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KSERA Project
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Annual Progress Report year 3

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Partner no	Partner name	Short name	Contribution received
1	Technische Universiteit Eindhoven	TU/e	yes
2	Istituto Superiore Mario Boella	ISMB	yes
3	Maccabi Healthcare Services	Maccabi	yes
4	CEIT RALTEC Gemeinnuetzige GmbH	RALTEC	yes
5	Vienna University of Technology	TUW	yes
6	Consoft sistemi S.p.A.	Consoft	yes
7	Universität Hamburg	UH	yes

1 Publishable Summary

1.1 Summary of project objectives

The overall objective of the project is to improve daily life of older people and people affected by Chronic Obstructive Pulmonary disease (COPD) and to facilitate their daily activities within their own domestic environment. Currently, no disease management systems exist for COPD.

The KSERA project purpose is to design a robot machine (Nao) and a smart home that measure and detect normal and anomalous living patterns of older people and people affected by COPD.

The robot will interact with a target person in his/her own domestic environment, will transmit data that permit to detect possible anomalies at a very early stage and will suggest actions to the target person to improve his/her conditions.

The project is particularly relevant for the socio-economic needs of all modern societies, especially in light of the following:

- Older people want to live independently in their own homes as long as possible, and the ratio between older people (aged 65 or more) and active working population is expected to drop from 1:5 in 2000 to 1:2 in 2050.
- Chronic Obstructive Pulmonary disease (COPD) is expected to be the 3rd leading cause of death in 2030 increasing the annual EU health care cost to €7.6 billion.
- Age-related diseases such as COPD causing a decline of the patients' capabilities, including mobility limitations and self-care restrictions.

1.2 Description of the work performed since the beginning of the project and main results achieved so far

In the first reporting period (February 2010 – January 2011) the project's focus has been on the technological aspects of the KSERA system and the preparations required for successful field trials in later stages of the project, while in the second reporting period (February 2011 – January 2012) the focus has been on the realization and testing of the first prototype. The first prototype, in fact, has been integrated and installed at the test sites in Austria and Israel, where it has been tested with real end-users in a real environment. The formative evaluation of the first prototype then guided the development and research in the second iterative design stage of the project. This has been the main focus of the third reporting period (February 2012 – January 2013). In this period, in fact, the final prototype has been realized and evaluated. In line with the foreseen schedule, the consortium has developed the following set of activities:

Assessment user needs, possible usage scenarios, use cases and personas - the specific needs of users have been analysed and resulted in a comprehensive description of the KSERA Scenarios, Use cases and Personas and the basic rules for ubiquitous monitoring. The different types of scenarios were ranked according to their importance, so as to be included in the first and in the second prototype. An updated version of different scenarios, use cases and personas involved integrating the recommendations received during the interim mid-term, the first year and the second year reviews was created.

Members for the Ethical Advisory Board (EAB) were nominated. Needs for ethical clearance in Austria, Israel, and the Netherlands were clarified and ethical clearance was obtained for the field trials in Austria and Israel. Different programming documents for the implementation of the trials were produced.

Development of a risk management plan - the main results are the assessment of the project risks and the construction of a risk plan. Further outputs were the interim progress report for the first period and the first annual progress report. The project ran smoothly, regular conference calls and progress meetings took place during the whole duration of the project and all the planned milestones have been achieved.

Design of the system architecture for the mobile platform, the assistive technology and the human-robot interaction interface - during the first year the Robot Mobile Behaviour was developed and resulted in a thorough report on the KSERA architecture and implementation details. This report was updated according to the recommendations of the interim mid-term review. A report on the basic robot navigation and localization capabilities (including navigation through a domestic environment and person tracking) was finalized during the second year, and used for the creation of the first prototype of robot mobile behaviour. During the third and last year, the final prototype of the robot mobile behaviour has been realized including the refinements identified by the formative evaluation of the first prototype and new and improved methods of intention reading (used to improve the navigation and localization functionalities of the mobile platform).

Analysis of the Human Robot Home interaction advanced algorithms have been implemented in order to build up basic social skills that enable smooth interaction with a person: when operative, the Nao robot is able to track the face of a person and estimate its head pose. This enables the robot to make eye contact, to monitor the visual attention of the user, and to time its actions. When speaking to a user, the speech is augmented with gestures and facial expression through the robots LEDs. It was shown that these features improve user experience. The robot's navigation and localisation algorithms are designed such that the robot approaches a person appropriately while avoiding obstacles. Together these features enable the robot to actively interact with a person and give instruction for his daily activities (i.e. physical activities, information about important data for the health of the person, etc.). For enabling video communication two versions of a wearable beamer for Nao were implemented successfully. The additional communication channel improves robustness and user tests show a positive effect on user acceptance.

Overview of sensors, sensors network and monitoring functions for ubiquitous data monitoring - during the first year the focus was on the selection of off-the-shelf devices to measure the physical conditions and environmental sensors, that were analysed and resulted in a report that enumerates the classes and the devices that were used to create the first prototype of the KSERA Ubiquitous Monitoring System, finalized during the second year. The report also explains how the data will be used to achieve the goals stated in the Use Cases and Monitoring Rules. Finally, during the third year, a second and final prototype has been realized including all the designed and developed learning and decision making algorithms for monitoring functions, and also the refinements based on the formative evaluation of the first prototype. The software modules has been designed, developed and tested in close collaboration with medical experts and elderly end users: depending on the input from the physiological and environmental sensors, and based on medical knowledge and practice, they enable the system to advise the COPD user. Several integration meetings involving all partners have been organized in the course of 2010, 2011, 2012 and 2013. Costs and benefits have been taken into consideration during the whole project so as to keep the system as cheap and flexible as possible: tools such as using web services for weather forecast were used in order to reduce the costs of the implementation of the project (Nao can give instructions to the person, for instance, in relation with the specific outdoor environment).

Development of a trial plan in real user environments including ethics and safety issues – the user involvement in the planning of the system design and the field trials led to the constitution of a framework and the guideline for the pre-trial, testing and post-trial phase, so that a smoothly running evaluation is guaranteed. The described workflows for studies in real user environments together with Socially Assistive Robots (SAR) and vulnerable target groups can be used as basis for on-going research activities in the research area of Assistive robots and Human-Robot-Interaction.

First prototype integration, installation, testing and formative evaluation - one of the objectives of the project is the creation of two prototype releases, and the first was finalized during the second year. This first prototype includes the integration of the basic components (Robot Mobile Behaviour, Human Robot Interaction, and Ubiquitous Monitoring System) and was integrated, installed and tested at two sites in Austria and Israel, under the advice and guide of the ethical advisory board. The formative evaluation was held with real users in real environments, and the results (that have

been reported in a dedicated deliverable) have been used to guide the development and research needed for the design of the second prototype, during the third year of the project.

Final prototype integration, installation, testing and end evaluation - during the third and last year, the second cycle of the iterative prototype design was performed, integrating the revised version of the SAR, the navigation based on context awareness and intention reading, an intuitive and easy to use human robot interface that enables joint attention and monitoring functions to detect abnormalities (in practice were integrated all the sub-components mentioned above). Also the final prototype has been tested at the same two sites of the first one: Austria and Israel, again under the advice and guide of the ethical advisory board. The final prototype has been tested with real end-users in real environments, and the test setup and results (including user experience and satisfaction) have been reported. The effectiveness of the program has been evaluated through questionnaires, data monitoring and changes in functional status and subjective feelings of well-being (using the evaluation metric identified during the project).

Exploitation and standardization activities - an analysis of the value chain has been made that underlies the KSERA application, during the second and the third year of the project. The analysis includes the market possibilities, the legal constraints, and a potential roadmap to market not only for the project as a whole but also considering the sub-components. In market perspective, the main envisioned *KSERA tool* is an automated Ambient Assistive Living solution (tele-care *product*) with humanoid robot for remote care of COPD patients. As such, the prototyped solution has been presented to standardization bodies in the last months of the project to check the achievable interoperability with other market products and standardization related issues.

Communication activities – KSERA performed many demonstrations to raise public awareness including a website of the project (<http://www.ksera-project.eu>), and a project leaflet. A workshop was organised in Hamburg on December 2012 involving two major European robotics companies (PAL Robotics and Aldebaran Robotics). The press was approached in all countries concerned by the project and this resulted in a number of references to the project on the web and in local newspapers. The project was also presented at local TV stations in Germany, Austria, Israel and the Netherlands, as well as on Dutch national radio. A press conference was organized in Turin in December 2010 and at the Parliament of Israel in January 2011.

For scientific dissemination a symposium was organised at the ISG*ISARC 2012 conference on gerontology highlighting KSERA's main results. Many scientific publications have been submitted and were accepted in conference proceedings and journals. These papers describe the many different results: context-aware robot navigation in domestic environments, human-robot interaction like non-verbal communication and eye-contact, the impact of user needs on the design of social robots, user acceptance and user experience of implementations of the KSERA system. KSERA is part of education programmes at universities in Vienna, Hamburg and Eindhoven through research projects and specific lectures.

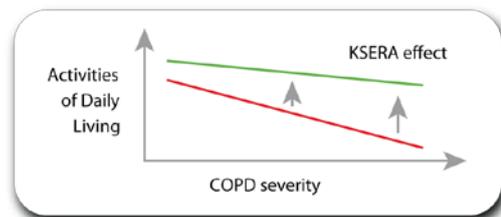
1.3 Expected final results and potential impact

The **applications** include:

- A mobile assistant to support and interact with an elderly person.
- Delivering useful communication (video, internet) to an elderly person.
- Advising an elderly person or caregivers about anomalous or dangerous situations on the basis of health and behavioural monitoring.
- A socially acceptable way of human-robot interaction

The **expected impact** is:

- Increasing the acceptance and adoption of service robots in domestic environments.
- Increasing independence and improving the quality of life (QoL) for elderly people, in particular those affected by COPD.
- Decreasing burdens on families and caregivers.
- Decreasing healthcare costs.



1.4 Additional information: <http://www.ksera-project.eu>

The project website provides more detailed information on the project, including KSERA-related events, collaborations, public reports and contact information.

The KSERA project is developed and implemented by a consortium of the following partners:

- Technische Universiteit Eindhoven (TU/e)
- Istituto Superiore Mario Boella (ISMB)
- Maccabi Healthcare Services (Maccabi)
- Technische Universität Wien (TUW)
- CEIT RALTEC gemeinnützige GmbH (RALTEC)
- Consoft Sistemi S.P.A. (Consoft)
- Universität Hamburg (UH)



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