Altcare: Safe Living for Elderly People

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***Abstract*-Elderly people are the most growing segment of the population. Most of the elderly people like to live an independent life at their own homes in a familiar environment. Living alone is not always safe, and often emergency situations like a fall and unconsciousness occur. We present an ambient assistant living system Altcare, based on static network video cameras. The Altcare automatically learns the common events and their location. Furthermore it detects the emergency situations happening with elderly people. In case of some emergency situations, the Altcare first confirms it with the monitored person. In case of a positive response or no response at all, the emergency situation is notified to the responsible persons, in order to get timely and effective help. Along with personal information and a short medical history of the elderly person, a patch of masked video showing the emergency event is also transmitted. The masked video on one hand maintains the privacy of the elderly people and on the other hand it helps the administrators to diagnose the problem accurately. Masked video is also helpful to provide specific initial first aid. In order to ensure timely help, the system receives acknowledgement for the sent emergency call. Some of the elderly people desire to be checked on a periodic basis. Our system gives the administrators a facility to check the state of the person at any time, which gives the elderly person a sense of safety and mental satisfaction.**

Keywords- Elderly people; Fall detection; emergency; monitoring; vision-based;

I. INTRODUCTION

Elderly people represent the fastest growing segment of the population and this trend will increase over the next years. Indeed, by year 2035, one third of the European population will be more than 65 years old. Elderly people are always more vulnerable to health risks and need more attention and health care facilities. Some major risks incurred by old population are unconsciousness and fall. Indeed 30% of the elderly people fall at least once a year. The fall event is responsible for 70 % of the accidental deaths in persons aged more than 75, and for increasing the level of fear, anxiety or depression. That in turn leads to reduction of day to day activity [1]. These facts clearly show that in the near future there will be an enormous increase in the demand of care services for elderly people. In fact, it will be difficult to provide expensive nursing home facilities to all of the elderly people. Another fact should also be considered; most of the elderly people like to stay at their own homes in a familiar environment and lead an independent life. But in fact due to health safety, an elderly person living alone is not recommended. These observations have encouraged the development of activity monitoring solutions in the form of fall detection devices and systems. The main goal is to detect a fall or inactivity and ensure rapid and efficient help when such an event occurs. So such systems not only decrease the budget for care services, but also provide to the elderly people an opportunity to stay in their homes and manage everyday tasks without significant burden for their care givers.

This paper gives an overview of our real world project Altcare (elder care) for providing ambient assistant living environment based on visual activity monitoring. We are able to detect and communicate emergency situations happening to the elderly people automatically without any human interaction. The elderly people normally do not like to interact with monitoring systems. In our proposed solution, they do not have to wear any sensor-based devices. Normally people do not like to be monitored visually, because it looks like a privacy breech. We solve this problem by masking the video of a person being monitored. Table 1 shows a survey done to get feedback from the elderly people about the proposed monitoring system. Survey results show that most of the people admire this solution. 46 randomly chosen elderly persons aged between 65 and 90 were asked about their satisfaction for the proposed monitoring system. 41 showed their interest, and agreed that it will increase their health safety. Some new suggestions also came during the survey that helped us to improve the architecture of the Altcare.

Table 1: Responses of elderly people to the question "would you like to have a camera-based Altcare system"

Number of People	Age range	Response
20	65-90	Yes
11	70-87	Yes, but regular human interaction
10	65-85	Perhaps
5	65-75	No

II. RELATED WORK

Most of the functional emergency notification systems already employed in the real world are non intelligent and require manual interaction [2], the elderly person must initiate a help request by himself. In a number of scenarios during the emergency situations, the elderly persons are not in a conscious state to call help for themselves. And in severe cases this emergency situation remains undetected even for a day or two, and this even may result in death.

Automatic detection of the emergency situation is either done by worn devices or environmental sensors. Normally an accelerometer or a gyroscope is utilized as a worn device. Worn devices as based on an active sensor often face battery life problems and other issues [3]. Environmental sensors

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normally include contact sensors, presence detectors, motion sensors, vibration analyzers and camera based video monitoring.

In [4] a sensor module containing a tri-axial acceleration sensor and an RF transmission module is worn using a waist band. From worn module sensor data is transferred to a person's PDA phone, where it is processed. In case of the emergency situations the phone sends the detected event with GPS information to a management system, which warns the family caregivers or a hospital. QuietCare [5] is a professional system that uses motion sensors to gather activity information of the elderly person. A base station gathers information from sensors at regular intervals, and then transmits it to QuietCare computers, where it is analyzed and in case of emergency an alarm is generated. In [6] mobility of a person is monitored using an accelerometer based worn portable unit. Mobility level summaries are transmitted hourly as an SMS to a remote server for long term analysis. Appropriate medical personals are alerted in case of a decrease in the mobility level.

In the last few years researchers started fall and emergency situation detection using video surveillance technology but none of the proposed work is mature enough to be deployed in real world environments. In [7] a multiple camera system is proposed. Images are first transmitted from the network cameras to a server through the intranet, where they are processed to check the emergency situation. Recently ANGELAH [8] has been proposed, a middle-ware level solution integrating both "elder monitoring and emergency detection" solutions and networking solutions.

We present the architecture for an emergency detection and communication system based on vision-based technology. Elderly people are monitored around the clock using network cameras with wide angle lenses. The system works as an independent unit and is able to detect the emergency situations without any manual initialization or interaction with elderly person. The system then communicates to the responsible persons through redundant paths to ensure timely and effective help for the concerned elderly person. The emergency situation is detected by verifying the location of the head with respect to the floor.

III. System Overview

The proposed system Altcare consists of a server and several client modules. The client module runs at the elderly person home and is responsible for the emergency situation detection and notification. The server module runs at the emergency management centre and receives the emergency calls from the client modules and relays them to emergency management personal. As the actual processing (emergency detection and notification) is done on the client side, the server can support a very large number of clients depending upon the service capabilities of the emergency management centre for elderly people. The server and client modules are connected with each other through internet. The Altcare server periodically checks the connection access to the client modules. In case of no access to a specific client the emergency management personal is notified. We propose a vision-based emergency situation detection and transmission. The client module consists of two basic sub modules, emergency situation detection module and emergency notification module. Both the sub modules perform their tasks independently. The emergency detection module works around the clock, while the emergency notification module is activated on the request of the emergency situation detection module in case of an emergency. An elderly person can also manually activate this module to call help at any time for him.

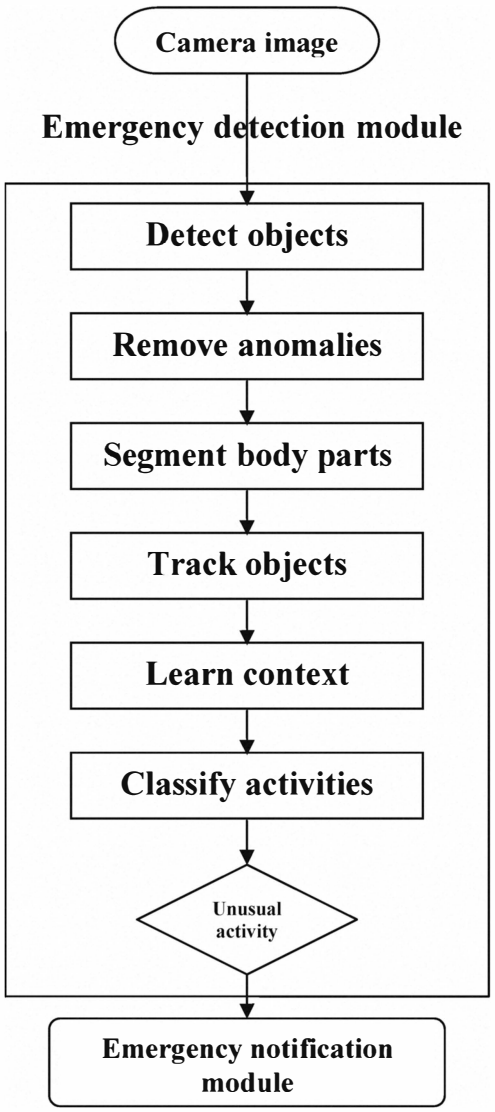

Fig.1: Flowchart for the emergency detection module.

A. Emergency Situation Detection

Elderly people are monitored around the clock by the video cameras installed in different portions of the house. We used wide angle lenses instead of fisheye lenses, so we have less lens distortion. The cameras with fisheye lens are normally installed under the ceiling for overhead monitoring, but we installed the cameras on the side walls of the rooms.

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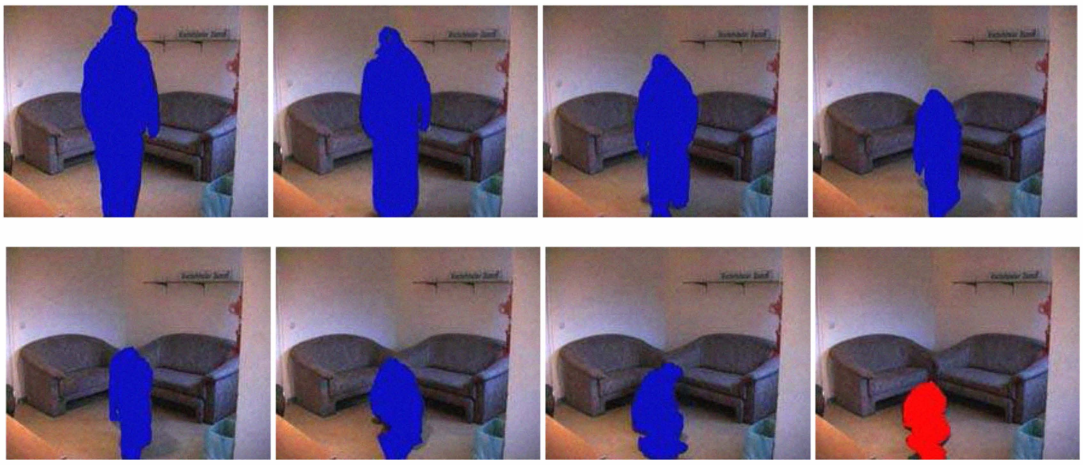

Fig .2 some of the images from a masked video patch showing a fall situation.

Thus we have more freedom to select an appropriate view in order to detect bending or falling. In addition, we have inherent advantage of a wide angle lens to cover a larger area. Our fall detection algorithm works on 2-D images from either of the cameras. Figure 1 shows the flow chart of an emergency detection module. In the first step, persons present in the camera field of view (FOV) are detected by segmenting them from the background scene. The detected objects (persons) are not perfectly segmented and often are affected by anomalies like shadows, reflections and highlights. So in order to process the detected objects further and to recognize actions, these anomalies are removed in a second step [9, 10]. In the next step individual body parts are identified from the detected objects. Feet und head locations of a person are of most interest. To keep record of the detected objects as independent identities, tracking of the objects is done through out their existence. Tracking also removes spurious objects with short appearances. An unsupervised training process runs in the background and automatically learns the scene context information with the passage of time through the movements of the elderly person and tracking information. The scene context information identifies normal resting places like sofa or a bed and non resting places like floor. This information not only removes false alarms but it also helps in the fall detection. The fall and emergency situations are identified using head and floor information [11]. After the detection of the fall, control is transferred to the emergency notification module which verifies the emergency situation from the elderly person.

The elderly person can give his reply by pressing a button, provided to him in the form of a keychain. This keychain contains a wireless transmitter which does not process anything by itself. It only signals the elderly person's reply to the Altcare client. In case of no response in a certain confirmation time, the Altcare client initiates the emergency notification.

B. EMERGENCY SITUATION NOTIFICATION

In the case of emergency, this module automatically notifies the responsible persons in the form of SMS, email, transmission of some recorded message on telephone, or a video patch showing the emergency incident. Redundant methods are used to ensure the delivery of the notification precisely and accurately. Fig. 3 shows the architecture of the emergency detection and notification system. The system performs the multiple notifications in parallel. For example the system automatically initiates a call through internet to the Altcare server module at the emergency management centre. The call on the server alerts the management personal with loud ringing. On call acceptance he receives elderly person details and a masked video patch showing the actual incident happened. Figure 2 shows some of the images from a masked video patch showing a fall incident. The masked video patch is generated by the emergency detection module, by changing the areas of detected foreground objects in the original camera images to a single color. Masking of the objects ensures the privacy of the elderly person. This information can then be forwarded to first aid personals and medical staff in the near by hospital. Summarized medically history and video patch specifically ensure correct first aid, diagnosis and medical treatment. Call acceptance at the server delivers an acknowledgement to the client module working at elderly person home.

Family doctor and relatives are notified with SMS. SMS due to its size limitation contains only basic information and serves as an alarm. Neighbours on their willingness are alarmed using a telephone call with a recorded message. Altcare client also sends patient medically history along with the video patch as an email to the family doctor. This information later on might be helpful for him.

IV. IMPLEMENTATION AND FUTURE WORK

The emergency notification module is in the process of development. The emergency detection module has already been implemented and has been tested in real home environment. It correctly identifies the fall and emergency situations. It should be extended in the future to detect the emergency situations happening at the normal resting places like a sofa and or a bed.

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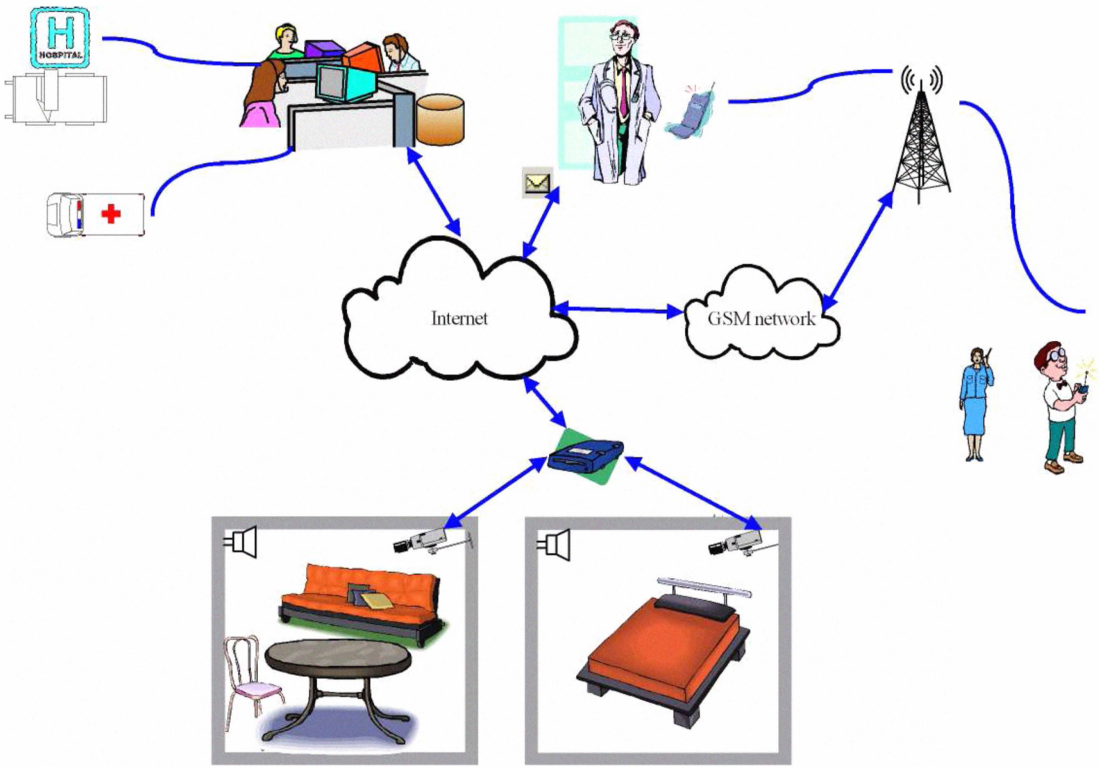

Fig. 3 Architecture of the proposed emergency detection and notification system

V. CONCLUSION

We presented a system to support danger free and safe independent living for the elderly people. The system takes care of elderly people around the clock by automatically identifying the emergency situations. While communicating emergency situations, privacy of the monitored elderly person is ensured by delivering a masked video patch. This video patch not only helps to counter check the emergency situation detection process but also helps the physicians to correctly diagnose the problem with the patient. It also ensures a proper and relevant first aid. The system informs multiple responsible persons using redundant means and gets the acknowledgement to ensure quick and effective help.

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