*Editorial*

# Signal Processing Technologies for Ambient Intelligence in Home-Care Applications

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The possibility of allowing elderly and people with different kinds of disabilities to conduct a normal life at home and to achieve a more effective inclusion in the society is attracting more and more interest from both industrial and governmental bodies (hospitals, healthcare institutions, and social institutions).

Ambient intelligence technologies, supported by adequate networks of sensors and actuators, as well as by suitable processing and communication technologies, could be one of the enabling factors to achieve such an ambitious objective.

Recent researches demonstrated the possibility of providing constant monitoring of environmental and biomedical parameters, and the possibility to autonomously originate alarms, provide primary healthcare services, activate emergency calls, and rescue operations through distributed assistance infrastructures. Furthermore, proactive systems help the user to perform daily activities, stimulating a more active and healthy lifestyle, and supporting functional rehabilitation and preservation processes.

Although some products are already appearing on the market, several technological challenges connected with these applications are still open, ranging from the development of enabling technologies (hardware and software) to the standardization of interfaces, the development of intuitive and ergonomic human-machine interfaces, and the integration of complex systems in a highly multidisciplinary environment.

The objective of this special issue is to collect the most significant contributions and visions coming from both academic and applied research bodies working in this stimulating research field. This is a highly interdisciplinary field comprising many areas, such as signal processing, image processing, computer vision, sensor fusion, machine learning, pattern recognition, biomedical signal processing, multimedia, human-computer interfaces, and networking. The focus is primarily on ambient intelligence and home automation technologies, considered as basic tools to build smart environments providing advanced home-care services.

The possibility of continuously monitoring the elderly and automatically detecting emergency situations clearly represents one of the priorities in home-care. The paper "Event detection using "variable module graphs" for home care applications," by Amit Sethi et al. proposes a new paradigm to better exploit ubiquitous audio-visual capture devices used in home-care applications, with a special focus on surveillance and complex event detection. Their approach relies on variable/module (V/M) graphs, a recent extension of factor graphs. V/M graphs are used to bridge the semantic gap between the huge amount of data produced by the capture devices and the useful high-level concepts to be elaborated by the vision system. From the application viewpoint, the primary objective is surveillance of location for subject tracking as well as detection of irregular or anomalous behaviors. This is done automatically with minimal human involvement, with the system being trained to raise an alarm when an anomalous behavior is detected.

Similarly, the work by J.-S. Hu, and T.-M. Su, titled "Robust background subtraction with shadow and highlight removal for indoor surveillance," tackles the problem of monitoring a person in the home environment. In this case, the

authors concentrate on the robust detection of foreground regions in complex indoor scenes, in the presence of illumination changes and dynamic backgrounds. These are typical conditions in ambient-assisted living infrastructures, where the environmental conditions cannot be strictly controlled, and the false alarm rate can become high. Their proposed approach achieves a robust background subtraction by suitably combining three models, namely the color-based probabilistic background model (CBM, based on a Gaussian mixture model), the gradient-based probabilistic background model (GBM, based on the short-term and long-term CBMs), and the cone-shape illumination model (CSIM, used to identify shadows and highlights).

N. P. Cuntoor and R. Chellappa further emphasize the behavioral analysis problem in their paper "Mixed-state models for nonstationary, multiobject activities." Here, the objective is to model and segment human activities in order to achieve a better knowledge on the actions performed by a subject, and how such actions are performed. The methodology developed by the authors to pursue this goal relies on a mixed state-space approach. The discrete-valued component of the mixed state represents higher-level behavior, while the continuous-state models the dynamics within behavioral segments. A set of behaviors is defined, based on generic properties of motion trajectories, and is used to characterize segments of activities. A Viterbi-based algorithm is used to detect boundaries between segments. The usefulness of the proposed approach for temporal segmentation and anomaly detection is illustrated in different contexts, including the UCF database of human actions.

If technologies enabling a timely response to harmful events are important, the possibility of preventing such events through an early analysis of dangerous behaviors would be even more attractive. The paper "The PARACHute project: remote monitoring of posture and gait for fall prevention," by David J. Hewson et al. describes the results achieved within a joint research project named PARACHute (Personnes Âgées et Risque de Chute), whose primary aim was to develop a methodology that enables the detection of an increased risk of falling in community-dwelling elderly. The main goal is to provide a remote noninvasive assessment for static and dynamic balance assessments and gait analysis. This is achieved by using a combination of two tools: balance assessment and gait analysis. The first is based on biomechanical tests (a force plate, providing a measure of the static and dynamic equilibria), while the second makes use of a vision system. The two subsystems perform local processing and can be remotely interconnected to medical and support networks.

Remote monitoring is also the main goal of the paper "Real-time transmission and storage of video, audio, and health data in energency and home care sitiuations," by Ivano Barbieri et al. In this case, the focus is put on the efficient transmission of large-bandwidth streams of audio-visual data for telemedicine applications (continuous monitoring and emergency handling). The proposed mobile communication system is based on the ITU-T H.323 multimedia terminal recommendation, suitable for real-time

data/video/audio and telemedical applications. The audio and video codecs H.264 and G723.1, respectively, were implemented and optimized in order to obtain high performance on the system target processors. Furthermore, offline media streaming, and storage and retrieval functionalities were supported by integrating a relational database in the hospital central system. A key aspect of the developed prototype is the use of low-cost consumer electronics in order to ease the market penetration of potential products.

Finally, the problem of assuring the privacy to endusers is of fundamental importance in hom-ecare applications, which have to deal with extremely sensitive data such as personal video and voice, biomedical signals. This problem is considered in the paper by Datong Chen et al. "Tools for protecting the privacy of specific individuals in video." The authors address two problems: first the automatic identification of people with limited labelled data, and second the problem of obscuring a human body in the video with preserved structure and motion information. The automatic identification is achieved by a discriminative learning algorithm, using a robust face detection and tracking algorithm. The body obscuration is implemented through a novel method, which removes the appearance information of the people while preserving rich structure and motion information. A prototype system was tested in a nursing home environment, demonstrating the possibility of minimizing the risk of exposing the identities of protected people while ensuring the usability of captured data for activity/behavior analysis.

We believe this issue will serve the readers well for many years to come on this important application area.

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