PROJECT PERIODIC REPORT

Publishable Summary

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1 PUBLISHABLE SUMMARY

1.1 Executive Summary

1.1.1 Introduction

The second Year for MOBISERV was a difficult and complicated challenge for the Consortium in many ways. As user needs are the central issue of the MOBISERV system design, from its conception (that was part of the year 1 activities) to its implementation (that is part of the year 2 & 3 activities), important user studies (with primary, secondary and tertiary users) were further conducted as part of the year 2 activities. These activities were in line with recommendations (i.e. R2, R5) made by our reviewers' during the 1st annual review. Technical developments and mainly developments referring to Interaction (part of WP6) and Human - System Interface (part of WP7) (that is an iterative process proposed by the user-center approach) cater for the potential needs of all "categories of" users (primary, secondary, and tertiary) as these are thoroughly identified in user studies. Consequently after receiving updated user responses, specific components (and in some cases even the higher level system design) needed to be refined, and implementations needed re-engineering. These design steps have proven more time consuming than originally expected. The same stands for integration activities that came next in the project timeline (as they were providing and getting feedback from individual components development activities).

These delays affected the second Year internal scheduling Workplan and called for coordinator mitigation measures. The coordinator conforming to Year 1 recommendations, started the implementation of an Earned Value Analysis methodology that allowed to directly relate effort consumption with workplan responsibilities, deliverables and milestones. On June 2011 the coordinator identified a significant delay in the delivery of the refined design specifications for several MOBISERV modules. Following the planned 2nd Year schedule and earned value analysis, the coordinator announced that it would be necessary to postpone acceptance of quarterly reported efforts until the planned milestones would have been successfully reached. Exercising coordinator powers to rule strict deadlines in order to compensate with delays, the coordinator announced that he would peg additional available pre-financing with milestone achievements. It has to be clarified that this pegging referred only to extra pre-financing (additional to the Year 1 accepted budget and additional to the Year 2 earned planned Budget).

In August 2011 at a plenary meeting in Lappeenranta Finland, the coordinator set out an analysis pointing out alternatives if the immediate milestones (MS3 and MS4) were not met. The alternatives were presented and an analytic contingency plan delivered to partners. Risk mitigation was also presented which accounted for work plan rescheduling, allowing room for effort restructuring among partners. The consortium has hitherto debated thoroughly on how to handle specific delays (e.g. Work Package 6 Information Coordination and Communication Support system and Work Package 7, First Integrated MOBISERV System Prototype). An overall position has been endorsed on November 15th-16th at an extra ordinary General Assembly where it was decided to stick to the initial goal of reaching milestones MS3 and MS4 even if there were three to four months delay in individual deliverables (e.g. D6.1, D7.2, and D2.7). The adopted plan indicated that during the last two months there would be an increase in effective effort to catch up with the interim delays.

Overall MOBISERV can report that there have been some task delays, nevertheless the consortium compensated the delays at the annual cycle.

1.1.2 Main achievements

In first 12 months, work-package **WP2** focused on requirements elicitation, prioritisation and selection, and on collecting all the information which will be necessary for guiding the design and for defining the specifications of the system. Additionally, the MOBISERV prototype and system usability framework has been defined, initial field trials of the Kompai robot have been conducted and the MOBISERV validation plan has been prepared and updated. The main achievement of WP1 was the milestone 1 (Initial System Requirements Specification, achieved by the delivery of D2.3).

During the second period, WP2 objectives were to plan and conduct initial field trials of individual MOBISERV components and, a soon as the First integrated MOBISERV System Prototype would have been made available, to conduct a first round of full field trials of the fully integrated prototype; the outcomes of these evaluations would result that more specific requirements will start to emerge and be refined as end users and stakeholders gain a clearer understanding and experience of the scope of the technology and the consortium sees how the technology needs to be further adapted to suit needs, and continue studying user acceptability issues. As, in the annual review it was perceived by the reviewers that the translation of user requirements into system requirements and specifications are satisfactorily elaborated, although few seem to be considered with regard to secondary and tertiary users, additional studies targeted to secondary and tertiary users conducted under WP2 (which, subsequently, fed WP3 - WP7 activities). The MOBISERV validation plan has been prepared and updated, further links with local groups of older adults have been established for evaluation and dissemination, additional field trials of individual components (i.e. the Kompai robot and the smart textiles) have been carried out and scenario(s) for cognitive stimulation game(s) were prepared in close collaboration with psychologists.

Furthermore, evaluation of the initial prototypes conducted with the aim to ensure that all MOBISERV components are appropriate and usable for the target users for whom they are designed, and address all aspects relating to achieving the desired functionality and usability. Though, as there have been delays in delivering the First MOBISERV System Prototype, the first round of evaluations was partially conducted. In particular, the fist two out of the three parts (Part A: Expert Evaluation and Part B: Small Focus Groups) were carried out as originally planned, whereas the remaining part (Part C), which involves field trials of individual components with users, was postponed for February - April 2012.

In the first 12 months, work-package **WP3** provided specifications for MOBISERV architecture, its components and interactions among the components, following the requirements gathering and analysis phase. The main achievement of WP3 was the milestone 2 (Technical Specifications, Test and Implementation Scenarios, achieved by the delivery of D3.1).

During the second period, WP3 activities were informed by the outcomes of WP2 activities (so as to cater for the more specific user needs identified in user studies), as well as by feedback received from the integration process of the individual MOBISERV components (WP7 activities). Based also on market, standards and technology monitoring, this resulted to an updated set of the MOBISERV system technical specifications, test and implementation scenarios (D3.2 - Issue I) (clarifying, also, the MOBISERV minimum deployment scenario); this set will be further refined after concluding with the first round of the full field trials of the fully integrated MOBISERV prototype (i.e. after carrying out the Part C of the evaluation of the First MOBISERV System Prototype), as they will be reported in D3.2 - Issue II.

In the first 12 months, work-package **WP4** started developing new approaches for nutrition support and well-being based on computer vision techniques. These activities are related to the

nutrition support and well-being of older persons and focused to the eating/drinking activity and facial expression recognition.

Work on *eating/drinking* activity *recognition* focused on the use of skin colour segmentation and the application of a well-established technique for human activity recognition. Preliminary results were encouraging on discrimination of eating from drinking and apraxia using privacy preserving representations called dynemes. Moreover, novel algorithms based on artificial neural networks have been proposed for improving the discrimination ability of the dyneme representation.

First results on *facial expression recognition* targeted to the aims of MOBISERV shown that the facial expressions are rather person-dependent and that generic subspace methods cannot solve efficiently the generic problem. Initial novel classifiers developed to cope with the multiclass classification problem. Furthermore, work on the face detection problem was carried out, proposing new computational intelligence techniques for fast and pose invariant face detection. To cope with the problem of facial image registration, frontal view recognition techniques were proposed as a pre-processing step in order to reduce the false alarms and boost the performance of facial expression recognition. Novel algorithms incorporating subclass information in the discriminant non-negative matrix factorization framework for facial expression recognition, were also proposed. Robust statistics were incorporated in the support vector machines to cope with outliers in the training set and provide more efficient classification performance for facial expression recognition.

During the second period, WP4 activities focused on testing and improving the initial algorithms produced for nutrition support and well-being and preparing the first version of the context-aware and nutrition support prototype (that was due to July, 2011). As far as *nutrition support* is concerned, work on novel classifiers that are based on Neural Networks and are combined with Self Organizing Maps for privacy preserving representations continued. Additionally, the possibility of using object detection algorithms for nutrition support was explored. A novel method for multidimensional sequence classification has been devised (it is noted that activities, such as eating and drinking activity, are considered as sequences of multidimensional human body poses or 2D trajectories obtained by tracking), with very good results. As far as *facial expression recognition* is concerned, a novel approach that uses subclasses in the discriminant non-negative matrix factorization criterion for facial expression recognition was proposed and the results were very promising. Furthermore, robust statistics were combined with novel SVM classifiers to boost their performance in facial expression recognition as well as a robust graph embedding framework was investigated. An efficient dimensionality reduction method, combining Random Projections (RP) and SVMs in a single iterative optimization framework, has been explored and the experiments on real data have also shown significant improvement on facial expression recognition.

A large scale video database for eating/drinking activity recognition has been created and is available at http://www.aiia.csd.auth.gr/MOBISERV-AIIA/index.html. This MOBISERV-AIIA Eating & Drinking Database can be used as a reference for all the researchers working in the field, and more importantly to serve as a valid dataset in which the MOBISERV algorithms can be trained and evaluated. This database has been enriched by recording performed at the premises of project partner Stichting ST ANNA Zorggroep in Eindhoven. In addition to the above, data collection and annotation activities with respect to facial expression recognition started. The results of these activities are and will be used for training and testing the computer-vision based algorithms developed under WP4.

The software libraries and services developed as part of the context-aware and nutrition support prototype have been modified and recompiled in order to be compliant and integrated with the MOBISERV robotic platform. The implementation of final versions for EatingML, DrinkingML and EmotionML libraries was carried out. A dynamic link library has been developed, which will be used in the integrated application in order to take decisions of eating and drinking events. A new module

responsible for taking decisions on eating and drinking activities based on the ActivityRecognition module xml results has been implemented.

Additionally, during this period a simple game for facial expression monitoring and recording has been developed resulting in a stable and user-friendly version, requiring the minimum possible interaction with the operator. The developed facial expression recognition algorithms have been also integrated into the robotic platform.

One of the main achievement of WP4 was the delivery of the first context-aware and nutrition support prototype (D4.2), which contributes in meeting the third project milestone.

In the first 12 months, work-package **WP5** activities focused on the design and initial development of the multi-sensor embedded system platform for vital sign monitoring. Daily and nightly garments were designed and are fully compatible with a unique data logger. An application on a Smartphone (Android) as user interface has been developed with the aim at showing the capability of the system.

During the second period, WP5 activities focused on the design and development of the final embedded electronics with two wireless communication systems: Bluetooth for the communication with the Physical Robotic Unit (or a Smartphone), and ANT for a body sensor network. The respiration measurement could be through a Strain gauge of by IPG. Layout routing, PCB populated and functional test. After the first prototype of garment and following the remarks of the users, a second generation of garments (sensorised shirt and band for day use, pyjamas for night use) has been designed taking into account the use of new technology for the respiration measurement. The data logger has been also updated with the integration of an ANT module (used for the wireless body array network), the addition of 4 LEDs, and the integration of the jack connector into the housing (in order to improve the ergonomics). The embedded signal processing has been also improved. The user interface on a PC was also updated. This refers to a multi-parameter acquisition software system, implemented in Java, which has been tested on Microsoft Windows7 and Mac OS X and therefore is available for both OS.

The main achievement of WP5 was the delivery of the Multi-sensor system integrated into wearable fabrics (D5.3), taking into account the results of user studies and early trials, which contributes in meeting the third project milestone.

In the first 12 months, work-package **WP6** collected requirements and constraints for the Information Fusion and channeling component, as well as for the MOBISERV communication system. Existing paradigms evaluated and work on the Interaction Flow for each one of the system high-level functionalities started. Furthermore, requirements for the remotely accessible services for secondary users have been analysed.

During the second period, WP6 activities involved the refinement of the MOBISERV Information Fusion and Communication System design, based on the outcomes of additional user studies conducted as part of the year 2 activities. A set of sequence diagrams has been prepared for each one of the five high-level functionalities selected for evaluation, and the components involved (especially those interacting directly with the MOBISERV Information Fusion and Channeling components, i.e. with the Interaction Manager) have been described - in more detail. Based on these diagrams, development activities of the InteractionManager as well as the MOBISERV communication system took place. WP6 activities, involved, also the design and development of services targeted to secondary users, which can be accessed remotely, over the web. Furthermore, as a broader goal of the MOBISERV project is the integration with smart home / home automation environments, this WP

involved activities with respect to the design and development of a collaborative interface between the MOBISERV robotic system (PRU) and the smart home assistive infrastructure. Initial developments of the MOBISERV Information Coordination and Communication support has been informed by integration activities conducted under WP7 and updated accordingly. Finally, initial security analysis of the MOBISERV system has been conducted.

The main achievement of WP6 was the delivery of the First Coordination and Communication system prototype (D6.1), which contributes in meeting the third project milestone.

In the first 12 months, work-package **WP7** focused on preparing and delivering - earlier than originally planned - a first robotic platform. The first robotic platform was delivered in advance, to organise early field trials and user interviews. This is an existing programmable robot that helped in getting useful information and specification from users in order to build the final MOBISERV setup (second robotic platform). Furthermore, development was made concerning the HMI (actually, the Human Robot Interface - HRI) in order to obtain a modular architecture allowing consortium to reuse components in a more advanced (functional but also aesthetical and ergonomic) version dedicated to the project objectives. Also, based on users' feedback, received during users' interviews, work on the MOBISERV prototype started by beginning the definition of the new platform shape (mobility and platform kinematics as well as embodiment).

During the second period, WP7 activities focused on preparing the MOBISERV robotic platform prototype and integrating the robot with the rest of the system components. The RobuBOX™ Kompaï application was used as a starting platform to be improved and modified in order to fulfill the project requirements, in terms of integration of different partners' components and in terms of ergonomics and comfort. Work on defining the new platform shape (mobility and platform kinematics as well as embodiment), and integration of the additional sensors (camera, micro, etc) carried out. Furthermore, activities concerning the definition of the new robot communication interface took place, with the aim to make this definition converging with the robuBOX software possibilities, including attached development tools. User studies with primary and secondary users have been conducted to identify both the design and content that will be most usable and acceptable. This resulted to a new specification of the Human-Machine Interface, including graphical and voice interfaces; this acted as our guide for subsequent development of the MOBISERV application for the primary and secondary users. The global MOBISERV application, installed in the robot's tablet-PC of the MOBISERV Physical Robotic Unit, interfaces with certain individual system components required to implement the five high-level functionalities that will be supported by the Fist MOBISERV System Prototype. In that way, the nutrition activity recognition algorithms (see [D4.2]) are integrated in the MOBISERV prototype for testing and performance evaluation. The MOBISERV system integrates also with the Wearable Health Supporting Unit (see [D5.3]), which monitors and encourages physical activity, and with the Smart Home Automation, to enable interaction with a mobile screen connected to the front door (as defined in [D6.1]).

The main achievements of WP7 was the delivery of the Robotic platform First Prototype (D7.1), which contributes in meeting the third project milestone, and the delivery of First MOBISERV System Prototype (D7.2), which marks the third project milestone.

In the first 12 months, work-package **WP8** produced two periodic issues of the MOBISERV Plan for the Use and Dissemination of Foreground. The project website was launched and the content of its static webpages were translated into all partner's local languages. Project dissemination material was produced (e.g. project logo, project general presentation and presentation template, brochure, poster in Dutch, etc) and has been used/ diffused in various events. The consortium participated in

numerous conferences/events and produced research papers, newsletter, press releases, press coverage, and other publications. Furthermore, the consortium liaised with working groups and projects relevant to the project and set up a list of contacts with end-user groups (elderly associations/ networks, associations of gerontology and geriatrics, health care associations, health care institutions, housing associations, individuals, etc.) mainly from the partner's countries. Finally, an initial version of the MOBISERV exploitation plan has been produced.

During the second semester, WP8 activities focused on identifying and participated in numerous conferences, workshops and events, and produced research papers, press coverage, and other publications targeted to the scientific community but also to the user communities covered by the project. Further links with groups of older adults and secondary stakeholders were established for raising awareness and for potential exploitation, and additional dissemination material was produced. Further exploitation plans were also investigated and updated.

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