Multipoint Video Control System Applicable in Assistance of Elderly and People with Disabilities

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Abstract – **Ambient Assisted Living (AAL) is a new research area which promises to address the needs of the elderly and people with disabilities. AAL has a lot of barriers and challenges that impede its development and more universal deployment. These could be summarized as: technological, ethical, legal and psychological challenges. An approach which allows overcoming part of these barriers, mostly related to the integration of a video control system in the assistive process, is presented by the authors in this paper.**

***Keywords* – AAL, Fall detection, Assistance for the elderly, ICEST 2012.**

I. INTRODUCTION

An on-going tendency in developed countries is the ever increasing percentage of the elderly population, a process also known as gentrification. The situation in Europe is very serious – according to Eurostat 2008 in 2015 the demographic growth in the EU will become negative and by 2060 up to one third of the EU population will be aged 65 or above [1]. Similar demographic processes are also evident in other developed countries such the US, Canada, Japan, etc. These tendencies would put additional stress to the social and pension systems in the affected countries as the ratio of working to non-working people will drop. Also, there wouldn't be sufficient resources in the caring sector as the demand for personal assistants, nursing homes, hospices, rehabilitation centers and hospitals will greatly surpass the availability.

This is the reason why in recent years a lot of efforts have been concentrated in the search of alternative caring solutions. Ambient Assisted Living (AAL) is a relatively new area of research whose objective is to provide a solution for independent living of the elderly and people with disabilities. AAL could be defined as the distributed collection of intelligent systems (either implanted, body-worn, or embedded in the surrounding environment) that assist and monitor the elderly in their daily lives, thus assuring a better quality of life [2]. Under quality of life we understand the physical, mental, emotional and social well-being of a person.

One of the main objectives of AAL systems is to provide personal safety. Falling is a major risk faced by older people with one third of the people over 65 falling each year. Currently fall detection is a well researched topic and sensor based solutions are available and commercialized. The majority of such solutions are based on accelerometers, but one of the drawbacks of these systems is that users always need to wear the sensor. The system will not work if the user forgets to wear the device.

Recently a number of researchers have been looking at developing solutions based on video cameras and computer vision approaches. A monitoring system based on video cameras has potential advantages. The video signal is semantically rich, thus a single camera in a room could pick up most of the activities performed in the room, and consequently could replace a large number of sensors.

Video and image processing could be applied in different areas and for different purposes in an AAL system [3]:

- fall detection – cameras could be used in order to extend or replace other more traditional fall detection algorithms based on accelerometers, motion sensors, smart floors, etc.;
- activity monitoring – cameras could be used in simple actions tracking or more complicated daily life activities monitoring or classification;
- security – cameras are used in solutions that ensure that the home is protected, most often this means video surveillance;
- safety – cameras could be used in solutions related to personal safety, for example tracking people with dementia or other mental illnesses;
- telemonitoring of physiological parameters such as pulse.

The implementation of computer vision in AAL systems is different and depends on the aim of assistance (in relation with the assisted person condition) and the type of used cameras. Simple 2D digital cameras are cheap and easy to find but often a single 2D camera isn't sufficient for the purposes of AAL and multiple cameras have to be used on the price of processing algorithms complication [5]. 3D cameras are more expensive but provide more information about the position of the user's body in space and one 3D camera could be sufficient for an AAL application [6]. Omnicameras provide 360° view of the environment and could be used in more specific scenarios such as location tracking [3]. Stereocameras use two lenses in order to obtain stereo video signal which could be beneficial, especially for fall detection [7], although the processing algorithms are more complicated. There are also several applications of wearable cameras such as Microsoft's SenseCam in AAL – they are used in home risk zones detection or detection of significant events [8]. Finally, there are a lot of multimodal applications – i.e. applications in which cameras are used in conjunction with other sensors to obtain better precision of the selected algorithms.

Video or image capturing systems and their applications in AAL are a relatively recent research field and there are still a lot of challenges to be overcome [3].

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Video and image processing on its own is not a new research area but AAL is, and as a consequence there are specific issues related to the application of computer vision in AAL which haven't been fully resolved: the choice of video or image processing algorithms; the problem with occlusions; data fusion from multiple cameras; multi occupancy of the environment; presence of a pet such as a cat or dog, etc;

This integration challenge is related to the integration of the video processing subsystem with the other components of an AAL system. Problematic issues are: the interfaces to the other parts of the system; the choice of where to process the sensitive information – locally or centrally; ensuring good protection of the sensitive information.

A major and very serious problem in AAL systems is the acceptance by the users – the AAL system would be useless if the user refuses to accept and use it. Factors that might get in the way of acceptance are fear, reluctance or inability to use technology, or unclear evidence of the real benefits of the AAL system. Video monitoring systems present an additional acceptance challenge - the users are often very concerned that they will loose their privacy and as a consequence are reluctant to accept camera-based solutions in their homes or rooms. There are various approaches to handle this problem: to process locally the video or images (i.e. to use smart cameras) and if possible to forward only alarms to other parts of the system which are accessible by careers; to use silhouettes and edges instead of full pictures [4]; and most importantly to educate the prospective users, to explain that their privacy wouldn't be sacrificed.

An approach allowing overcoming a part of the acceptance barriers is presented by the authors in [9], where special attention is paid to the privacy. The problem was solved by interactive (voice) communication between the assisted person and the system, immediately before the beginning of video registration. The proposed two step approach for reliable fall detection was further improved and adapted in such a manner as to be able to embed it in multipoint video assistive system.

II. Method and Devices for Video Control

The paper presents the multipoint video control component of an AAL system which detects critical situations such as fall of the assisted person. The architecture of the AAL system is presented at Fig. 1. The main part of the system is a small computer (Mini PC), used as a gateway, on which a specially developed control application is running. All of the body-worn and environmental sensors, as well as the supplementary devices, are connected to the gateway via a standardized (Bluetooth, ZigBee, WiFi) or proprietary interfaces. If an emergency situation is recognized, and there is no consecutive person's reaction in a predetermined period, an alert is sent to the authorized person (or relative) via a GSM module embedded in the Mini PC.

The multipoint video control system is introduced as a means of improving the efficiency of the system. Sometimes an alarm would be triggered when there is no critical situation – e.g. the assisted person has slipped but has not fallen or has fallen but is not injured, and without the video monitoring component the AAL system will generate a false alarm.

Fig. 1. Architecture of the AAL system

The idea behind the introduction of video monitoring component is to verify that a generated alarm is indeed valid and whether further action should be initiated in order to provide help to the assisted person. Thus, the purpose of the video component is to increase the reliability of the AAL system and to increase the efficient use of the available monitoring and human caring resources.

The video monitoring is organized in a network of IP cameras situated at different places in the assisted person's home, in a manner allowing coverage of the whole area. The used cameras are model HS-691B-M186I (manufactured by EasyN), and have features appropriate for the concrete task.

It can be seen form the table that the cameras are equipped with audio input/output, which gives possibility to establish voice contact with the assisted person, for example immediately before starting the video monitoring.

The program window of the software application running on the gateway is presented on Fig. 2. As can be seen, the operator has the possibility to enter the architectural plan of the assisted person's home and to choose appropriate locations for the cameras in order to ensure coverage of the whole home area. The camera icons are fixed on the e-plan during system installation.

Fig. 2. Software toolbox for system configuration

When a potentially critical state is recognized by the system and there is no consecutive adequate reaction by the assisted

person, the AAL system sends a SMS (Short Message Service) message to a previously specified cell phone number or numbers.

If the contact person has access to a telecommunication network (such as WiFi, 3G, LAN), he or she could establish connection to the Mini PC and could remotely start video monitoring mode. This way the contact person would be able to assess whether the situation is indeed critical, could accept or reject the alarm, and could initiate any further action if it is required.

In order to minimize the traffic between the contact person and the Mini PC instead of video monitoring mode, the system could generate and send one or several MMS (Multimedia Messaging Service) messages showing the state of the assisted person and the reason for the alarm triggering. Of course, specific image processing and analysis algorithms are needed in order to recognize critical situations and to choose the suitable images to send. These algorithms are currently under research and development.

All triggered events as well as the corresponding reactions are stored in a local Mini PC database and could be accessed at any time.

III. Conclusion

The paper presents a multipoint video control system applicable in AAL systems for elderly and people with disabilities. The presented approach permits flexible realization of such a system, in accordance with the concrete needs and requirements of the assisted person, the architectural specifics of his/her home, the furniture, etc. The developed software application for control of IP cameras network allows the realization of a comprehensive AAL system not only in a single home, but also in specialized nursing homes, hospices, rehabilitation centers, etc. Additional plus of the system is the possibility for integration of additional network architectures, e.g. a network of detectors to monitor environmental parameters, controllers to turn on and off electrical devices, to measure their power consumption, security and alarm systems, etc.

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