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Intelligent Environments for Social Care

Sue Sharples, Vic Callaghan, Graham Clarke

In January 2004, fourteen residents in a Lanarkshire nursing home suffered pointless deaths due to smoke inhalation from a fire. Last winter in England and Wales, 21,800 older people died needlessly as a direct result of the cold. And around 180,000 older people every year suffer robbery, injury or death after being targeted by "bogus caller" criminals. Older people should be feeling supported and cared-for, yet instead many are spending the last years of their life living in fear, isolation and distress.

There is already a care crisis in the UK, as society cannot afford to provide degree of support needed by elderly or disabled people; and this problem may soon escalate, spiralling out of control as the ageing population increases. Yet there is a solution: utilise *technology* to supplement and aid the work of carers, to provide better support without the excessive costs of traditional 24-hour care.

There is a growing trend towards the use of simple technology throughout one's home to enhance the environment, providing increased comfort and security. Some gadgets, such as remote-controlled front-door locks or pendant-alarms, have already been used successfully as aids to vulnerable people. Until recently though, such items have only been able to act independently; but if they are connected together via an electronic network, they have the potential to provide a much greater support system that could go a long way towards enhancing the quality of life of anyone using them.

Such systems already exist to some degree in the form of *Intelligent Environments*: buildings with an infrastructure which allows sophisticated co-ordination of devices such as heating, lighting, blinds and so on, to provide occupants with a comfortable, safe environment. In the Department of Computer Science at Essex University, research in the *Intelligent Inhabited Environments Group* is centred upon such systems. One of our aims has been to investigate the use of this technology to provide enhanced safety and quality of life to vulnerable groups of society. However, we are not interested in adding intrusive cameras or resorting to "Big Brother"-style monitoring; rather, we are focusing on exploiting the new rise of *embedded technology* - everyday objects like passive sensors and smoke-detectors, door-locks, telephones, or radios, that each contain a tiny computer processor which enables them to be controlled electronically. These devices can communicate with each other across a network to share information and form a fully controllable environment for occupants. Such systems are in fact becoming widespread, since they are already being installed in hotels and offices all over the world. Far from being excessively expensive though, in fact they have shown to be very cost-effective, as they can save considerable amounts of money, for example by switching off devices when not needed or by optimising heating for economy.

For some time our research group has had an experimental system, called an Intelligent Dormitory, or *iDorm* (recently featured on Tomorrow's World), consisting of a bed-sit room such as one might find in University student accomodation, but equipped with many embedded sensors and devices. Now a larger prototype, this time an entire flat - the *iFlat* - is being developed in the new Network Centre building currently under construction on our

campus. The iFlat has been designed to provide a cohesive intelligent environment, featuring a sophisticated network of hi-tech equipment and gadgets.

Traditionally, such systems have required significant knowledge or skills on the part of the user, to control them effectively. However, our research is primarily based on *Artificial Intelligence* - computers that exhibit elements of "human" thinking, and are capable of reasoning, learning, and adapting to new circumstances. So our system incorporates methods that enable it to *learn* from a resident without being "programmed"; thus, it is ideally suited to vulnerable people who may not want or be able to interact with the technology themselves. The system uses the wealth of information available from its sensors and devices to learn about an occupant's lifestyle and preferences. We call this *Evidential Learning,* since, over time, it builds up patterns, or *evidence*, of actions that are repeated or occur regularly. It is then able to perform some of these actions itself, thus gradually reducing the need for the occupants or carers to do so (unless they wish to). This might include simple tasks like switching on the lights as it gets dark, through to more complex sequences of tasks, for example, as the occupant retires for the evening, locking the doors and windows, turning off lights and heating in the living-room, and switching on an electric blanket to warm up the bed. This will obviously help occupants who physically have difficulty performing these tasks due to limited mobility; but it would also help those who are mentally- or memory-impaired and may not always remember, or may not even understand the importance of, certain actions like locking a door or switching an oven off.

This type of system could be implemented either in a residential home, or in sheltered housing, or even in a resident's own existing house, enabling him to remain independent for longer without being so reliant on carers. The intention though is that it will supplement, rather than replace, human care, while also relieving care-givers of some of the more mundane tasks and enabling them to spend more quality time with their clients.

The system is designed with certain safety features - such as how to respond to a fire or how to prevent the internal temperature from falling low during cold weather. Unlike other systems though, it does not impose rigid pre-programmed inflexibility on occupants. Since it learns most of its behaviour from the occupants themselves, it appears "tailor-made" to suit any occupant, and it will even adapt if they or their preferences change. An added advantage is the possibility that the system could (with the occupant's permission) also be used to monitor his or her health, either by detecting long-term gradual deterioration, or by alerting a doctor to a more immediate situation such as a fall or a stroke.

In large companies, electronic ID-tags are worn by occupants, used as a means of tracking them and locating them in an emergency. In a residential care-home such devices could be an invaluable aid to health and safety. Worn as a non-intrusive bracelet, pendant or badge, they could act as a personal alarm button (similarly to existing pendant-alarms) to alert a carer that the wearer needs urgent assistance; they could be used to locate occupants in a fire or other emergency situation; and they could even supplement the role of Hearing Dogs or Guide Dogs, by notifying the blind or hard-of-hearing of a doorbell, phone ringing, or smoke-alarm, via a warning light or sound. When communicating with the environmental system too, they could even detect if an intruder (such as a bogus caller's accomplice) was in another room and signal an appropriate alert.

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Although this type of research may clearly raise some issues about personal privacy, it has the potential to significantly improve, and even save, many lives; the majority of people when questioned have said they would welcome such technology and the increased feelings of safety, comfort and independence it would provide. In fact it seems likely to us that only through the use of such technology will we have the power to improve the current abysmal state of the care industry, and to significantly increase the quality of life of those vulnerable people who most need our help.