

**07462 Abstracts Collection**  
**Assisted Living Systems - Models, Architectures**  
**and Engineering Approaches**  
— Dagstuhl Seminar —

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**Abstract.** From 11.11. to 17.11.2007, the Dagstuhl Seminar 07462 “Assisted Living Systems - Models, Architectures and Engineering Approaches” was held in the International Conference and Research Center (IBFI), Schloss Dagstuhl. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

**Keywords.** Assisted Living Systems, Models, Architectures, Engineering Approaches, Aging, Ambient Technology, Human Interfaces, Sensor Technology, Software Technology

**07462 Summary – Assisted Living Systems - Models, Architectures and Engineering Approaches**

The Dagstuhl seminar on Assisted Living Systems (Seminar 07462) took place in November 2007 (14.11.2007 - 17.11.2007). The seminar was attended by more than 40 specialists from 14 nations and 5 continents. The key question was, if assistive technologies based on computer-based Ambient Intelligence Technology can help to substantially extend the period of self-determined life for elderly people. Assisted living systems were discussed from three different viewpoints: the medical/psychologists viewpoint, the outside viewpoint (users and industry), and the inside viewpoint (sensor and software technology). This was reflected in 5 sessions on the phenomena of aging, ambient technology, human interfaces, sensor technology, and software technology.

*Keywords:* Assisted Living Systems, Models, Architectures, Engineering Approaches, Aging, Ambient Technology, Human Interfaces, Sensor Technology, Software Technology

*Joint work of:* Nehmer, Jürgen; Kleinberger, Thomas

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1474>

## **Software Architecture Trends and Promising Technology for Ambient Assisted Living Systems**

*Martin Becker (FhG IESE - Kaiserslautern, D)*

Driven by the ongoing demographical, structural, and social changes in all modern, industrialized countries, there is a huge interest in IT-based equipment and services these days that enable independent living of people with specific needs. Despite of promising concepts, approaches and technology, those systems are still rather a vision than reality. In order to pave the way towards a common understanding of the problem and overall software solution approaches, this paper (i) characterizes the Ambient Assisted Living domain, (ii) briefly presents relevant software architecture trends, esp. applicable styles and patterns and (iii) discusses promising software technology already available to solve the problems.

*Keywords:* Ambient Assisted Living, Software Architecture, Technology, Middleware

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1455>

## **Sensor Technologies for AL Systems Integrated Health Monitoring and Emergency Call System**

*Roc Berenguer Perez (CEIT - San Sebastian, E)*

Most developed countries are facing an ageing population, leading to an increasing demand on both health care and social welfare systems. There is a general agreement that these increasing needs can not be met by increasing the provision of hospital care or other forms of institutional care. Therefore, home care is an obvious alternative to meet the future needs of the elderly people. In this way, new home sensor networks need to be developed. The presented position statement establishes the basis for future integrated health monitoring and Emergency call system based on vital signs sensors.

*Keywords:* Assisted Living Systems, Sensor Technology, Health Monitoring, Emergency call system

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1456>

## Integrated Human Behavior Modeling

*Michael Berger (Siemens - München, D)*

In order to prevent emergencies or critical situations where humans are the origin, a timely provision of information thus obtained for the coordinating services and the on-site staff (e.g., emergency dispatch centers, emergency physicians, police) is necessary. The detection of critical situations and the early alarming, e.g., in case of deterioration of the person's health status or a critical incident in a public space like a stadium, could prevent acute emergency cases and the resulting negative impact on individual persons and the environment. To analyze the current situation, the human behavior must be understood, analyzed and modeled on the basis of, e.g., monitored activities, user mobility, and selected biological parameters. Only an integrated and comprehensive human behavior model can be the basis for the prevention of emergency cases.

*Keywords:* Human Behavior Modeling

*Joint work of:* Berger, Michael; Beyer, Dagmar; Prueckner, Stephan

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1457>

## Assisted Living Systems: Human Factors Considerations

*Johnell O. Brooks (Clemson University, USA)*

Although many older adults wish to live independently, remaining in their own homes as long as possible, they may face obstacles such as transportation issues, social isolation, upkeep of the home, and increasing in-home care costs, which prevent them from doing so. The use of technology within the home, through technology-based assisted living systems, has the potential to alleviate some of these obstacles. Incorporating human factors principles to maximize safety, efficiency, and usability is key to the development of these systems.

*Keywords:* Older adults, aging in place, human factors, assisted living systems

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1458>

## Integration of Home Automation Technology into an Assisted Living Concept

*Martin Flöck (TU Kaiserslautern, D)*

A brief overview over a real-world Ambient Assisted Living (AAL) project in Kaiserslautern, Germany, is given.

It does not only incorporate scientific re-search but also involves the prospective senior users right from the beginning. The authors' perception of AAL is characterized as follows: The aspects of safety, comfort, health, and communication cannot be separated but need to be addressed simultaneously. To achieve this, only off-the-shelf home automation devices are used to limit the hardware costs. Every developer, however, should be careful not to overrate the capabilities of modern technology. To create AAL environments worth living in, social environments of the addressed AAL users must be identified and conserved in their new surrounding.

*Keywords:* Ambient Assisted Living, Senior Housing, Activities of Daily Living, Sheltered Housing

*Joint work of:* Floeck, Martin; Litz, Lothar

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1459>

## **Dynamic Services for Assisted Living Environments**

*Nikolaos Georgantas (INRIA Paris-Rocquencourt, F)*

Software technologies for assisted living systems can be derived from the more mature domain of pervasive computing and the relative emerging ambient intelligence field. We present herein our position about the need for interoperability enablers extending the software service paradigm and for dependability as key elements of assisted living software systems.

*Keywords:* Assisted Living Systems, Software Technologies, Pervasive Computing, Ambient Intelligence, Service, Middleware, Interoperability, Dependability

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1460>

## **Functional Changes in Older Adults: Impact on Home Technology Design**

*Victor A. Hirth (University of South Carolina, USA)*

This talk will outline leading causes of functional decline in older adults and how Smart Home Technology could impact the health and well being of older adults.

## Functional Changes in Older Adults: Impact on Home Technology Design

*Victor A. Hirth (University of South Carolina, USA)*

The aging demographic being experienced by all western countries has significant impact on health care utilization as well as the ability to remain in independent living situations. Chronic medical conditions and functional disability impair older adults' ability to remain independent. Ambient assisted living technologies may help less the burden of disability and increase the likelihood of older adults remaining independent into their later years.

*Keywords:* Chronic disease, functional and cognitive decline, geriatric syndromes

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1461>

## Ethical Aspects in the Design of AAL Systems

*Veikko Ikonen (VTT - Espoo, FIN)*

This presentation gives guidance on ethical issues that should be taken into account when designing applications and services that utilise MINAmI platform for mobile-centric Ambient Intelligence. The guidelines also cover issues related to implementing the MINAmI platform itself. The guidelines are divided to impact on design solutions: what kinds of solutions are ethically acceptable and impact on design process: how to design ethically acceptable solutions. Impact of ethical principles on design solutions is analysed on two levels: 1) general technical features of mobile AmI and impact of ethical principles on them and 2) impact of ethical principles on application field specific features of mobile AmI. In the latter the focus is on MINAmI-specific application fields: health care, assistive technology, housing and everyday. During different phases of the technology design process, required ethical considerations are different. The perspectives of different stakeholders should also be taken into account. By means of a holistic perspective we can consider the challenges, threats and opportunities in advance when designing new technologies for our future everyday environments.

*Keywords:* Ambient Intelligence, Smart Environments, Ethical Issues

## Ethical Assessment in the Design of Ambient Assisted Living

*Veikko Ikonen (VTT - Espoo, FIN)*

This paper tackles on ethical issues that are relevant when designing new technological service systems for the assisted living.

In this paper we present our preliminary ethical guidelines that are built on six ethical principles that are selected based on the ethical assessment of MINAmI scenarios. The aim of ethical assessment is to conclude concrete and clear ethical guidelines that could be used as check lists in MINAmI platform design, demonstrator design and further in general in designing applications onto the MINAmI platform. We assume that this kind of checklist is also useful for other Ambient Assisted Living type of developmental work.

*Keywords:* Ambient Assisted Living, Ambient Intelligence, Ethical Guidelines, Privacy, Scenarios, Human-Centred Design

*Joint work of:* Ikonen, Veikko; Kaasinen, Eija

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1462>

### **Position statement: Physical activity monitoring of elderly patients - 3 tricks to advance the field?**

*Bart Jansen (Vrije Universiteit Brussel, B)*

This position paper argues in favor of three approaches for advancing the field of monitoring physical activity of elderly patients.

*Keywords:* Elderly patients, physical activity, robot imitation

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1464>

### **Position statement: Telemonitoring - a too limited view on the wellbeing of the patient**

*Bart Jansen (Vrije Universiteit Brussel, B)*

This position paper argues for using a 3D camera for the monitoring of physical activity of elderly patients.

*Keywords:* Telemonitoring, physical activity

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1463>

### **Assisted and Independent Living - The User Perspective**

*Arthur I. Karshmer (University of San Francisco, USA)*

There is little doubt that the elderly population of the world is growing. The greatest growth in this segment of society happens to be in the industrialized nations and is becoming a serious public policy issue, which will have a dramatic economic impact.

Many approaches to solving this problem have been presented from various perspectives. In the current work, we examine the challenges associated with the users of services for the elderly. While much of today's discussion centers on technologies and best practices, it is essential that the user be considered in any proposed solutions.

*Keywords:* Assisted Living, Aging

*Joint work of:* Karshmer, Arthur I.; Farsi, Daryoush

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1465>

## **Position paper: Establishing the Market for Assisted Living Solutions**

*Thomas Kleinberger (FhG IESE - Kaiserslautern, D)*

Comprehensive assisted living solutions require interdisciplinary contributions, during development as well as during operation. What can be done, so that the prerequisites for a real market for comprehensive assisted living solutions are fulfilled? The position paper list the actions that are currently started by EU and local governments in order to foster the evolvement of the market for assisted living products.

*Keywords:* Ambient Assisted Living, Market, Action Plans, AAL169

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1466>

## **Aging and Technology**

*Rosemarie Lamm (University of South Florida - Lakeland, USA)*

This paper presents the physical and mental changes related to the aging process and the limitations it presents for the elderly. Chronic diseases also limit function and ability to be independent. This limitation results in social isolation with psychological alterations including dementia. Technological interventions are a promising approach for minimizing these limitations. Technologies are also being developed to monitor elders and provide information to caregivers and health care providers. Automated living assistance systems promote elderly individuals' ability to "age in place".

*Keywords:* Aging, Physical changes, functional limitations, technology, automated living assistance

*Joint work of:* Lamm, Rosemarie Santora; Lamm, Edwin Roth

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1467>

## **Assistive Technology for Successful Aging: Perspectives from Developmental Behavioral and Neuroscience**

*Shu-Chen Li (MPI für Bildungsforschung, D)*

Growing into old age is a personal privilege and a societal achievement. However, it is also a challenge for both the individuals and societies. The impressive gains in extending average physical longevity to 75 years and beyond is not necessary accompanied by high-levels of physical, psychological, and brain "fitness". Thus, it is important to seek ways to help older adults maintaining functions in these domains in order to maintain life quality in old age. Adaptive assistive devices and environments are promising technological advancements for promoting successful aging. Sufficient plasticity in the aging psychological and neurocognitive systems are necessary for technologies to engender desired effects. Designs and evaluations of assistive technologies need to consider dynamic changes in developmental resources across the lifespan. This paper reviews evidence of behavioral and neurocognitive plasticity in old age and highlights psychological principles for successful aging technologies.

*Keywords:* Successful aging, Plasticity, Assistive technology, Resource allocation

*Joint work of:* Li, Shu-Chen; Schellenbach, Michael; Lindenberger, Ulman

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1468>

## **Session 3/5 Position Statements and Session 1 Key Messages**

*Max Mühlhäuser (TU Darmstadt, D)*

The PDF documents enclosed represent position statements given at Sessions 3 (HCI) and 5 (Software / System Support) as well as a 1p summary of key messages collected during Session 1

*Keywords:* Ambient assisted living, HCI, middleware, smart environments

## **Software Development Support for Ambient Assisted Living**

*Max Mühlhäuser (TU Darmstadt, D)*

Key issues in software development support for Ambient Intelligence and Ubiquitous Computing are briefly discussed; special requirements in the context of Ambient Assisted Living are related to these issues.

*Keywords:* Software Development, Ambient Intelligence, Ubiquitous Computing, Ambient Assisted Living

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1469>

## **Multimodal Interaction for Ambient Assisted Living (AAL)**

*Max Mühlhäuser (TU Darmstadt, D)*

Ambient Assisted Living calls for considerable advancements in user interfaces, compared to conventional computers and applications. Multimodal interaction plays an important role in this context. The contribution start from the broader perspective of ambient intelligence and ubiquitous computing, discussing major requirements imposed on multimodal interaction and interactive software development. These more general requirements are then briefly revised with respect to AAL specific issues.

*Keywords:* HCI, User Interfaces, Multimodality, Ambient Intelligence, Ambient Assisted Living

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1470>

## **Living Assistance through Ambient Technology: An Industrial View**

*Hartmut Raffler (Siemens - München, D)*

Ambient technologies are technologies which are decisive for an Ambient Intelligence Environment. Ambient Intelligence (AmI) refers to the presence of a digital surrounding that is sensitive, adaptive and responsive to the presence of people. AmI is going to assist people in their daily life in a non-intrusive way. Assisted Live is not only restricted to homes. Assisted Living will encompass our home, our car, our work and the public spaces. ICT will become part of the environment in which people fulfil their tasks and in which people live. An Ambient Intelligence Environment will effectively support us in the completion of our daily tasks. This definition has to be extended to the industrial and business environment.

*Keywords:* Ambient Intelligence, Agents, Assisted Living, Framework for AmI, Context Awareness

## **Aging Users are Still Users**

*Mary Shaw (CMU - Pittsburgh, USA)*

Today's tech-savvy boomers will remain comfortable with technology as they age, though they may need different interfaces.

They need help with evaluating technical resources, but they will continue to adapt, tailor, configure, and program those resources. They need assistants, not supervisors.

*Keywords:* Ambient Assisted Living, Ageing Users, HCI

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1471>

## **Some important aspects of Medical and Nursing House Call sustaining Assisted Living of Ageing Population**

*Vasileios Spyropoulos (Technological Education Institute of Athens, GR)*

Although the house call a decade ago was declared a vanishing practice, statistics show an upwelling of home visits by physicians, in the developed countries, during the last ten years. A major reason for this is the radical alteration of the contents of the physicians' black bag that beyond the stethoscope includes also, a Personal Digital Assistant with embedded Cell-phone safekeeping detailed patient-records, sophisticated point-of-care diagnostic equipment and reagents, along with other technical means, that allow for providing care, comparable to that of an emergency room, at home. It is the purpose of the present study to explore the most important issues concerning the emerging contemporary house call Medical Practice, and to present the technical and managerial means we have developed, in order to support the adaptation of an ancient medical ritual and a traditional intervention mode, to the 21st Century managed care needs.

*Keywords:* House call, homecare, point-of-care in vitro diagnostics, portable imaging equipment, medical record, continuity of care record, treatment plan

*Joint work of:* Spyropoulos, Basile; Tzavaras, Aris; Botsivaly, Maria; Moschidis, Manolis; Mertika, Kostantina; Sochos, Periklis; Koutsourakis, Kostas

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1472>

## **Assisting age related capabilities by ambient technology to prevent functional decline**

*Elisabeth Steinhagen-Thiessen (Charité - Berlin, D)*

The elderly is characterized by age related capabilities and handicaps. Whereas age related capabilities like plasticity and adaptability on changing living conditions can lead to subjective well-being and support the recovery of limiting conditions like disease and disability, age related handicaps can enforce these conditions. Multimorbidity can lead to acute and chronic functional decline, especially when limiting conditions are enforced by age related handicaps. In a "circulus vitiosus" disease and disability threaten the independence of the elderly

that leads to immobility, social isolation, depression and other health conditions with amplification and generation of new diseases. Ambient Technology has the potential to interrupt this "circulus vitiosus" by limiting age related handicaps, assist age related capabilities, prevent acute or chronic diseases and as a consequence can improve the quality of life of elderly and their care giving relatives. In this overview we demonstrate a brief summary of past experience with Information and Communication Technology (ICT) as part of Ambient Technology (AT) in the "TeleReha" project and ongoing approaches in the "Vitanet" project and the "FOG-1" project followed by a future considerations conducting ICT-Project in elderly.

*Keywords:* Ambient Technology (AT), Ambient Assisted Living (AAL), Information and Communication Technology (ICT), elderly, multimorbidity, quality of life

*Joint work of:* Gövercin, Mehmet; Willmann, Richard; Lanfermann, Gerd; Kraft, Tobias; Mix, Stefan; Steinhagen-Thiessen, Elisabeth

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1473>

## Sensors for AAL – what is actually missing?

*Gerhard Tröster (ETH Zürich, CH)*

Ambient Assisted Living (AAL) relies on continuously monitored and reliable data describing the vital status, the situation and the behavior of the elderly. Wearable, on-body sensing, computing and communication systems will outperform the "ambient intelligence" approach, at least in the near future. Future wearable systems consist of a "Smart Phone" as the personal computing and communication hub, and on-body sensors, mainly integrated in the clothes

*Keywords:* AAL, Wearable Computing, Smart Textile, context recognition

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1475>

## Aware Communities

*Howard Wactlar (CMU - Pittsburgh, USA)*

Aware homes have become commonplace in industrial and academic research for prototyping assistive technology. It is vital that we rapidly move beyond the paradigm of an aware and responsive home to the development of an aware and responsive community infrastructure by incorporating devices and methods into a small urban community of homes, recreation facilities, retail, and service providers, on city streets with vehicular traffic. This will enable technology development to aid aging residents and those with disabilities with their

instrumental activities of daily living that extend beyond the confines of their home. We have been developing McKIZ (McKeesport Independent Zone) as a community development project which will be used as an integrated test-bed and evaluation environment for technologically assisted living. Blueroof Technologies (a not-for-profit corporation) has already developed, built, and tested a prototype of a Smart Cottage for seniors that includes a vast collection of at-home sensors, monitoring devices, internet accessibility, and advanced technology systems. McKIZ will build on this technology system to integrate sensors and technology systems into the community on streets, in buses, in stores, and the community center recreation facilities.

## **Cognitive Orthotics for Coaching Routine Task Performance**

*Howard Wactlar (CMU - Pittsburgh, USA)*

### **Cognitive Orthotics for Coaching Routine Task Performance**

One of the frustrations and detriments of dementia and other cognitive deficits is the breakdown in remembering and properly sequencing the steps in the performance of various routine tasks. This can range from simple morning hygiene to preparing simple meals and performing at-home medical procedures or operating home-medical devices. For those with mild cognitive impairment, cognitive orthotic systems can be implemented as coaches to prolong one's ability to independently perform the instrumental activities of daily living and self-care.

Such a cognitive orthotic system consists of three components: (1) Training the system by recording someone performing the task in the home environment as a sequence of operations, (2) observing a new instance of the operation sequence and recognizing that this operation deviates from the training data in a significant way and (3) providing corrective feedback to the user in the form of audio and video prompts. The key idea is to avoid trying to recognize the individual, labeled steps of the proper operation sequence in the video, but instead simply align the new video against the training videos, and note significant deviations. We establish a new paradigm for learning by observation that does not require complete kinematic understanding of detailed activities in arbitrary visual and sensor sequences, but aligns a given new sequence with previously established training data to detect significant deviations.

## **Policy-based Home Care Systems**

*Feng Wang (University of Stirling, GB)*

It is accepted that home care systems need to be customised and personalised for individual person. They also need to evolve over time. Besides, conflicts may occur between care services. We propose applying policy-based management in home care systems to facilitate the delivery and evolution of home care systems, and help the detection and resolution of conflicts in these systems.

*Keywords:* Policy-based management, home care systems, evolution, policy conflict

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1476>

## Reference Architecture for Ambient Intelligence

*Reiner Wichert (FhG IGD - Darmstadt, D)*

A lot of software infrastructures for distributed device ensembles with quite different approaches have been developed in the past. This article describes the need of a reference architecture for real ad-hoc cooperation of distributed device ensembles which must support self-organization of its components. Self-organization means that the independence of the ensembles' components is ensured, that the ensemble is dynamically extensible by new components and that real distributed implementation is possible.

*Keywords:* Ambient Intelligence, Self Organization, Ad-hoc Communication, Reference Model, Goal-driven Interaction

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1477>

## The impact of sensor-enhanced regional health information systems

*Klaus-Hendrik Wolf (TU Braunschweig, D)*

The expected economic impact of new health enabling technologies is often used as motivation for their development.

Another motivation is the predicted positive impact on health care in general. The objective of this paper is to give a simple example for an economic calculation based on statistical data. A positive effect on health care in general can only be gained if the new technologies are sustainably integrated in health care processes.

*Keywords:* Ageing society, health information systems, sensors

*Joint work of:* Wolf, Klaus-Hendrik; Marschollek, Michael; Howe, Jürgen; Haux, Reinhold

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1453>

## Ambient Assisted Living Systems - The Conflicts between Technology, Acceptance, Ethics and Privacy

*Wolfgang L. Zagler (TU Wien, A)*

Installing and using AAL Smart Home-systems in the homes of older people not only offers a tremendous potential for increasing safety and quality of life but may also evoke reluctance and anxiety.

Will such a system become a "Big Brother" watching the steps and the behaviour of the inhabitants and betray them to their outside world? In several field-trials of an AAL Smart Home-system with inhabitants of senior residences we were able to learn about the issues concerning acceptance, ethics and privacy when senior citizens and their care persons are confronted with this kind of technology for the first time.

*Keywords:* AAL, Ambient Assisted Living, Smart Homes, field trials, acceptance, ethics, privacy protection, data protection

*Joint work of:* Zagler, Wolfgang L.; Panek, Paul; Rauhala, Marjo

*Full Paper:* <http://drops.dagstuhl.de/opus/volltexte/2008/1454>