6YdHobY
[Texas] http://www.willowgarage.com/blog/2009/10/26/texas-robot
[TexasMovie] http://www.youtube.com/watch?v=u624jZ_cP14
[Ubot] http://www-robotics.cs.umass.edu/Robots/UBot
[UbotLink] http://www.sciencedaily.com/releases/2008/04/080416212725.htm
[UbotMovie] http://www.youtube.com/watch?v=koc6xhPM420
[VGO] http://www.vgocom.com/
[VieDome] http://www.viedome.tv/index.php

© Florence Public

[Wakamaru] http://www.mhi.co.jp/en/products/detail/wakamaru.html;
http://www.wired.com/techbiz/media/news/2003/04/58593#ixzz0iMliPoIe
[Wii] http://www.wii.com/
[WiiFit] http://wiifit.com/
[Withings] http://www.withings.com
[YourselfFitness] http://en.wikipedia.org/wiki/Yourself!Fitness
[Yujin] http://yujinrobot.en.ec21.com/company_info.jsp

© Florence Public