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Detection of human presence in the context of resident supervision in nursing home

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Abstract

Nursing homes are overcrowded and medical staff is overworked. Then, the management of this type of institution become so difficult. Monitoring system may be used to facilitate task of nurses and medical staff. Various solutions and supervision systems require extracting information regarding people present in the monitored environment. Innovative sensors are required to have more robustness. The need of new sensors is identified by the drawbacks of supervision software. In this manner, we have initiated our work to develop a bed sensor, as the implemented monitoring system cannot detect the presence of the immobile and silent subject in his room. Generally in nursing homes, a resident get on his bed when he get in his room, so the subject spent more time in his bed when he is present in the room. Thus, bed sensor provide an important information for medical staff. Information will be presented in simple manner to nurses, so the manner to present this information represent a significant task in e-Monitor'Age project.

Keywords: *Human presence, telemedicine, signal processing, thermal sensor, Classification.*

I. INTRODUCTION

Nursing homes provide around-the-clock services in an institutional setting to residents who have physical and/or mental disabilities that do not allow them to stay at home and live in community. Quality of care provided by nursing homes can be viewed from three angles: structure, process and outcome. Structure refers to facility's capacity to provide high quality care. Examples of elements of structure are the professional background of nurses and aides, physical plant and policies and procedures. Process refers to the manner in which care is delivered. catheter care, restorative nursing techniques, skin care and organization social activities represent examples of process. Outcomes, narrowly defined, are measures of change in health status attributed to antecedent care. Incidence measures, recovery and cure rates, mortality rates, and functional improvement or decline are important examples. Thus in e-Monitor-Age project we have used monitoring system to improve quality of care in nursing homes.

II. E-MONITOR'AGE PROJECT

The e-Monitor'Age project aims to improve services and adapt care for each resident in a nursing homes. Welfare and safety of the resident represent a major concern in our work. Then our project must optimize the work planning of nurses in order to bring greater availability of medical staff to the resident. e-Monitor'Age project is based on the development of a Computer Assisted Management System, based on intelligent supervision software. This software uses data from innovative (heterogeneous) detectors (integrated in the electrical installation of nursing home) that are continuously updated to reflect the environment, the behavior and certain physiological parameters of the residents.

III. STATE OF THE ART

Several solutions from the state of the art have been already implemented and tested in frame of National and European projects. Doppler radar motion sensing systems have been used to detect physiological movements since the 1970's[1]. Networked passive Infra red sensors were used in Quovadis[2] and CompanionAble[3] projects to detect and localize[4][5] the elderly people. Also a Video Camera has been exploited in order to track the supervised person [6]. Sound signal was used both to classify sound events, and to localize the event's source [7, 8]. A multi modal localization system has been experimented using fusion techniques to combine sound signal and binary pyroelectric infrared (PIR) sensor network [9]. In CAPTHOM project [10], a multi-sensors system was used to detect the presence of the human in order to identify a situation of emergency. Other technologies were used also as ultrasound and vibration shock detection. The main drawbacks of currently available occupancy systems are high rates of false alarms and failure to detect stationary subjects.

There are also various systems which are designed to evaluate sleep quality of the subject in his bed. They are currently under development by academic and industrial laboratories. Each system uses a specific sensor set-up, such as: optical sensor [11], respiratory sensor [12], infrared sensor [13] (pyroelectric), accelerometer signals to estimate actigraphy [14], bed temperature [15] signals measured by a set of thermostats, etc. The Lullaby system measures the parameters

of the sleep environment, such as sound, light level, temperature, and motion (body movements) in order to help users assess the quality of their sleep [16]. A non-invasive wearable neck-cuff system for real-time sleep monitoring is proposed in [17]. To estimate sleep quality, this monitoring system is based on physiological signals: accelerometer to detect movement, breathing, sound signals and oximetry to detect apnea. In the state-of-the-art, we also found a pressure sensitive bed sheet [18] which is able to identify sleep posture and body position in the bed and Sleep Hunter [19][20] based on movement detection (through actigraphy) to predict sleep stage transitions using a Smartphone. This mobile system merge movement detection with sound analysis to identify three sleep phases (REM, deep and light phase): for example, coughing or snoring often leads to transient asphyxia, which decreases the oxygen capacities, and in turn, results in body movements during sleep. To validate results, this monitoring system has been compared to the Zeo system [21].

IV. PREVIOUS WORKS

We have already studied and developed a bed presence and sleep quality estimation sensor. The signal processing algorithms are described in [22][23]

In the *EMonitor'age* project the bed presence system has been implemented in a two parts distributed architecture: a) the first part includes acquisition and filtering process which is implemented on sensor b) the second part includes recognition algorithms which is implemented and running on the server.

1) Acquisition and filtering process

This first step includes median filter which is implemented using C language. The software was implemented on ARM 9. Once the signal is filtered, a communication layer based on KNX protocol is implemented and embedded in the sensor in order to link it to the server.

2) Centralization of treatment

On the server, k-means algorithm was implemented in real time using java language. The results are recorded in a SQL Server data base. PCvue is used to recover data from all installed sensor in the nursing home.

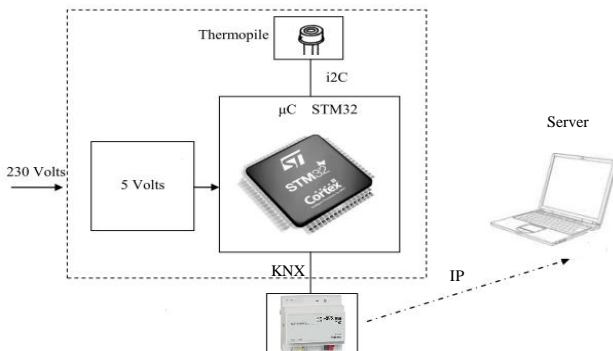


Fig1. System Architecture

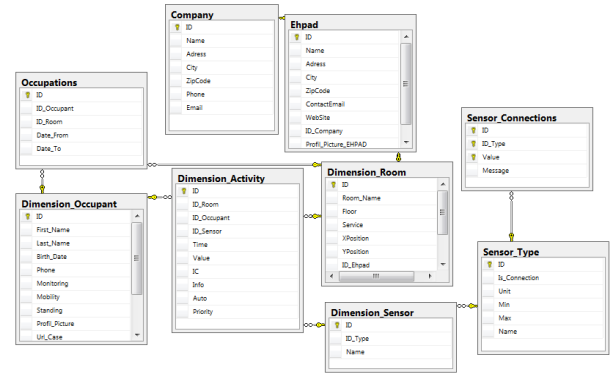


Fig2. e-Monitor'Age data base implemented under SQL Server Express

V. RESULTS

The result is posted through web application implemented on the server. The Figure 3 shows that the subject was detected in his bed at 20h00 and he got off from the bed at 7h00. During the night, the system has detected numerous absences of the resident but these detection of absences are not confirmed by motion sensor. Thus, that represents a false positives detection of our system.

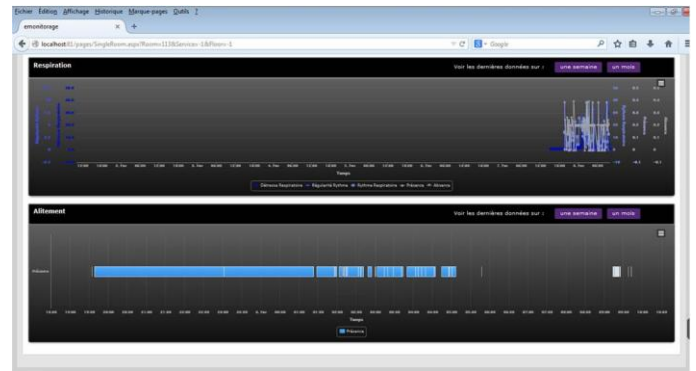


Fig3. Result posted through web application

VI. CONCLUSION AND PERSPECTIVES

Thermal signal is affected by numerous factors like the room environment of resident because the ambient temperature and other person presence mislead the sensor.

Physical characteristics of the subject represent also a factor which affect the performance rate of our recognition system. Also cloths wearied by the observed person may affect the robustness of our implemented system.

Other algorithms such as k-medoid will be implemented to substitute k-means in our next work.

The centralization of our algorithm of recognition give us an opportunity to combine with other modalities such as motion sensor or sound sensor.

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