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Vision Based Monitoring System for Old Age Homes

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ABSTRACT

Nowadays, a smart home is becoming the buzzword. Smart homes are monitored by multiple sensors for safety, security, health care, and comfort. The old population, and the average age of the people is increasing day by day, and taking care of old persons is becoming a challenge. Due to less availability, of care taking staff 24X7 observation, is not possible in old age homes. This paper proposes, a vision based smart old age home monitoring system. The system maintains, a daily schedule of old age persons, provides timely reminders, and also monitors the execution of schedules using a camera. If a schedule is not followed, the system intimates, the old age home staff in the monitoring room. Whenever, a person raises his hand for emergency assistance, the system recognizes the gesture, and intimates the staff. Kinect V2, is used to capture the environmental depth details, as it provides features for recognition whereas, a person's privacy, is maintained by, not recording the RGB content. Object contours in separated frames are extracted using the Canny Edge Detection (CED) algorithm, and feature extraction is done using Speeded-Up Robust Features (SURF). The system recognizes four main activities - drinking water, eating food, relax position, and requires attention. The system is trained for activities, and feature matching for activity recognition is done using the K-Nearest Neighbor (KNN) algorithm. Our system shows 83.34% recognition results and precision, and a recall computed for our system is 91% and 92 % respectively. The proposed system is not a replacement for the care taker, but the system will help to improve life style.

Index Terms: scene analysis, action recognition, monitoring systems, smart home.

1. INTRODUCTION

With an increase in number of the old age population and societal changes, taking care of old persons is becoming a challenge. Researchers have proposed different solutions for Smart Homes using technological advances, where personal activities are detected and monitored using different sensors [1]-[4]. Providing information of a few activities using too many sensors is not, a robust solution for the proposed problem.

One of the important tasks of old age persons is maintaining their daily schedule such as eating food, taking medicine, drinking water, taking rest, and doing the recommended exercises. It is observed that they, find it difficult to maintain their schedule regularly, and providing nursing staff 24X7 is challenging. To address this, providing timely reminders, and monitoring it can be a robust solution.

Here, we have proposed, a system for a smart old age home. It allows the experts to add a personalized schedule for the old age people, and monitor it using a camera and intimate staff for special attention. With continuous monitoring, this system verifies, the actual activities with a proposed schedule. The system helps in efficient utilization of staff in old age homes, without compromising on the required service. The system uses only, one sensor for capturing depth data unlike other smart homes, where sometimes, a person has to use wearable sensors.

2. LITERATURE SURVEY

Technological advances are now widely applied for improving life style and comfort. Literature mentioning advances in smart home is available and remarkable progress is seen in the domain. M.R. Alam

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et al. provided review of smart homes with its past, present and future status [1]. They discussed smart home definitions from different researcher's perspective, provided review of different smart home projects categorized into healthcare, security, and comfort. Further, they discussed about categories and purpose of smart home monitoring devices along with algorithms and methodologies used. Data acquisition devices are categorized into sensors, physiological devices and multimedia devices. They have commented that there is need of more research in image-processing and voice recognition systems and concluded paper with future challenges in domain. S Banerjee et.al. have proposed surveillance system for old people in a hospital room [2]. Their system is based on ten passive infra-red sensors installed in room and all connected to parallel IO cards and to PC in observation room. Activities of old person, and hospital staff are recorded. 1450 sequences out of 1637 possible sequences of movements are correctly detected by computer, in comparison with manual analysis. Proposed system is highly sensitive to position of sensors and number of sensors, as standing in door activity is also detected as leaving room. Also, other details like lie down on bed is not detected by system.

J. Krumm have proposed multiple human tracking using stereo cameras in Easy Living project [3]. Multiple person's activities such as walk, stand, and sit are detected by system. People can enter and leave the space during the demonstration. Instead of using too many sensors, vision based systems is appropriate solution for monitoring activities. Domain will be befitted with advances in human motion recognition [4], [5].

Demiris G. et. al. have surveyed older adults' attitudes towards and perceptions of smart home technologies [6]. They have surveyed 15 adults over age 65. They concluded that, all participants had an overall positive attitude towards devices and sensors that can be installed in their homes in order to enhance their lives. However, group considered for study is very small and opinions may vary with location.

Main advantage of using vision based system is person need not wear sensors on body. But installation of RGB surveillance camera and monitoring these contents in observation room may violate privacy of a person. Use of depth capturing device Kinect V2 provide features for recognition, without using RGB details. Proposed system automatically detect activities and intimate only if special attention is required. Technological advances are now widely, applied for improving life style and comfort. Literature

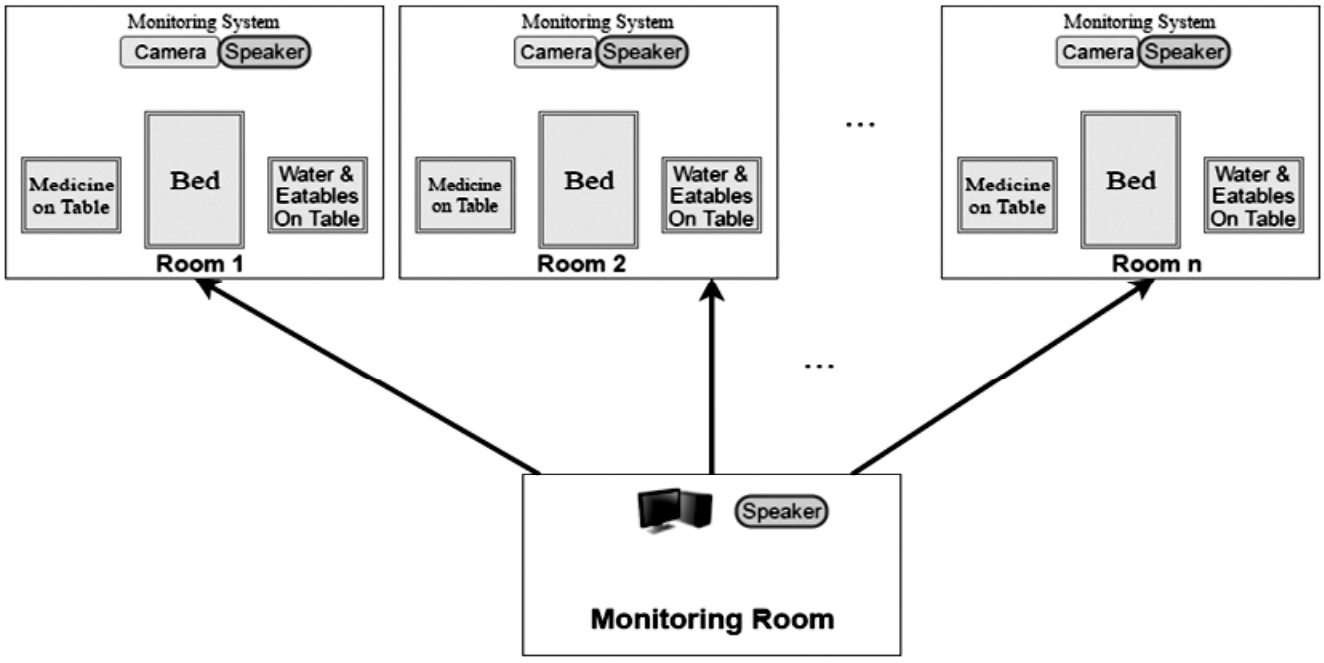

Figure 1: Architecture for smart old age home monitoring system

mentioning advances in a smart home are available, and remarkable progress is seen in the domain. M.R. Alam et.al. provided a review of smart homes with its past, present, and future status [1]. They, discussed smart home definitions from a different researcher's perspective, and provided a review of different smart home projects categorized into healthcare, security, and comfort. Further, they discussed about the categories and purpose of smart home monitoring devices along with the algorithms and methodologies used. Data acquisition devices are categorized into sensors, physiological devices, and multimedia devices. They have commented that, there is need of more research in image-processing and voice recognition systems, and concluded the paper with future challenges in the domain. S Banerjee et.al. have proposed, a surveillance system for old people in, a hospital room [2]. Their system, is based on ten passive infra-red sensors installed in the room, and all connected to parallel IO cards and to a PC in an observation room. The activities of an old person, and the hospital staff are recorded. 1450 sequences out of 1637 possible sequences of the movements are correctly, detected by a computer, in comparison with manual analysis. The proposed system is highly, sensitive to the position of sensors, and the number of sensors, as standing in door activity, is also detected as a leaving room. Also, other details like lie down on the bed is not detected by the system.

3. METHODOLOGY

Providing 24×7 personal assistance to all persons in an old age home has become a challenge. One of the important tasks for old age people is maintaining their daily schedule such as eating food, taking medicine, drinking water etc. So, we are proposing the smart system for an old age home. This system provides the following main functionalities:

- Daily schedule of each person can be maintained from the control room.
- Individuals are given timely reminders, in voice command for the respective planned activities.
- Continuous monitoring of personal activities using a camera is performed, and verified with a planned schedule. The system maintains a record of schedule Vs actual execution.
- System intimates to the control room for assistance, if a planned activity, is not performed even after two reminders.

Fig. 1.1 shows the architecture of a vision based monitoring system. Cameras in all rooms are connected with a control room server using a network. This system considers one person per room. Steps for vision Based monitoring and action recognition are:

Steps for Vision Based Monitoring and Action Recognition

1. Enter personalized daily activity schedule in, the system.
2. The system provides timely intimations, using audio to old age persons as per the planned activities.
3. Depth sensor monitors and recognize the performed activities.

Table 1
Confusion matrix for activities

	a	b	c	d
a	18	4		
b	3	9		
c		1	11	
d				12

Table 2
Activity details

Label	*Activity*
a.	Drinking Water
b.	Eating Food
c.	Relax
d.	Require Attention

3.1 Separate frames in captured depth video.

3.2 Edge detection – CED algorithm

3.3 Feature Extraction – SURF algorithm

3.4 Action recognition – KNN algorithm

4. Verify, action performed with a planned daily schedule
5. Make an entry, of the correct activities and notify, for unexpected movements to the monitoring room.
6. Intimate to, the monitoring room staff for assistance, for raised hand action recognition

The daily activity schedule of all persons is maintained from the server room. The system will timely, intimate old age persons about all the planned activities using an audio. The depth sensor will monitor the daily schedule, and the action recognition algorithm will identify, the performed activities. The frames in the video need to be separated, and individual frames are further processed for of action recognition. The Contour feature is used for further processing, and an object contour is extracted using the CED algorithm, and SURF is used for extracting, the feature points of the contour for further matching. KNN is used for recognition of action. The performed action is verified against the planned activity schedule. Each performed activity, is recorded with time and any, unexpected movement is notified to the monitoring room using an audio. Old age persons can raise their hand for emergency assistance. The Hand raising gesture by, old age persons will intimate to, the monitoring room for the assistance.

4. EXPERIMENTATION AND RESULTS

The proposed system implementation is tested in the laboratory. Kinect V2 is used for capturing the scenarios. Currently, it is tested for the activities of two subjects. Total three hours video sequence of each subject is recorded, and the results are analyzed. Both the subjects have performed specified four activities 24 times alternately. In total six hours video is recorded with 48 activities of two subjects. Out of those, 40 activities are detected correctly, and 8 activities are classified incorrectly, in the other categories. Table 1.1 shows the confusion matrix for the considered activities, and table 1.2 shows the label used for those activities. Our system gives 83.34 % recognition results for the considered activities. It is observed that, the system is mainly, confused between ‘drinking water’ and ‘eating water’ activities, as they, are very similar for recognition. Precision and recall computed for our system is 91% and 92 % respectively.

5. CONCLUSION

The Smart home concept is becoming popular due to its utility, in day-to-day life for the betterment of life style of old age people. The research and availability, of different products gives rise to a vast variety in sensors, protocols used for communication, and its application algorithms. The proposed system uses depth information for the recognition of activities that address the major issue of violation of privacy as compared to the RGB stream. The system recognizes four major activities - drinking water, eating food, relax position, and requires attention. The system is tested for two subjects with three hours continuous individual monitoring, and our system gives 83.34% recognition results. The results can be improved by using a multi-camera environment, and by applying more robust recognition algorithms.

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