Accompany: Acceptable robotiCs COMPanions for AgeiNg Years - Multidimensional Aspects of Human-System Interactions

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Abstract— **With changes in life expectancy across the world, technologies enhancing well-being of individuals, specifically for older people, are subject to a new stream of research and development. In this paper we present the ACCOMPANY project, a pan-European project which focuses on home companion technologies. The projects aims to progress beyond the state of the art in multiple areas such as empathic and social human-robot interaction, robot learning and memory visualisation, monitoring persons and chores at home, and technological integration of these multiple approaches on an existing robotic platform, Care-O-Bot®3, and in the context of a smart-home environment utilising a multitude of sensor arrays. The resulting prototype from integrating these developments undergoes multiple formative cycles and a summative evaluation cycle towards identifying acceptable behaviours and roles for the robot for example role as a butler or a trainer. Furthermore, the evaluation activities will use an evaluation grid in order to assess achievement of the identified user requirements, formulated in form of distinct scenarios. Finally, the project considers ethical concerns and by highlighting principles such as autonomy, independence, enablement, safety and privacy, it embarks on providing a discussion medium where user views on these principles and the existing tension between some of these principles for example tension between privacy and autonomy over safety, can be captured and considered in design cycles and throughout project developments.**

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I. INTRODUCTION

With the increasing life expectancy in the world, the proportion of people aged 60 years and above will have reached a ratio of around 1 person in 3 by 2060 (Fig. 1). This is reflected by the statistics from the 27 European Member States [1], as well as World-wide trends [2]. At the same time, the industrialised countries are facing an explosion of costs in the health-care sector for the elderly. Current nursing home costs range between $30,000 and $60,000 per person annually [2].

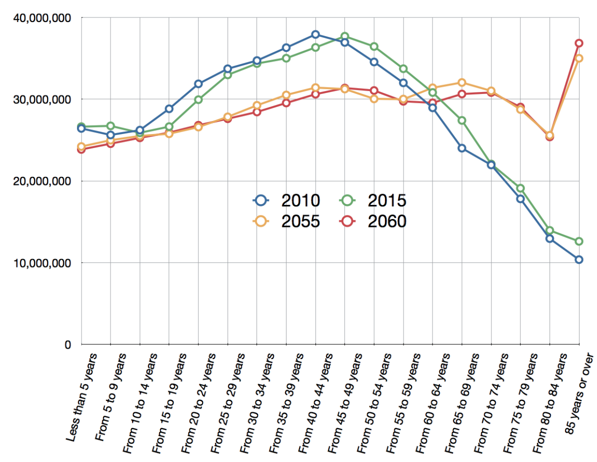

Fig. 1. Population projections for the 27 Member States, showing an almost doubling in number of people aged 65 and above (from 17.57% to 29.54%), while the number of people aged between 15-64 will see a decrease from 67.01% to 57.42%. [1] accessed on 17 Jan 2013 with data code *t_proj* to access population projections

The ACCOMPANY (Acceptable robotics COMPanions for AgeiNg Years) project funded by the Framework 7 programme focuses on a multidisciplinary approach for developing different aspects of state of the art in relation to companion technologies. It is based on an existing robot platform, Care-O-bot®3, a state of the art service robot designed for home environments, towards functioning in capacity of an acceptable companion. Developments focus on social and empathic interaction, as well as robot's ability to learn from interactions. Furthermore, it incorporates the state of the art in environment and activity monitoring towards providing a home solution for cases where robot presence can complement environmental sensors. These all aim to assist in the context of care for the elderly people. Project developments are guided by incorporating user-centred design through formative evaluation to formulate requirement and summative evaluation to assess requirements achievements during the life cycle of the project. Furthermore, ethical aspects of utilising artificial care companions at home are considered during the project.

The development of service robotics has so far been mainly driven by technological developments. It has remained close to the mainstream market offering services within the reach of technological developments and within the constraints of safety and affordability. This is understandable from a commercial point of view but it has not been sufficient to generate service robots that can be effective in the domain of elderly care. In order to be effective in this domain, systems need to be tailored to the needs and expectations of its users, elderly and their carers. Moreover tailored functionality needs to become available within these systems to allow customising and personalising them to their intended users. In the ACCOMPANY project the concept of service robotics will be brought into the elderly care domain through:

1) Specification of functionality answering needs within elderly care and its development and
2) Development of robot behaviour to enhance acceptance and efficiency.

Iterative development: generally research efforts aimed at the development of health robotics start with the technical development based on an assessment of needs from the intended users. After completion of the prototype the outcomes of the evaluation of the system can only seldom be used to improve the system and as a result many only partly developed systems are the result of publicly funded R&D effort (Robotics for Healthcare report 2008). The following sections provide an introduction into different development areas of the project and their progress to-date.

II. DIFFERENT DEVELOPMENT AREAS & THEIR PROGRESS

A. *User requirement analysis & scenario definition*

The first area of work focuses on the user requirement analysis & scenario definition. Within this, firstly, needs of independent living elderly people were assessed. Publicly funded care provision to solve these needs was described for four countries, the Netherlands, Italy, UK, and France. Secondly, user panels were formulated in the Netherlands, UK, and France. The first round of focus group meetings with these panels focused on the needs of elderly citizen in trying to remain in their homes independently. Focus group meetings with three different types of users: a) elderly persons ($n = 41$), b) professional caregivers ($n = 40$); and c) informal carers ($n = 32$) make clear that there is no single activity that can be selected as the activity causing elderly people to lose their Independence. Overall, activities concerning three activity domains (i.e. mobility, self-care, and social activities) were found to be the most problematic.

Within the ACCOMPANY project a basic fetch-and-carry task was selected (related to the activity domains mobility and self-care) and a first preliminary scenario was created. More detailed user feedback concerning this preliminary scenario was required for the formulation of basic system requirements. Therefore a second round of focus groups were conducted in the Netherlands, UK, and France, in which this first preliminary scenario was discussed. The group consisted of elderly persons ($n = 39$), formal caregivers ($n = 44$) and informal caregivers ($n = 24$) in the Netherlands, UK and France. In these focus groups meetings a scenario was presented as a series of pictures to the participants (the robot fetching and carrying a bottle of water for the user). Afterwards every picture was discussed in the group. The participants were asked what should be kept in mind when designing a robot for this scenario concerning the topics interaction, sensory/memory, recognition, the environment and daily activities. Questions such as "Where should the robot be?", "What should the robot need to know about the user?", "Do you foresee problems concerning the robot and the interior of your living room?", "What could be problematic?", "What do you like/dislike?", and "How should the robot act in [a given] situation?" were example questions asked. All these resulted in comments that were gathered and

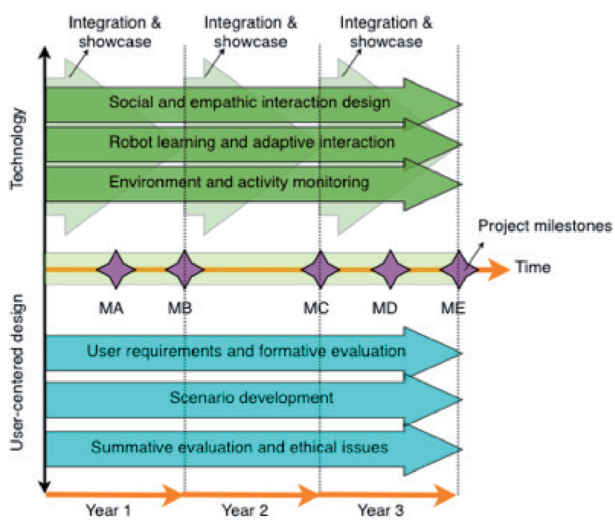

Fig. 2. Accompany Project objectives, highlighting technological development as well as user-centred design and developments achieved via formative and summative evaluation

translated into user requirements. This led to a total of 68 user requirements concerning, amongst others, the execution of the task, visitors, robot behaviour, and additional robot functionalities that are further detailed in [4], [5]. From here a more elaborated scenario was developed in which various roles of the robot were outlined. For the future three more rounds of focus group meetings are planned for more elaborated user feedback to support the other activity domains.

B. Social & empathic interaction design

The second area of activity focuses on social and empathic behaviour in interaction with Care-O-Bot and its environment. Empathy is ”a key component of social interaction” [8]. It is a primal level of interpersonal interaction whereby signals from one person are picked up by another [9]. In psychology, empathy is defined as a multidimensional construct composed by different aspects such as cognitive and affective.

From our perspective, highly inspired by philosophical perspectives derived from ecological psychology and phenomenology of perception, the empathy is not considered as just the result of an internal judgment or a merely cognitive activity. It is a social product emerging dynamically as an outcome of the interaction whereby actions and perception of people synergise with one another. The reciprocal meaning emerges in interaction, by direct experience in the world. This means that the work builds upon continuous and expressive qualities in interaction to come forth to the whole range of perceptual-motor, emotional, social and cognitive skills of the elderly person. As the meaning emerges in direct interaction with the surrounding, the design should further be context-depending and pay attention to the elderly persons unique experience.

Empathy as such will be explored and applied in several elements of the Care-O-Bot. Our design for interaction provide ground for empathic relations to emerge. The Graphical User Interface to be used by the elderly person, contains features of empathy. But before the elderly person is able to control to Care-O-Bot we designed an attention grabbing interaction attached to the tablet used for the GUI. The ”Squeeze Me”, ”Call Me” and ”I-Suggest” are prototyped interaction devices that enable the older person to get attention from the robot, simply to make the robot come closer in order to start a more elaborate interaction towards higher-level assisting or collaborative functions desired. The way of asking for attention results in a coherent approach in terms of movement qualities of the robot towards the user to assist [10]. The GUI was designed with different layers of interaction according to the action-possibilities that the robot can perform. The GUI consists of 3 interaction modes: the person’s viewpoint, the Care-O-Bot centred mode and an overall mode (list of all action possibilities). The person’s viewpoint provides action-possibilities when the robot is co-located in the same room with the person. The interface shows actions that the robot is capable to execute in the current given context. If the elderly person is thirsty, the action possibility of *drinking* is relevant.

Fig. 3. User-view, action-possibilities in the current context to be executed by Care-O-Bot are provided in order of contextual relevance.

But in event that the cup is dirty, it will not show this action possibility but suggest to ”clean the glass” The available action possibilities are displayed by relevance and appropriateness to the context. Most relevant action-possibilities are given centrally and larger size than less relevant ones, making them easier to reach on the screen than smaller ones. (Fig. 3). The Care-O-Bot centred mode shown in Fig. 4, allows the person to see and explore the environment through the robot’s eyes. The view-through-the-eyes interface further explores expressive ”feelings” that the robot can have [11]. Feelings constituted by the internal properties of the Care-O-Bot such as battery level and external properties such as environment temperature or the way the user addresses the robot. These feelings are expressed via a shape changing mask and several graphical filters such as blur, saturation and opacity. Further

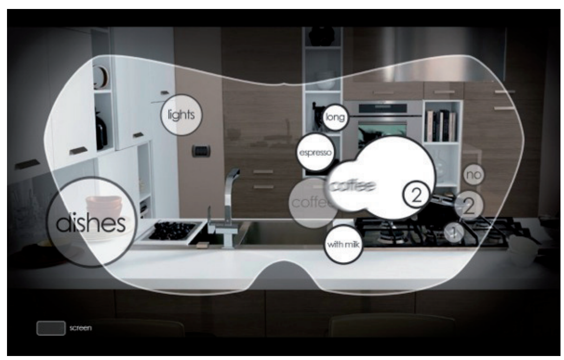

Fig. 4. Robot-view, see through the eyes of the robot to see what action-possibilities there are in the context and current view of the robot. The shape-changing mask and graphical filters express further feelings of the robot.

interaction paradigms based on perceptual crossing will be explored in prototypes in order to build mutual understanding towards empathic relationships.

The technical aspects of the social and empathic interaction activities focus on implementing a context-aware planner for the generation of empathic expression. This includes retrieving contextual information from sensory information embedded in the environment in order to tailor and improve the Care-O-Bot's social behaviour. Previous research findings [12], [13], [15], [16] have shown the importance of proxemics in both human-human and human-robots interactions. These findings [12]–[15] have also indicated that users' proxemic preferences vary depending on situation and interaction context. Therefore our initial focus is to implement a context-aware planner to improve the Care-O-Bot's proxemics behaviour (how interactants negotiate interpersonal space within an interaction). This can be achieved by having the Care-O-Bot adapt its approach distances and orientation in real-time, taking account of a user's context (i.e. user's preferences, location and activity) and the robot's task context (i.e. reminder , fetch and carry task etc.) when approaching the user for interaction. Development of the context-aware planner is currently in progress.

C. Robot learning and adaptive Interaction

Two of the major challenges in the ACCOMPANY project are the concepts of co-learning and re-ablement. Co-learning extends the ideas of learning, outlined by the UK Department of Health as follows:

"Services for people with poor physical or mental health to help them accommodate their illness by learning or re-learning the skills necessary for daily living", UK Department of Health's Care Services Efficiency Delivery [6].

Re-ablement is defined as follows:

"Support people to do' rather than 'doing to / for people'" Welsh Social Services Improvement Agency. [7]

For a robot companion this presents both challenges and opportunities. In terms of co-learning we envisage that the person and the robot work together to achieve a particular goal. Typically the robot can provide help and assistance, but in return also requires help and assistance. The robot can assist by informing the person that it has particular capabilities which may prove fruitful (or indeed that it already knows how to address this particular problem) but the user may provide the cognitive scaffolding to ensure these capabilities are used effectively.

In terms of re-ablement the robot is tasked with promoting activity' in the person via interaction. This idea is extended by ensuring that the robot engages in empathic and socially interactive behaviour. For example the robot should not attempt to encourage immobility or passivity in the user, but to re-able the user by making motivating suggestions to persuade the user to be active or engage in an activity in the home. It could prompt the user to carry out tasks, for example: writing a greeting card after reminding the user of a relative's birthday, or bring relevant events to the user's attention and suggest to the user an activity in order to avoid social isolation.

In order to fulfil these challenges in the ACCOMPANY project we have designed and implemented a first instantiation of a learning architecture which provides the foundations for co-learning and re-ablement. This was achieved by analysing various robot components, user needs via scenario conceptualisation and an analysis of the robot house ontology. A set of behavioural generation components were designed and implemented to allow non-technical persons to implement robot behaviours. In addition we have also designed and implemented a memory visualisation and narrative generation facilities on the robot. The facility allows users and others (carers, relatives) to review the behaviours of the robot both visually and though a temporal narrative of behaviour execution. We believe that such a facility will benefit users by allowing review of past events, allow exploitation of the robot by learning from previous experiences, aiding socialisation between users and carers, and serving as a memory prosthetic.

Ongoing work will start to exploit these mechanisms to allow co-learning to take place. Learning data will be derived from demonstration, typically via user's use of tele operation or via a touchpad. Sensory data will include all available sensory sources to the robot (stored in a relational database). The user will decide which sensory aspects should be considered by the robot when teaching. Where no such decision is made, a weighting based on the mutual information between each sensory dimensional state and the proposed action will be made. Both of these mechanisms allow the robot to decide, either automatically or with user assistance, what is important in its decision making for that particular behaviour. In normal operation, where the current sensory state most closely matches a stored and taught behavioural memory, the actions from that memory will be executed. Secondly, when the user is teaching the robot, such polling will effectively predict which behaviour would be executed if the robot was in normal operation. This latter feature acts as the main mechanism for co-learning because if the predicted behaviour sufficiently matches the taught behaviour up to that point then the robot can suggest that it already has knowledge of such a procedure and that this may be useful in achieving the task the user is specifying (see [17]) for a detailed explanation and implementation of such a schema).

D. Environment and activity monitoring

Another area of research addresses the question of how an embodied system can come to have an internal representation of its context: the spatial aspects of its surroundings, objects and humans as well as human activities. Currently, many homes for the elderly are being equipped with sensors to monitor activities or detect alarms. We will use this to increase the robustness and accuracy of the internal representation. This means that data from different sensing devices on the robot (i.e. camera on the robot, laser range sensor) will be fused with data from sensors in the environment (i.e. switches on kitchen cabinets, pressure mats in seats, cameras on the ceiling) to accurately identify the state of objects related to household chores and activities of people in the home.

One of the activities concerns the fusion of data from the robot itself. The Care-O-Bot has a powerful sensing head with two colour cameras used for stereoscopic vision and one time-of-flight sensor that directly delivers 2.5D range data. A challenge here is to combine both modalities to create accurate 3D point clouds with associated colour

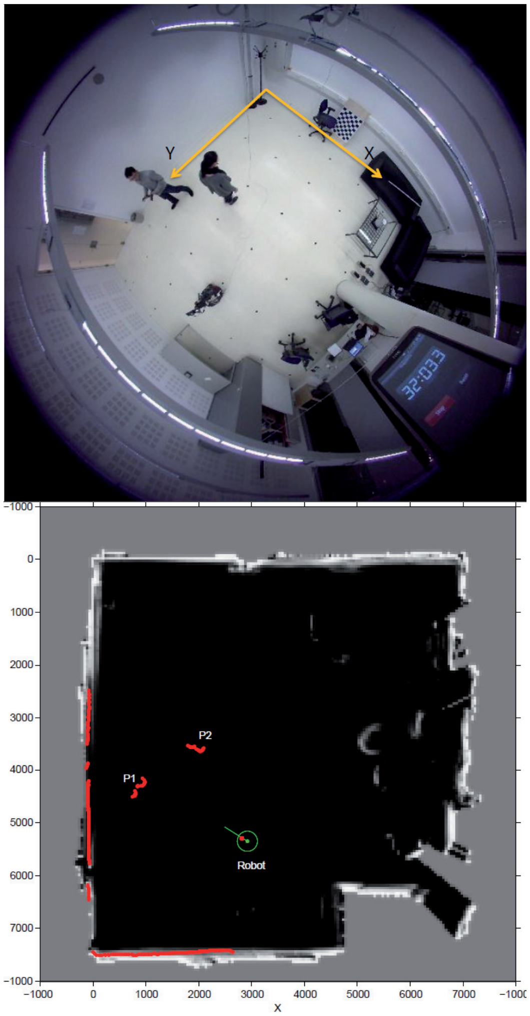

Fig. 5. An overview of data that are used in our data fusion system. The top graph shows an image frame captured by the overhead camera, where the yellow arrows indicate the direction of X and Y axis in the world coordinate system. The bottom graph shows a pre-computed probabilistic background map of the same area (in grey scale). The green circular marker indicates the location and the orientation of the robot. The red dots are the laser detection points in world coordinates. We show that the two persons (P1 and P2) in the camera image are also detected by the laser scanner. In our system, the two data source are fused to jointly estimate human locations.

information even in unstructured image areas. The method that is developed first undistorts and rectifies the colour and range images. The projected time-of-flight measurements serve as a first guess for the disparity computation from the rectified stereo images. A cost function is developed that compares the depth estimates from block matching in stereo and the time-of-flight estimate. After thresholding and filtering a final depth image is made that is more accurate than the stereo-only estimate.

A second task in this area is focused on robust localisation of humans using the sensors on the robot and the cameras on the ceiling. We developed a Bayesian framework for fusion of data from the laser range scanner mounted on the robot and a fish eye camera mounted on the ceiling. The vision system is based on earlier work on person detection [18]. Here we used a probabilistic background model in combination with a template to detect locations of humans. The laser range finder is used to learn a probabilistic occupancy grid for the background. Then the shape of humans is learned from the data and human locations are represented as distribution over the occupancy grid (see Fig. 5). After persons are localised with the single camera, particles are sampled around the location of the persons with a normal distribution. These particles are then weighted by the likelihood of the laser observations. The final detection is computed by the weighted sum of the particles that are sampled from the same person [19].

We evaluated the data fusion method on a 165 camera frames with multiple humans. Our proposed fusion system consistently outperforms the single-camera and the single-laser approach, and approximately 80 percent of the detections are less than 200mm from the ground truth location. In contrast, only 70% of the camera-only detections and 27% of the laser-only detections are within such distance of the ground truth.

Currently we use the RGB-D camera on the robot (Kinect) in combination with the ceiling camera to train a skeleton model in order to discover the pose of the human.

E. Integration and showcase

Another area of work relates to integrating all components developed so far, to ensure that the robotic platform meets all interface requirements for the developed components and all functionality required in the scenarios. This includes in particular also adaption to the existing software architecture based on the ROS open-source framework as well as software components and to a certain extent also hardware components.

Furthermore this activity coordinates the implementation of the scenarios within the different integration phases and the final showcase. In the following, the adaptation of the robot and the smart home environment is described, as well as the contents of the first integrated user scenario that was derived from the requirements input of the user panels.

1) Hardware modifications: In the beginning of the project, Care-O-bot 3 was introduced to all project partners to collect the requirements for hardware adaptations of the current demonstrator. One major result from the requirement analyses was that the fixed height of the tray would pose problems to sitting persons and persons in a wheelchair. In particular, the integrated touchscreen was not found intuitive as a human-robot interface, as the touchscreen served at the same time as a tray to place objects on. As a result of this, new kinematics for the tray manipulator was considered and developed that allows for a higher flexibility of the tray positioning and separates the user input from object placement through the usage of both sides of the tray: One side contains the user interface in form of a tablet pc that can be removed, and the other side provides space for object placement along with sensors to detect if the space is empty or occupied (see Fig. 6). The new kinematics of the tray

Fig. 6. Design drawings of the new tray kinematics with 3 degrees of freedom that allows height adjustment of the tray and switching between tablet pc and object placement

manipulator has now 3 degrees of freedom compared to only one in the original solution. This allows e.g. for adjusting the height of the tray for object handover, or to tilt the tray in order to request user input via the touchscreen. The tray could be even placed vertically, e.g. for the transmission of a skype call.

2) Scenarios: As a result of user requirement studies presented in section II-A, three different scenarios will be implemented that showcase the newly developed components and features to assist elderly people in their homes featuring social/empathic behaviours of the robot and the re-enablement concept as well as activity/chores monitoring. The scenario that has been implemented in the first year provides the foundation for the remainder of the project: all new components are integrated and available in a first functional prototype. In the following passage highlights the background story of the first year's scenario:

"The user sits on the sofa in the living room and watches TV/reads. The robot has noticed that she has been sitting there for 2 hours and has not had anything to drink for a while (in fact for 5 hours). It approaches her in a friendly/un-intrusive manner with slow/gentle movements/trajectories, adopting an appropriate social interaction distance, produces appropriate attention seeking behaviour - according to previously learnt user-preferences. The robot waits for the user to turn towards the robot. The robot then reminds the user of having something to drink by showing on the interface the action possibility "drink". This action possibility is displayed with a big label to highlight its relevance. The user selects "drink" via the interface. The robot then uses learnt information on the user's drink preferences, goes to the kitchen, picks up a small bottle of water, brings it to the user, offering the bottle with an inclination of the torso. The robot notices when the user has taken the bottle from its tablet. The robot observes if the user drinks and otherwise, would remind the user to drink some water. After completing the tasks the robot adopts an "empathic" position (next the user, pretending to "watch TV"), shifting position in synchronisation with the user."

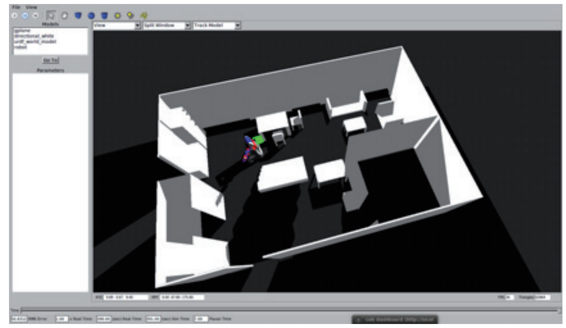

Fig. 7. Simulation environment of the robot house allowing developments in absence of robot and robot house.

For the implementation of the scenario, a simulation environment of the robot house was generated (see Fig. 7), such that the different partners could individually pursue their component and integration tests without direct access to the physical robot.

F. Evaluation & Ethical Issues

1) Acceptability: In the ACCOMPANY project we will run experiments in real world settings to evaluate the appropriateness of different roles (such as co-learner or a butler) for the robot in assisting users. In these experiments, we will assess the effects of the robot's navigation, movement, affective and empathic behaviours on the way users perceive these behaviours, and in what way that in turn affects their responses towards the robot and its acceptance.

Current acceptance models and studies (eg. the Almere model [20]) are too general and based on "data" collected in various kinds of lab settings (mock-ups, lab installations and videos). Instead, acceptance should be studied over longer periods and in real-life settings. No research model exists across varying technological and organisational settings. UTAUT [21] challenges to further explore the specific influences of factors that may alter the behavioural intention to use an information system in alternative settings. Experience, gender, age, and voluntariness of research participants are also considered for inclusion in a future model. We aim to research acceptance of specific functions, roles and behaviours in specific practical situations faced by the elderly, with specific personal, mental, and physical properties and (dis)abilities. To do this, longitudinal field studies are required. See also the discussion section in Heerink et al. [20]: "Moderating factors: age, gender, voluntariness and computer experience are personal characteristics that are known to be moderating the processes that determine acceptance." Moreover, self-efficacy and self-esteem moderate the relation between *intention to use* and *actual use*. What people respond in a questionnaire about the *intention to use* in general does not comply with their *actual use* of the system in the long run.

2) Evaluation activities: For the evaluation activities, the methodology developed will be based on a multi-criteria grid that will take into account issues related to all the domains that need to be evaluated: acceptability, ethics, usages, effectiveness compared to the functionalities defined in requirement list as well as an economic model. This evaluation grid will take into account the state of the art from both a European (HTA) and French (GEMSA) perspective in respect to evaluation [22], in order to evaluate the project developments.

The evaluation grid is based on the developed scenarios emerging from user requirement work earlier. Although the project platform benefits from integration into a robot house, a real residential house with the usual features of a domestic living space, in order to match the testing environment closely to the *real-life* and to make the users feel more at home, the evaluation protocol will simulate the relational conditions that would be encountered in their homes. In real terms this means that the usage evaluated will take place in a relational network, a triad that could facilitate but also potentially hinder the acceptance of the robot.

This exploratory technique is thought to enable identifying factors that influence the acceptance of the robot, as well as manner in which the robot could be best used. The work currently underway is focused on the development of the protocol in a smart-house in which relational triads (an elderly person with their own informal carer and healthcare professional) and an observation system (video camera, two researchers present) will be used, coupled with a face to face debriefing that will be both individual and collective (by triad).

3) Ethics and ethical framework: Social care may be funded by the individual but it is also provided by the state. Individuals with substantial resources purchasing their own care may well have an acceptable (to them) level of control over the care provided for them, including that with a technological element. Vulnerable individuals who depend on state funding for their care provision may have substantially less control. Even those who are purchasing technology for themselves can only exercise choice insofar as choices are available. The fact that care is intensely personal

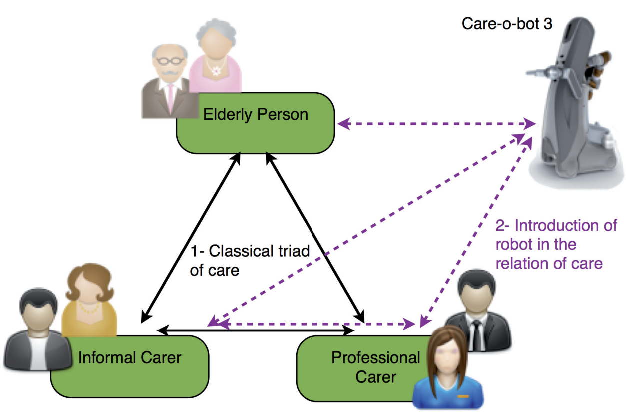

Fig. 8. Traditional triad of care needs to be re-organised to incorporate Accompany robot

is just one reason to consider the ethical dimensions of technology designed to provide care. Another is that the purpose of technological care is often to enable the user to live in her own home for as long as possible, and any device that has the capacity to collect and transmit data from a person's home raises privacy concerns. Given that robots are expensive, another issue is whether robotic technology genuinely offers something more than lower tech' assistive technology that includes some two way human interaction. One possibility is that the presence' generated by the robot offers more in the way of companionship than intermittent human company gained by telephone or tele-visual links.

It is arguably better to anticipate and address ethical concerns at the design stage of technology, though it may not be possible to anticipate all concerns and people may disagree about what the ethical concerns are and how they should be addressed.

In ACCOMPANY project, consideration of the ethical issues runs throughout the project, roughly in three phases. In the first phase, we looked at what the range of potential ethical concerns might be and suggested several principles that should govern the design of the robot. This research was theoretical in the sense that it drew on existing literature and established general moral theories and principles, even though the researchers based their thoughts around the capabilities of the emerging ACCOMPANY robot design aims. The principles suggested by this theoretical analysis were:

- autonomy - being able to set goals in life and choose means;
- independence - being able to implement one's goals without the permission, assistance or material resources of others;
- enablement - having or having access to means of realising goals and choices;
- safety - being able readily to avoid pain or harm;
- privacy - being able to pursue and realise one's goals and implement one's choices unobserved;
- social connectedness - having regular contact with friends and loved ones and safe access to strangers one can choose to meet.

Clearly, however, there will be occasions when these principles will be in tension, for example a user may value their privacy or autonomy over their safety. The next phase of the research, which is currently ongoing, recognises that an authoritative guide to the preferences of those who are elderly are the elderly themselves. In this phase potential user input is being sought on the extent to which any of the values assert themselves as having priority when potential users discuss scenarios designed to place them in tension. This data can also be analysed to determine whether the responses of the elderly to the scenarios suggest further principles that the purely theoretical analysis neglected. In the final phase, we will re-visit the framework suggested in phase one and revise it in the light of the data collected in phase 2. At this point other issues emerging from robot's design can also be addressed.

III. CONCLUSIONS AND FUTURE WORKS

A. Conclusions

This paper presented our coordinated effort in the area of companion robotics and smart environments. It highlighted the multidimensional approach, ranging from user requirement analysis to identify the needs for companion technologies, to empathic and social interaction design to engage with users at a primal level of interpersonal interaction, memory and relearning for a robot to be able to recognise and interact efficiently, environment and activity monitoring so that a robot and its environment can exchange information about individuals and their tasks, and finally ability to integrate technologies under one platform. These developments, emerging from different disciplines and areas of advanced ICT, are then evaluated for acceptability, and towards initial requirements set at the start of the project. Additionally, the paper shows that as new studies try to approach the issue of companion technologies, there are different ethical considerations needed at different levels of developments. These relate to tension between autonomy, independence, enablement, safety, and social connectedness. Overall, the paper shows the extensive range of activities that support human-system interaction, in the context of the FP7 Accompany project.

B. Future Works

The project has started its second year of activities where developments in its first year will be evaluated against requirements initially set. During the second year, further development will be based on formative evaluation cycles allowing to add to the extensive amount of work achieved to-date. Activities during the second year of the project will result in completion of the second project scenario, which will also act as a demonstration and evaluation tool during the third year.

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