Overnight Supervision of Alzheimer's Disease Patients in Nursing Homes
System Development and Field Trial

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Abstract: The number of patients affected by Alzheimer's disease among the population is currently growing, while the availability of resources for their assistance is decreasing. A solution for this problem is provided by the use of Ambient Assisted Living technologies, with the objectives to prolong the independent living of patients at home, to relieve assistance burden on caregivers, and to improve care effectiveness in nursing homes. This paper describes an integrated system designed to support the work of nurses during the night, to ensure comfort and safety of Alzheimer's disease patients in nursing homes. The project started from a similar solution designed for home use, suitably re-engineered for adoption in nursing homes. The system has been designed according to nurses' requirements and expectations, both by revising some existing functionalities, and by developing new components. The results gained from an experimental trial are also presented and discussed.

1 INTRODUCTION

Staff working in care and nursing homes typically experiences a high workload, due to the need of carrying out a lot of tasks in a relatively short period of time. Usually, this happens because of budgetary restrictions on the amount of personnel recruited, with respect to the number of patients cared after. In fact, since 2010, due to the global economic crisis, growth in public health spending came almost to a halt across the OECD (Organisation for Economic Cooperation and Development), with even reductions in many countries. Since then, the spending growth has been very slow, often in line with overall economic growth (Organization for Economic Cooperation and Development, 2015). Despite the current trend of moving long-term care out of institutions into patients' home premises, the role of nursing homes remains relevant, especially for those patients affected by chronic diseases, like dementia or Alzheimer's disease (AD), who cannot be assisted at home. Information and Communication Technologies (ICT) should be exploited to improve the working conditions of the care staff, and to improve the quality of care. Experiences showed that the impact of technology on underlying clinical work processes should be carefully evaluated and analysed. Possible blocks in the execution of routine procedures due to the adoption of technology tend to distract staff from care issues, and can result in new errors. Typically, in reaction to this condition, nurses develop problem-solving behaviours that involve bypassing new technology, or adapting work process so as to minimize disruption in operational procedures (Bowens et al., 2010; Lowry et al., 2015; Huston, 2013).

Several ICT-based solutions have been proposed to facilitate home-caring of people affected by dementia or AD during the night hours. In fact, nighttime activity is a common occurrence in persons with dementia, which increases the risk for injury and unattended home exits, and impairs the sleep patterns of caregivers (Lee et al., 2014; Kim et al., 2014). Technology has been applied to develop tools that alert caregivers of suspicious nighttime activity, to help

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prevent injuries and unattended exits (Occhiuzzi et al., 2014; Mao et al., 2015; Vuong et al., 2013). Night-time attendance of patients affected by dementia or AD may be difficult to manage also in nursing homes, especially because the number of nurses available is reduced, with respect to daily hours. As a consequence, it is of interest to evaluate the applicability of technology for night monitoring of AD patients in nursing homes, in order to assess the impact of technology on nurses' work flows, and on the quality of assistance provided to patients.

This paper describes an integrated system for the monitoring of AD patients, realized by evolving and updating an already existing product named UpTech (Chiatti et al., 2013). The UpTech project focused on AD patients and their family caregivers; it was carried out as a multi-component randomized clinical trial (RCT), integrating previous evidence on the effectiveness of AD care strategies, in a comprehensive design, to reduce the burden of family caregivers of AD patients, and to maintain AD patients at home. Indeed, often the relatives who take care of AD patients are subjected to high levels of stress, that could also contribute to the onset of physical problems. The positive outcomes of the UpTech experimental phase (Pombo et al., 2015), providing the use of technological devices as alternative or complementary form of support, have suggested its application in a different scenario, represented by the nursing homes. The aim of the UpTech RSA project is to support and help assistance of AD patients in nursing homes, during the night hours, by means of a set of sensors located in patient's room, and suitable software applications to detect dangerous events and raise alerts for the nurses.

When dealing with *monitoring* of people, this condition is often seen as violating the privacy of the user. Therefore, in order to satisfy the requirement of providing an unobtrusive monitoring, only simple environmental sensors have been employed in the UpTech RSA solution, that are less intrusive and more acceptable than other options, like wearable devices, or video cameras. Wireless sensors have been chosen and used: on one hand, this enables a simple installation, on the other hand, power consumption is a critical aspect, which has to be evaluated at the design stage.

The paper is organized as follows: the context of application of the proposed technology is discussed in Section 2, whereas Section 3 is focused on design and deployment issues. The field trial implementation is presented in Section 4, and the results gathered from the practical use of the technology in a real nursing home are discussed in Section 5, showing how the data collected from sensors may be translated into useful information for understanding the patients' needs and requirements. Finally, Section 6 concludes the paper and suggests possible future developments.

2 CONTEXT

Dementia is becoming increasingly prevalent worldwide and is today considered as one of the most burdensome disease for the western societies. Alzheimer's Disease is the most common form of degenerative dementia. Generally, the onset of the illness occurs in the pre-senile age, however it could be even earlier. A person with dementia can live 20 years or more after diagnosis, during which he/she experience a gradual change of the functional and clinical profile. As consequence of the disease, a progressive loss of cognitive capacity is occurring, eventually leading to disability and to a severe deterioration of quality of life. During the so-called "dementia journey", the disease affects not only the patients but also their informal (e.g. families) and formal (e.g. care staff) caregivers, on whom the bulk of the care burden falls (Chiatti et al., 2015).

Up-to-date, there is no cure for dementia thus the attention to the symptomatic non-pharmacological treatment for the patients and their caregivers has become increasingly relevant, especially as the literature shows that these can be more effective that most of available drugs (Spijker et al., 2008). Although home remains the preferred place for care delivery, a substantial number of patients need to access (permanently or temporarily) to residential care facilities, when home care is no longer feasible. In the residential context, infrastructure and staffing levels are not always adequate to manage residents with dementia. Residential care services are indeed labour intensive and the quality of care here depends largely on the staffing level and characteristics (Kahanpää et al., 2016; Milte et al., 2016). As the ongoing financial crisis is reducing the budget available for residential care services, a detrimental effect on personnel standards might occur. This concrete risk of staff shortcomings might, in turn, lead to a substantial proportion of avoidable hospitalisations, use of emergency departments, icreased carers' burden and stress, and inappropriate use of chemical and physical restraints (e.g. antipsychotics).

The literature suggests that education, training and support of available staff, supervision, improvement of job satisfaction could be effective measures to increase quality of care in this care setting (Institute of Medicine, 1986). In addition, technologies and other environmental factors have been identified as the most promising measures to improve working conditions in the residential care setting, to reduce the care burden and to improve the overall quality of care (Freedman, 2005; Ancker et al., 2015). The potentials of new technologies have been tested to reduce the need for constant monitoring of dementia patients, increase their safety and wellbeing within the residential setting. So far, however, few solutions have manage to survive to the prototyping phase and have been concretely exploited in the market.

3 DESIGN AND DEPLOYMENT

The system described in this paper represents an evolution of a project named UpTech, aimed at improving the quality of life of both AD patients living at home and their family caregivers. This project involved nurses and social workers, who periodically went to the patients' houses, and the installation of technological kits. Each kit consisted of a network of wireless sensors installed in the house, for the monitoring of the patient. Data were processed by a central control unit and, in case of danger, a notification was sent to the caregiver. The new system, called UpTech RSA, targets the nursing home environment and has been devised primarily for the overnight monitoring of patients, when there is a lack of personnel in the building. Moreover, the main differences between the two systems concern:

- number of users: in the nursing home, multiple patients are monitored at the same time. Thus, the central control unit is able to manage data coming from more than one set of sensors;
- sensors: different types of sensors are employed, due to the diversity of the physical environment;
- system architecture: the whole network can be seen as a set of sub-networks, one for each room;
- alarm management: the monitoring system is an aid for the nurses, the notifications are not sent to the remote caregiver as in the previous system.

The project development stage conducted in the Laboratory was aimed first at the improvement of the previous UpTech kit, secondly at the design and implementation of the modules required for the new system. In particular, the radio transceivers firmware was re-designed, to implement an efficient data acquisition and transmission procedure. At the same time, particular attention was paid to the energy consumption exhibited by the transmission nodes, by taking into account the values of power absorption in the different operation phases, and implementing all the possible strategies for its reduction. As for the new components, the following modules have been designed: the structure of the database used to store the collected information, and the applications necessary to implement the decision algorithms, in charge of making actions depending on particular values of the acquired data.

The system requirements have been identified by collecting nurses' requests, thus the developed functionalities are related to the usual daily care procedures. Specifically, the set of sensors installed in each room enables the following functionalities:

- door opening detection;
- window opening detection;
- "French-window" opening detection;
- presence in bed detection;
- presence in the bathroom detection.

The door opening detection is achieved using a magnetic sensor, wireless connected by Sub-GHz technology at a frequency of 868 MHz to a gateway, by means of a properly designed electronic equipment.

Figure 1: Magnetic sensors for windows opening detection.

Figure 2: Self-calibrating mat sensor, for under-the-mattress positioning.

Similarly, the detection of windows opening is made through the same technology (see Figure 1). The user's presence in the bathroom is detected by a self-powered Passive Infrared Sensor (PIR), which is connected to the radio transmitter module. For ease of installation, and to avoid damage to the fixtures of the building, these sensors have been placed on top of the entry doors of the bathrooms. A mat sensor has been adopted to detect the user's presence in bed; it is available in two versions, with and without self-calibration. The sensor without self-calibration is placed over the mattress, under the sheets, while the other one is placed under the mattress (Figure 2), and therefore it appears more comfortable for the patients and for the daily operations of bed maintenance. The gateway represents a central node that forwards data to a PC located at the nurses' station. Then, the application running on the PC filters the incoming information. Data related to events are saved in a local database (DB), while those referred to the operating status of the sensors are verified in order to monitor the correct operation of the technology kits.

The electronic boards transmit an event to the central server every time there is a status change, that is, for example, activation/deactivation of the PIR sensor, or opening/closing the door. Accordingly, the data stored in the database contain the sensor information (id, gateway address, name and type), the date and time when the notified event occurred, and the status of the sensor represented in binary format as follows:

- activation: $state = 1$;
- deactivation: $state = 0$.

In addition, the server assigns a unique id to each DB row in order to implement a robust mechanism for transmitting information to the mobile interface. This allows the mobile device to identify one or more missing events, and to request them back from the server. In fact, a mobile Android application has been developed, running on a tablet or smartphone, and so easily portable. This allows the nursing staff to receive event notifications even when they are outside the nurses' station and cannot access the fixed desktop interface. Events data, properly processed, are displayed through not only mobile, but also desktop interfaces (Figures 3 and 4). In the first case, the user can see a scrollable list of events identified by the name of the sensor that generated it and the room

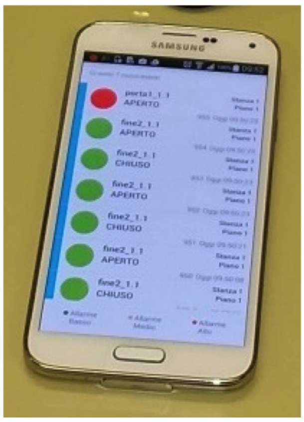


Figure 3: Mobile interface running on a smartphone.

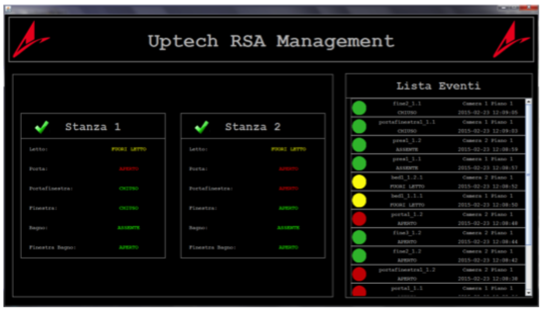


Figure 4: Screenshot of the Desktop Interface, *two sections* version.

name, as shown in Figure 3. Each event is tagged with a colored circle: depending on the associated level of alert, the circle may be green, yellow or red. In the latter case, two versions are available:

- a *two sections* version: the interface is divided into two parts. On the right there is a scrollable list of the events acquired by the sensors, while on the left the status of the sensors in each room is shown. There is a top bar which becomes coloured and flashing when an event occurs;
- a *multi-user* version: the main screen shows all the rooms monitored. When an event occurs in one room, the corresponding frame becomes colored. By clicking on the box, it is possible to see the details of sensors state.

Given the wireless transmission mode of the sensor nodes and their battery supply, the monitoring of the sensors state itself becomes very important. Therefore, a procedure for the periodic sending of alive messages has been implemented in the sensors. They are constantly monitored by the central processing system, that generates alarm messages in the case of failure. Despite its importance, this procedure is extremely critical, because sending *alive* messages too frequently causes an increase in the batteries consumption. Otherwise, the transmission of the *alive* message at a lower frequency can give rise to long time intervals in which the sensor is not active, but the system is not informed about the failure. When an *alive* message does not reach the local server at the expected time, the latter notifies a malfunction of the sensor node to the nurse, who can promptly find out the problem and act accordingly.

4 FIELD TRIAL

4.1 Experimental Set-up

The system described in Section 3 is already available as a prototype. Following the initial development phase in the Laboratory, aimed to better adapt the technology to the emerged operational requirements, the prototype has been installed in the nursing home "Villa Cozza" in Macerata (Italy). In this phase, the supervision of two rooms (tagged as room 2 and room 3) has been implemented, while the final version of the system will be able to dynamically accept a plurality of rooms, depending on the operating requirements. Each room is equipped with a sensors kit consisting of three magnetic sensors (one applied onto the window, one onto the French window, and one onto the room front door), a PIR sensor in the bathroom, and a force sensor placed in the bed, as shown in Figure 5. A single gateway device has been used to manage wireless communications with the sensors in the two rooms.

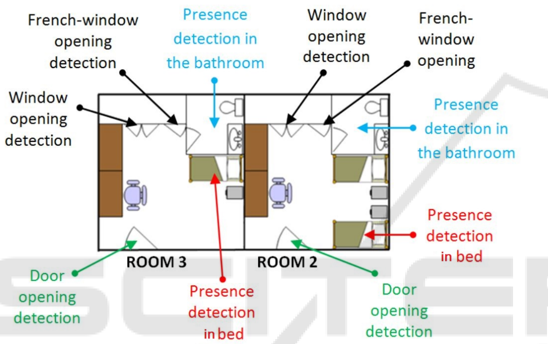


Figure 5: Floor plan of the two rooms equipped with the UpTech RSA sensors in the nursing home "Villa Cozza", Macerata (Italy).

In room 2 two female patients are housed, only one suffering from Alzheimer's disease. Her bed has been equipped with a force sensor. The other one is not autonomous and can move only by a wheelchair; consequently, the events generated by the different sensors can be originated only by the movement of the first patient. In room 3, instead, a single female patient is housed, also suffering from Alzheimer's disease, but in this case she can not move autonomously. As the system represents a support tool for improving the safety of patients, it can be well-compared to an alarm system. Moreover, the type of sensors employed do not collect personal data of the two patients involved. According to the national laws, in this case the ethical approval is not required.

A critical issue encountered during the installation phase has been to enable the communication between the gateway, positioned in the corridor in front of the two rooms, and the central server, located in the nurses' station on the upper floor. Such a problem arises because the building where the nursing home is located is not equipped with a communication infrastructure (e.g. a Local Area Network): there are no network cables, or WiFi coverage. Moreover, the nursing home is hosted in a historic building and, as often happens in such cases, the walls are thick and made of concrete, thus making wireless communications very difficult. Both a Power Line Communication (PLC) and a mixed wireless infrastructure (WiFi and Hiperlan) have been experimented, finally selecting the wireless solution as the supporting communication architecture. In order to overcome obstacles like metal doors and thick walls, that limit signal propagation, multiple Access Points (APs) and links have been setup.

4.2 Evaluation Survey

Some weeks after the installation a survey for the evaluation of the system has been conducted over 18 nurses. Although some of them are not very familiar with the technology, the results are highly positive. In Table 1, some of the most significant questions and results are listed. The 100% of respondents believes the kit is easy to use and recommends it for the monitoring of AD patients in nursing homes during the night. All the nurses state the system has not been a source of stress for them. In fact, its introduction does not generate further work for the staff. They just carried on the usual activities, but with an additional monitoring tool. Only the 6% of nurses believes that it was stressful for patients. Indeed, operators have received some sporadic grumbles due to the discomfort produced by one of the bed sensors. As mentioned in Section 2, the bed force sensor without calibration must be placed between mattress and sheet: this may annoy the patient during sleep time, due to a difference in thickness. This leads us to conclude that the sensor with calibration is preferable, as it has to be placed under the mattress, and will be consequently used in the subsequent installations. Apart from that, patients have noticed any change.

Moreover, the nurses stated that, during the trial period, there have been some dangerous episodes detected by the kit, such as the opening of a window during the night, and a patient's fall out of the room. In both cases the system detected the alarming situation and the staff was been able to intervene promptly. Despite the positive opinions, some problems were found, in particular due to the occurrence of false alarms. They were caused primarily by failures in the communication link, resulting in multiple sending of alarm events.

Still considering nurses' opinions, some ideas for improving the system were identified. First, false alarms must be avoided, as they can generate a feel-

Table 1: The opinion of the nurses about the experimental deployment of the UpTech RSA technology at the nursing home "Villa Cozza".

Question	Yes	No
Is the kit easy to use?	100%	0%
Do you think that the patients monitored have suffered a stress?	6%	94%
Do you think that the kit has been a source of stress for nurses?	0%	100%
Would you recommend the use of this kit in nursing homes?	100%	0%

Question	Positive	Medium	Negative
Overall opinion on the technological kit	89%	11%	0%

Question	Yes	Quite a lot	No
Do you think that the kit can improve the assistance provided in nursing homes?	61%	39%	0%

ing of distrust by operators against the entire system. Secondly, customizing different alarms for each user would be preferable, since each patient has different behavioural and health conditions. Finally, implementing an even more friendly user interface would encourage the adoption of the system by nurses unfamiliar with technology.

5 DATA ANALYSIS

5.1 Context Characterization

In addition to the real-time monitoring of patients, it is possible to perform several types of analysis on the data collected by UpTech RSA sensors over time, such as obtaining information on the patient's habits and, as a consequence, detecting any changes or unusual behaviours. In the following, some sample graphs are shown, representing selected daily activities of the monitored patients, obtained thanks to the events detected by the sensors. The analysis refers to data collected from May to June, 2015, by the sensors located in both the monitored rooms.

First of all, in order to give significance to the analysed data, some information about the patients and the daily activities conducted in the Alzheimer's ward are necessary. Table 2 represents a sort of daily diary. Patients remain within the ward during the day: they can stay together in the common areas, where they also have lunch and dinner, and can go in/out of the rooms whenever they want. The entry doors of the rooms are generally closed during the night. They are opened by the shift nurse who performs two inspection rounds per night, in order to verify that the patients are sleeping and do not need assistance.

Table 2: Diary of daily activities.

Time	Activity
7:30	Rooms cleaning
7:00 - 10:00	Patients get out of beds
Morning	Patients stay in the common areas, can go in/out of the rooms
11:30-12:30	Lunch in the dining room
Afternoon	Patients stay in the common areas, some of them have a rest
17:30-18:30	Dinner in the dining room
19:00-21:00	Patients go to bed
22:00	First nurses' check round
3:00	Second nurses' check round

In room 2 there are two patients: only one is monitored through a bed sensor, because she suffers from AD and often wakes up in the night and goes out of the room. The other patient moves by wheelchair and is not able to get off the bed on her own. The AD patient in room 3 has bed rails, so she can not get out of the bed autonomously during the night.

Although the system is able to monitor the patients throughout the entire day, the interesting events are those occurring during the night. In that period, in fact, the user is left alone for most of the time and thus the data acquired are more significant. The graphical visualization of the analysis output provided in the following sub-section has the ability to help the reader in recognizing and understanding a large amount of data, and in easily identifying anomalies and behavioural patterns that would not be obvious otherwise.

5.2 Data Representation and Analysis

The raw data collected by the sensors installed in the rooms are often difficult to interpret. Therefore, in order to carry out the data analysis, first of all it is necessary to find a representation allowing to understand them immediately. Lotfi et al. (Lotfi et al., 2012) affirm that, among the various representation methods presented in the literature, the start-time/duration is the most effective one for large data sets. The data acquired from each sensor can be seen as a binary signal, in which the value "1" is the activation and the value "0" is the deactivation. Representing information according to a start-time/duration method means converting the binary signal into two separate sequences of real numbers corresponding to the start-time and duration of each activity, respectively. Figure 6 shows the start-time/duration graphs of the activity detected by the bed sensor, i.e. presumably sleeping, for each room. Each point on the graph indicates a "sleep" and is characterized by a start-time (on the abscissa) and a duration (on the ordinate). All activities lasting less than 10 minutes have been ignored because they could indicate sensor activations and deactivations due to involuntary movements of the subject while asleep.

Looking at the charts is easy to notice the triangular shape assumed by the set of points. This result was expected because life in the nursing home is scheduled by the daily diary and, thus, the sleeping activities are bounded by specific and almost fixed time constraints. Therefore, it seems plausible that patients never go to bed before 6:30 PM, and the sleep duration is inversely proportional to the start-time. The sparse distribution of points in the triangular-shape diagrams indicates that the monitored subject wakes up several times during the night. In Figure 6 (b) a group of points is located between 12:30 PM and 13:30 PM: this suggests that sometimes the patient has a rest after lunch. On the other hand, looking at Figure 6 (a), the presence of two outliers (highlighted by red circles) becomes immediately evident.

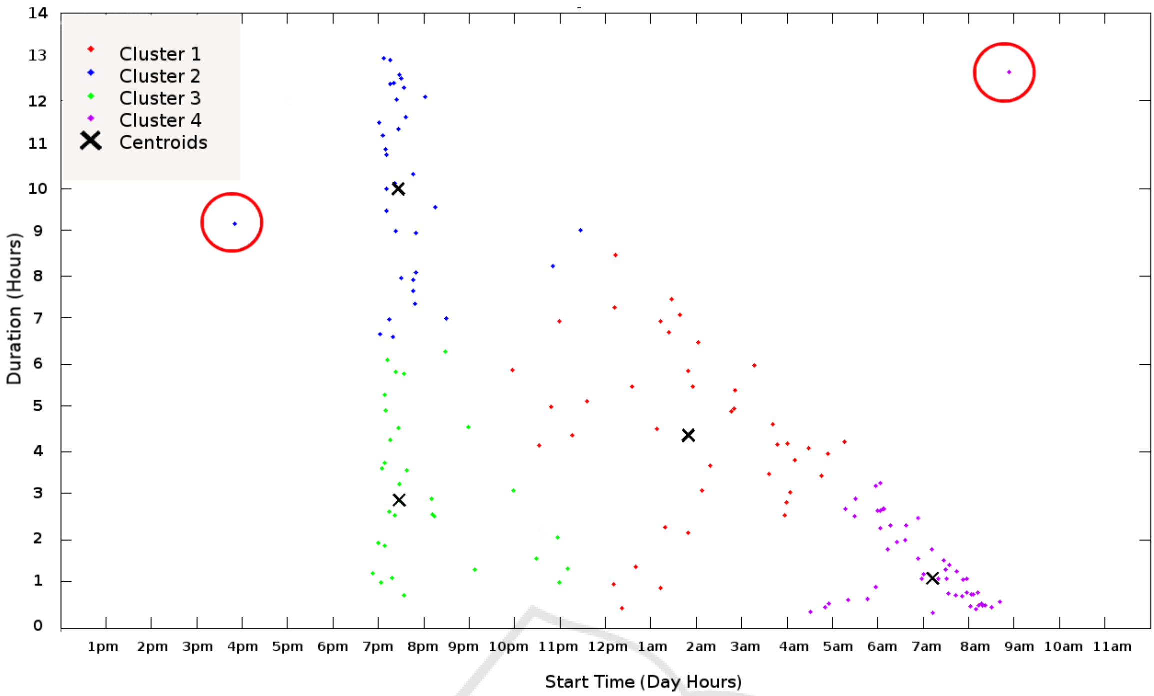
Analytically, a first detection of outliers is performed using clustering techniques. In the present case the K-means algorithm is applied (Nazerfard et al., 2010), which allows condensing the data. Different techniques can be used to separate normal data and outliers (Chandola et al., 2009). In this case, a variation of the threshold filtering method have been chosen: it consists in both comparing a specific feature of the points with a threshold and excluding the outliers. Specifically, for each cluster identified, and for each point in the cluster, the considered feature is the euclidean distance between one point and the others belonging to the same cluster. Such distances are then compared against a threshold empirically chosen: all points whose distance exceeds the threshold are considered outliers. Moreover, to improve the clustering effect, another iteration of the algorithm is performed, by excluding the abnormalities found from the dataset. Clustering is employed as a pre-processing method, and it can be considered as the basic level of data analysis. It does not provide a definitive result, in fact its application to the dataset has the only aim to help understanding data by means of a graphical representation.

Another information that can be extrapolated by combining the data obtained from the bed sensor with those detected by other sensors, is the identification of the action carried out after the user came out of bed. This will enable the possibility to calculate the occurrences of predefined patterns of activities, instead of single ones. Such an analysis allows to identify potentially dangerous situations with respect to behaviours commonly exhibited by the subject, and not considered as alarms. Each point on the graphs in Figure 7 indicates a "sleep" and is characterized by a start-time (on the abscissa) and an end-time (on the ordinate). As for the start-time/duration, the start-time/end-time representation requires the conversion of the binary signal in two separate sequences of real numbers which in this case correspond to the start-time and end-time of the activity. The type of activity shown is still the sleeping, but, according to the action carried out subsequently, the shape and colour of the marker changes. In fact, the graphs show, for each room, the actions executed within 4 minutes after the patient got out of bed (end-time), i.e.:

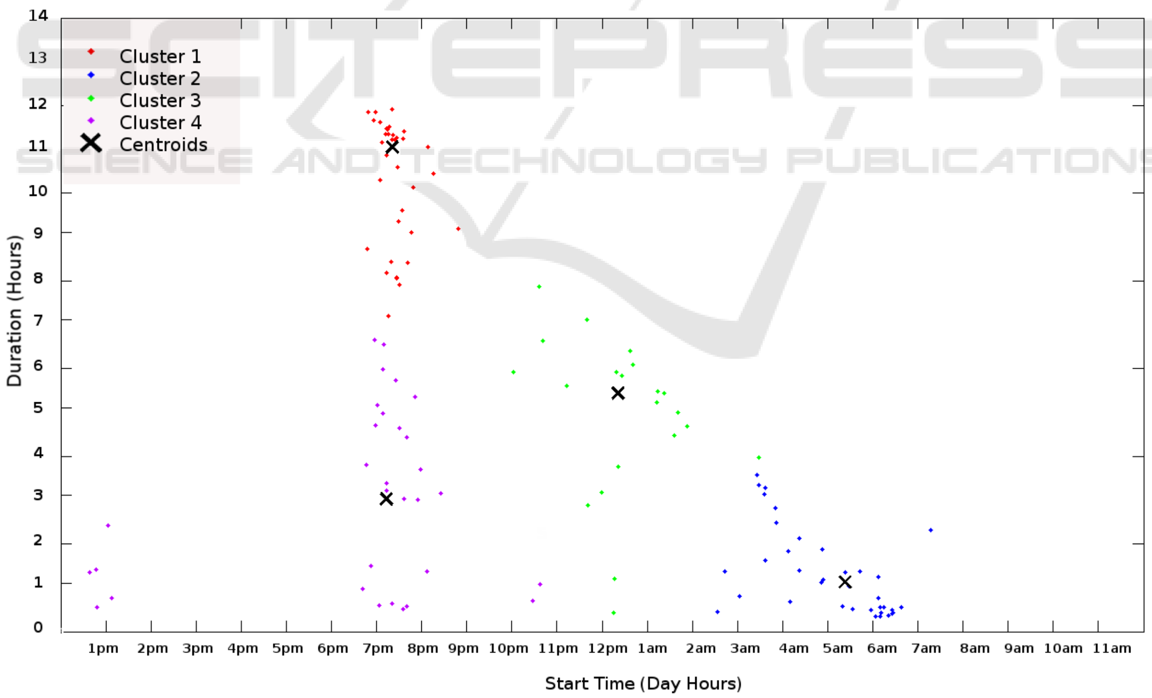
- door opening (marked as a green circle);
- window opening (marked as a black square);
- presence in the bathroom (marked as a blue cross);
- no other activity (marked as a red cross).

This kind of representation has been chosen to emphasize, especially in Fig. 7 (b), that some of the actions are performed only when the patient gets up at certain times. For example, the patient in room 3 enters the bathroom within 4 minutes after waking up only in the morning, i.e. only when nurses remove the rail from the bed. The other activations and deactivations occurring during the night could indicate that the subject has moved or was seated up on the bed, while the openings of the door or window are probably due to the presence of the medical staff.

Conversely, looking at Figure 7 (a), the observer can notice the patient very often goes to the bathroom or opens the door immediately after getting up. This agrees with the reports of the nurses concerning the

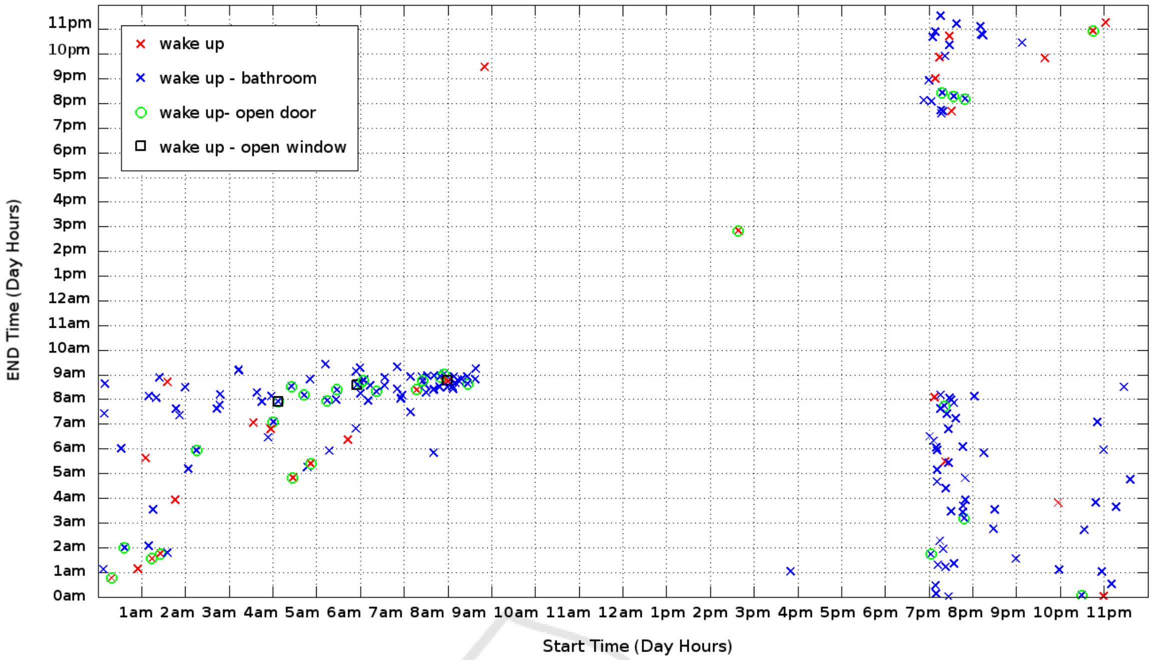


(a) Room 2

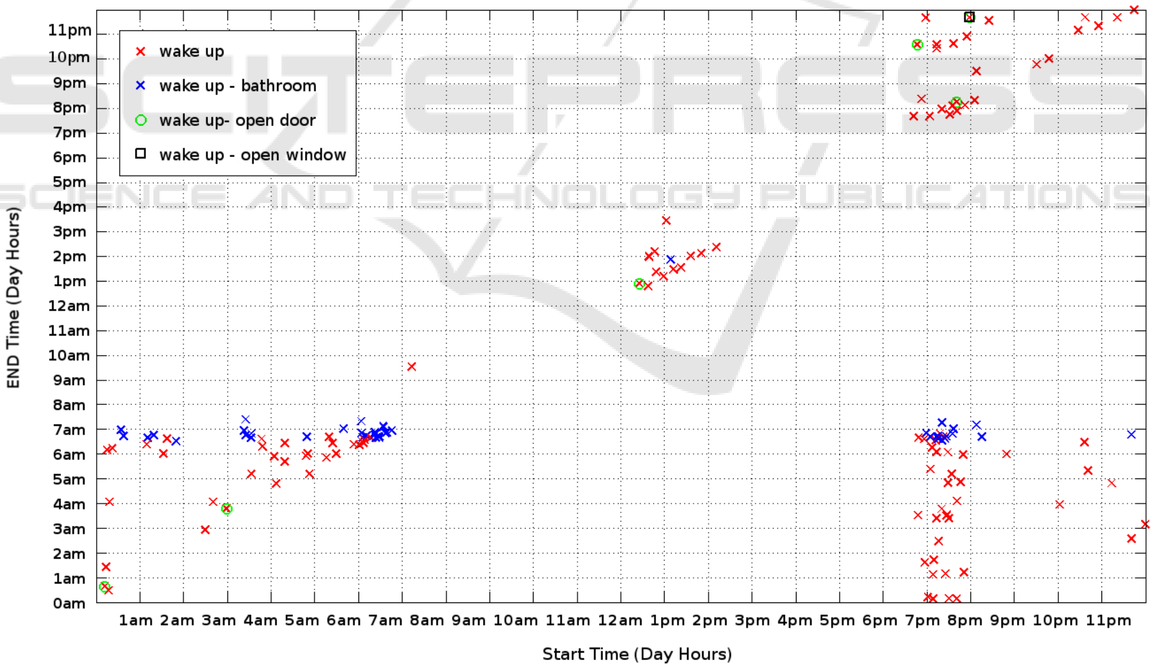


(b) Room 3

Figure 6: Start-time/duration graphs of the "sleeping" activity detected from May to June 2015, respectively in (a) room 2, and (b) room 3.



(a) Room 2



(b) Room 3

Figure 7: Start-time/end-time graphs representing the activities performed after waking up by the patients housed respectively in (a) room 2, and (b) room 3, from May to June 2015.

fact that the monitored elder is very lively, and often gets up during the night.

In Table 3, the percent occurrence rates of each activity described above are given, limited to the night hours.

The analysis described so far is just the very first step to identify the user's behavioural patterns and abnormal situations. Until now, we focused on the rep-

Table 3: Hit rate of the getting up action followed respectively by the action of entering the bathroom, opening/closing the door, or opening/closing the window, in the time slot between 09:00 PM and 06:00 AM.

Event detected after awakening	Room2	Room3
Presence in the bathroom	76%	15%
Door opening	14%	2%
Window opening	0%	0.2%
None	10%	82.8%

resentation and visualization of data, extracting some preliminary information on the habits of two monitored patients. Nevertheless, there is still a long way to go. Although the detection of outliers can be very useful in this context, however, it is necessary to set up a predictive system able to identify in advance any anomalous situation to help the nursing home staff making the necessary arrangements. As already hinted, one of the aspects emerged during discussion with nurses is the need of alarm personalization. In fact, a situation may be potentially dangerous for a user, while it may be harmless for another one. This strongly depends on motor and cognitive skills of each patient. Although this can be done manually by nurses via graphical user interfaces, a significant contribution comes from the analysis of patients' habits. One of the future developments is to extend the behavioural analysis in the long term, aimed at recognizing unusual, and, therefore, potentially dangerous situations and notifying them to the staff, in a completely automatic way.

6 CONCLUSION AND FUTURE WORK

The issue addressed in this paper is the need to offer assistance to a growing number of AD patients, by providing solutions that can be applied both at their homes, and in nursing homes. Different types of patients have their own specific requirements: this case deals with AD, but it could be possible to adapt the current solution to patients with different pathologies, by changing the sensors selected and offering proper services. The results obtained from the first experimental installation of the monitoring system highlighted the effectiveness of the proposed solution to support the nurses during the night supervision of patients. The effectiveness could grow even more by extending the pool of monitored patients. Monitoring all the patients leads to increase the convenience for the nurses and, above all, the degree of safety of the patients. For example, by monitoring the presence to bed at night time for all the patients, it could be possible to detect any accidental fall or necessity to help. Other advantages brought by the UpTech RSA proposal are the introduction of innovative technologies in the nursing home facility, the efficient use of human and technical resources, and the quality of care improvement.

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