



SAFE INDOORS

AN ITALIAN CARE HOME WANTED TO MONITOR ITS PATIENTS' POSITIONS DURING THE NIGHT, TO ENSURE THEY WERE SAFE AND NOT AT RISK OF FALLING. AFTER TRYING VARIOUS STANDARD TECHNOLOGIES, THE HOME SWITCHED TO AN ENTIRELY NEW METHOD OF POSITIONING, AS GIUSEPPE CONTI EXPLAINS

Although, indoor positioning has achieved technical maturity, few applications have been specifically designed to deal with the needs of old people. This is particularly important as demographics show that our population is fast ageing. By 2060, the average age in Europe will have risen by seven years, life expectancy at 65 will have increased by five years and the number of people older than 80 will have tripled.

In light of such changes, one of the great challenges will be to ensure the wellbeing and safety of an increasing ageing population. This will become critical, particularly in facilities hosting ageing people with cognitive impairments (CI), the occurrence of which becomes more significant from the age of 60, causing progressive degenerative decline of cognitive functions. Among CIs, Alzheimer disease is currently the pathology with the highest impact socially and economically.

Ensuring the safety and improving the quality of life of patients with Alzheimer disease is the mission of San Bartolomeo, a 125-bed, state-of-the-art nursing home in Trento, Italy. Due to the frailty of the patients, it is of paramount importance to deliver the highest safety standards, especially at night when caregivers are limited due to staff costs.

Standard safety policy at night included regular, routine safety checks of rooms. However, the staff noticed that these were also the most significant cause of night disturbances because of the associated lights and noises. This badly affected the sleep of the patients, in turn contributing to the worsening of their physical and cognitive conditions and causing night wandering. Moreover, despite the safety checks, guests remained alone for most of the night, and accidents could be potentially discovered only after hours had passed. As a result, the number of fatalities is highest at night.

To limit risks and prevent accidents, staff resorted to using bed barriers, which affected the patients' dignity and autonomy. The managers of the nursing home wanted to change this policy to increase the autonomy of the patients and, ultimately, ensure they had a better quality of life.

In 2014, they started exploring the use of technologies to determine in real-time the indoor positions of the 25 guests of the Alzheimer unit, to spot dangerous situations and notify caretakers when needed. Identification of falls was by far the most important requirement since these, together with age-related physiological changes and co-morbidity, are potentially very dangerous – on average, 10-25% of falls result in lacerations or fractures (wrist and hip being the most frequent). Furthermore, the risk of falls is highest during the first nine months following admission (usually twice as high as in the following months), due to the guest not being familiar with the new indoor space. A further requirement was to be able to detect from location data the beginning of night-wandering, which is extremely dangerous as it is the greatest cause of falls.

Early results

After some early experiments in 2014, the staff of the nursing home decided not to use indoor location technologies that rely on bracelets or necklaces, such as Bluetooth, ZigBee or Ultra Wide Band, as several patients removed such devices or simply forgot to wear them. The challenge was therefore to be able to locate people indoors without their wearing any device.

A first project, in late 2014, experimented with the use of cameras and computer vision algorithms to detect dangerous behaviours.

However, the solution, which was tested in the nursing home for a few months, proved unreliable, producing a high number of false positives due to changes in illumination over time; it was also virtually unusable at night, despite an attempt to complement the cameras with infrared light-emitters.

In mid 2015, further development, based on the experiences of the first project, resulted in a completely new system, 'MentorAge', based on a low-cost sensing units that combined a Microsoft Kinect and a micro-PC running software designed to analyse movements of old people from articulation of body limbs.

MentorAge calculates the indoor positions of multiple guests in real-time in the order of a few centimetres in full darkness. It processes indoor location data to detect dangerous patterns, including falls, wandering, elopement and prolonged stays in specific areas, such as toilets.

By analysis of the 3D image of the environment, the system extracts the position of the arms, legs, torso and head of a patient, and processes their position in real-time to detect patterns representative of dangerous conditions. For instance, by analysing the position of the head (next to the floor) and of the limbs (not moving), it can infer that the person has fallen.

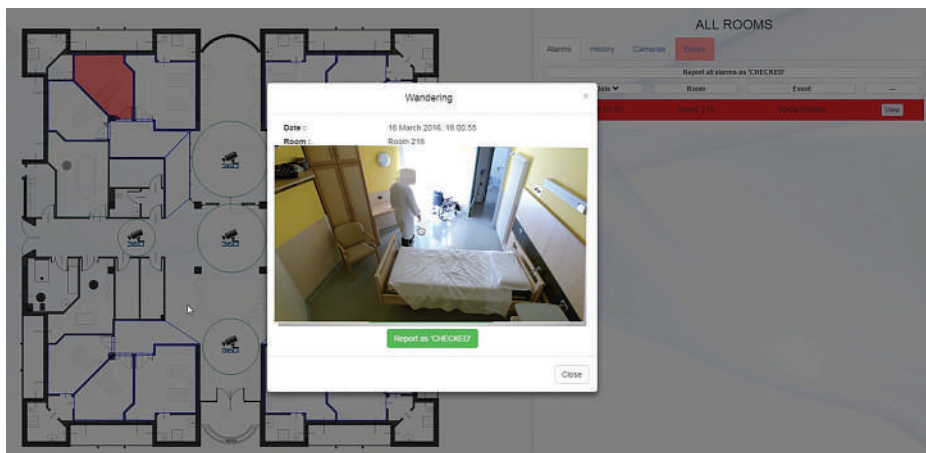
Such contextual intelligence enables, for instance, the avoidance of a false alarm whenever a person leans down to pick an object that has fallen on the floor. Accurate positioning of the different limbs, and the analysis of their movements and layout, is also used to differentiate a person from a dog, for example. The centimetre-level accuracy of the positioning can also detect conditions that may be indicative of a potential risk, such as a person about to get out of bed; caregivers can then intervene and prevent potential falls.

Whenever a dangerous condition is identified for a given room (rules can be tailored to each guest), the location information is sent via Wi-Fi to a central server that dispatches the alerts to the caregivers.

Testing

The initial system was initially tested in a few rooms to calibrate the algorithms in a real operational scenario. The prototype was then engineered to include a web-based control panel for the nurses and an app, which was installed on the smartphones and smartwatches of the caregivers. This provides prompt notification alerts for night staff, without using loud centralised alarms, which could be a major source of distress and disruption of sleep for the patients.

Once the caregivers received the alert, with the associated position shown on a map, they could decide to turn on the video camera embedded in the MentorAge unit to check if support is required. To ensure maximum privacy, video cameras were activated only following an alert and were automatically turned off once the



The nurses' web-based control panel



Detecting a fall using a wall-mounted Microsoft Kinect

alert was dismissed. Furthermore, no image was recorded by the system.

This proved to be a far more respectful and privacy-savvy alternative to traditional routine checks, significantly reducing night disturbances. After an initial testing phase, the management decided to scale up the infrastructure, installing 32 MentorAge units early this year to extend indoor positioning across the whole Alzheimer unit. The results is an indoor location infrastructure that can maximise the safety of seniors during their daily activities, yet maximise their autonomy, always respecting their privacy and dignity while reducing burden on caregivers.

The experience of the project has shown how, within residential care, being able to centralise the indoor positioning and monitoring of patients can reduce costs while providing high-quality services with limited staff. The project has also demonstrated how indoor location technologies can be used to create ageing-friendly indoor spaces.

Lastly, the project has demonstrated that in addition to traditional verticals, such as retail or personal mobility, indoor location can be a



Caregivers have a smartphone and smartwatch app that receives notifications of falls

driver to redesign care and assistance, which are set to become unsustainable in light of projected demographic evolution, and can help to create valuable market opportunities within the 'silver economy'.

INDOOR LOCATION CAN BE A DRIVER TO REDESIGN CARE AND ASSISTANCE

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