

Smart home technology: Have older people paved the way?

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A. van Berlo, Smart home technology: Have older people paved the way?

Gerontechnology 2002; 2(1): 77 - 87. The terms smart homes, intelligent homes, home networking have been used for more than a decade to introduce the concept of networking devices and equipment in the house. According to the Smart Homes Foundation the best definition of smart home technology is the integration of technology and services through home networking for a better quality of living. If simple plug-and-play tools for controlling lights are included (e.g. X10 tools) or the computer networks in houses are accounted for as smart home technology, hundred thousands of homes all over the world may be called smart homes as well. Only recently, some dozens of projects with smart technology in the houses of older people have been realised or started. The aim of introducing smart technology in these houses is the wish of the tenants to stay independent in their own house as long as possible. Applications are focussed on safety and security, care and comfort. In this presentation an overview will be given of the detailed applications in both new built houses and renovation projects. A summary of the first findings of experiences and reactions of older tenants will be included. Key factors in the further technical development of smart homes are the proper electrotechnical infrastructure, flexible solutions in infrastructure and applications because of shifting needs and wishes, acceptable user interfaces, and costs. Even more important for acceptance and breakthrough will be the content and services that can be delivered to the home. A wide range of companies is developing business models to serve the end consumer. Reference will be made to The Smartest House of the Netherlands, a new demonstration house of the Smart Homes Foundation, where both consumers and companies give feedback on the current market developments. The Internet and mobile telephony have been keen drivers to stimulate the interest of technology in the household. But also several economic and socio-cultural factors will cause changes in society in which smart home technology will really break through. The ageing western societies and the clearly expressed needs of older people have raised particular awareness of the several parties in the building process for the opportunities of smart home technology. Finally, based on expected product launches and technical developments at major international companies, as well as based on the feedback of older people currently living in smart homes, some expectations for the near future will be given.

Key Words: smart home, network, user interface

The terms smart homes, intelligent homes, and home networking have been used for more than a decade to introduce the concept of networking devices and equipment in the house. According to the Smart Homes Foundation the best definition of smart home technology is: 'the integration of technology and services through home networking for a better quality of living.' Areas of application are: home automation and energy control, information and communication, working and productivity, and entertainment. These areas particularly refer to the technical network islands which regularly exist apart from each other. In these islands companies from a certain business branch work together and adopt certain standards; also they refer to certain areas of applications. There are bridges between the islands, but it is questionable if there will be ever one single network for all data and signal transfer in the home.

With reference to the definition up to present time the implementation of complete

smart homes with all network islands has been limited to some demonstration houses and high-end luxurious villas. In Europe demonstration houses have been built in amongst others London, Milan, Zurich, and Duisburg. The so-called 'Smartest House of the Netherlands' is a demonstration house of the Smart Homes Foundation and will be discussed later. Looking at houses with single network islands, there is a different situation. Home automation and energy control has been implemented in some thousands of houses Europe-wide. If simple stand-alone plug and play tools for controlling lights (–e.g., X10 tools) are accounted for as smart home technology, 10's to 100's of thousands of homes all over the world may be called smart. For achieving 'intelligence', however, one really needs a network with sensors, actors and software and not single stand-alone solutions. Single networks in the other application domains are particularly coming up in the working and productivity area. Here, PC-networking is meant, where all PC's in the house, the printer, scanner, PDA etc. are linked to each other via an Ethernet network, including firewall protection and the use of a server.

In this paper, the review on smart home technology will be limited to the area of home automation, as this is the area of most interest for older people so far.

DRIVERS FOR BREAKTHROUGH OF NETWORKED HOUSES

Western society is changing rapidly. There are social and economic changes, which have an impact on our entire society. All countries have to face the ageing phenomenon. At the same time we see in many countries dips in birth and fertility rates. At the present time, there are shortages of skilled younger people in many economic sectors. Furthermore we see that many young adults postpone or even abandon starting a family, because they are too busy in work or cannot afford to own a house in the expensive city areas. Another relevant aspect is that we live



Figure 1. The tenant opens the front door via a magnetic card

more and more in a society where at the same time individualisation and globalisation both strongly advance. The economic growth has created more wealth in most layers of Western European societies. This has caused among others an increased interest in investing in one's own house, either by building a new one or refurbishing the existing one. An important driver for smart home technology is the fact that traffic in most countries, particularly in and around cities, causes so much of a problem with getting to work that telecommuting really becomes a good alternative. Finally, liberalisation of telecom and in the near future of energy will raise interest in the actual use of these means and resources. All aforementioned social and economic trends will have an effect on the way we live and use our house. At the same time we see technical drivers for a growing interest in smart home technology: In the past few years Internet connection has arrived in more than 50 % of all houses in the western societies. The number of multi-PC households has increased enormously as

well. In the telecom sector, the explosion in the use of mobile telephony has increased the interest in a wireless world of living. Finally, there is a continuous search for more broadband transfer of data, entertainment, and communication. In this area, the right business models still seem to be lacking, but it is a question of some years to come that most households will have been connected to at least 0,5 Mb/s and many to 10 Mb/s or more.

All aforementioned trends stimulate interest in the smart or connected home. Connected thus means that each electrical product or apparatus is connected to one or more telematic networks within the home and via the residential gateway(s) to the outside world.

HOME AUTOMATION FOR OLDER PEOPLE

Only recently, some dozens of projects with smart technology in the houses of older people have been realised or started. The Smart Homes Foundation in the Netherlands has been initiator and consultant for many of these projects in the Netherlands. In 1997, in the Province of North-Brabant in the Netherlands, it was felt that demonstration projects were needed for those people who could have a clear benefit: older people who like to be independent and out of care as long as possible. The purpose of doing demonstration projects was to identify the real wishes and needs of older people themselves to find solutions from the technology offered on the market and to try to understand what extra steps would be involved in the building process. Five projects spread over the province (2,3 million inhabitants), with in total 120 apartments of around 70 - 80 m² were initiated for senior housing. From the beginning (early 1998) senior citizens were involved to express their wishes and needs. All five projects were subsidised as far as consultancy and project leadership by the Smart Homes Foundation concerns. During the year 2000 all five projects have



Figure 2. Access control: watching TV, speak via the alarm phone and push button on the phone to open the door remotely

been finished and older citizens are living now in the houses.

In the five demonstration projects and those that followed, the applications were not always the same. However, 80% of the applications in each project are from the following list:

- (i) Safety & security: Access control (Figures 1-3), Intruder alarm, Smoke alarm, Automatic lighting at night (Figure 4), Automatic cooker switch off (Figure 5);
 - (ii) Care: Active person alarm (Figure 6), Passive person alarm, Authorised access to the apartment for the care worker;
 - (iii) Comfort: Automatic lighting, Automatic screens and curtains.
- Most applications are illustrated.

The projects differ from each other that for instance, in one project there are no automatic curtains and in the other there is no intruder alarm. The implemented technology varies widely. This is due to the fact that there are many suppliers of bus-systems and safety alarm systems, many installers with different views and preferences and of course due to the fact that the amounts of investment differ from project to project. Basically, one can speak of home automation when there is a bus-system involved, which acts as the electronic nervous system of the house. There are many proprietary systems on the market. In Europe one tries to make a

leading standard for bus-systems, but after many years this is still a slow ongoing process.

Safety & security

Top priority for many older people is the feeling of living safe and secure in their own house. Therefore, one likes to know who is at the central access door of the flat and at the front door of one's own apartment, before one opens the door. In many projects this access control has been facilitated via remote control by phone, on TV and electronic locks on central access door and own apartment door.

A smoke detector is installed in all projects, most near or in the kitchen. In some cases there are even smoke detectors in kitchen, living room, and bedroom. If smoke is detected an alarm signal is given to a call centre automatically. First, the call-centre operator will speak to the tenant via the safety alarm phone if there is a real fire.

In all houses automatic lighting at night is a common application. Older people have more frequent nightly toilet visits than younger people. With automatic light switching on when the legs are put out of the bed, one can better orientate and find the way to the bathroom without risks of falling. There are many technical ways of carrying out this application: dimmed lights



Figure 3. The tenant switches intruder alarm on / off via proximity key



Figure 4. Passive infrared sensor with night light below

near the bed, light under the bed or lights in the hall or the room next to the bedroom. In most cases there is a passive infra red sensor close to the bed or under the bed. In one case a bed mat is used.

In most cases the electric or gas cooker can be switched off via an extra button, which also switches off the light on the working area. On the other hand the cooker cannot be used if the light on the working area is not switched on. If the resident leaves the house, the cooker is always automatically switched off. The same is true when the tenant goes sleeping and uses the button 'everything off' above the bed.

Care

In all houses where senior citizens live, an active person alarm phone is installed. This phone dialler is used for automatic transfer of all signals that could occur in the house: active person alarm, passive person alarm, smoke alarm, and intruder alarm. The tenant

is free to wear the pendant or bracelet for active alarm. Most tenants do not wear it.

Since most tenants do not wear a pendant for active person alarm, in all smart homes for older people the concept of passive person alarm has been introduced. This means that the house continuously detects movement of the resident and automatically warns the call-centre if no movement has been detected for more than the installed period (e.g., 3 hours). Of course the house must 'know' if the resident is at home or not or is sleeping at night. For this, several solutions have been introduced to 'let the house know' what the resident is doing: buttons at the front door and buttons above the bed. An ideal solution, without extra action for the resident, has not been found yet.

If care is needed in one of the apartments of a flat, which is located somewhere in town, the care worker needs the key of the front door of the resident. In most villages, the key is at neighbours or children. If the front door is well locked, it is not always possible to open the front door with this key. In cities many residents don't have an address where they can leave the key of their home. In this case the care worker must bring a bunch of keys of the apartments where care is needed. This is not a safe situation, since criminals can get easy access to the various apartments if they rob the bunch of keys. Therefore, the concept of electronic locks has been introduced where care workers get access to the individual apartment when they arrive.



Figure 5. Extra button next to the electrical cooker in order to simultaneously switch on / off cooker and lights above the dresser



Figure 6. One of the chosen solutions for intruder alarm off and simultaneously inactivity measurement on and vice-versa: a simple switch 'day / night' above the bed

Different technical solutions have been worked out, where the care worker can get automatic access.

Comfort

Apart from the safety aspect, automatic lighting of areas is used from a comfort point of view. If one enters the house, light is automatically switched on in the evening or night. The light in the bathroom (Figure 7) and toilet is also switched on automatically. In some apartments infrared sensors are used which one can simply activate or de-activate.

Automatic screens (Figure 8) are more common than automatic curtains. In most projects the latter is an option, for which the residents have to pay themselves.

EXPERIENCES AND REACTIONS OF OLDER RESIDENTS

The demonstration projects were carried out in order to gain more insight into real wishes and needs and actual use of smart home technology by the residents, to find solutions from the technology offered on the market,

and to learn about the process of implementation. Here only the first results of interviews with the older residents will be reported.

The starting point was that the residents, who moved to new built apartments, should be able to stay in their newly dwelling for the rest of their life. The age of the residents varied between 62 and 85. A majority was living alone, but there were many couples as well. They would live fully independent, but if care was needed, they would receive it from the regional Home Care organisation. Only if a resident would require intensive nursing care would it be necessary to move to a nursing home. All apartments were designed with two bedrooms, a bathroom, a living room, and a connected separate kitchen. The flats vary between 18 and 80 apartments. For all residents the move to the new apartment meant a reduction in available space and the abandoning of the garden, but they all strongly desired the new living space. Reasons were the fact that some residents did not feel safe and secure in their



Figure 7. Passive infrared sensor in the bathroom for automatic light



Figure 8. Automatic curtain

old house anymore, that it was too big to maintain or that they expected an increasing need for care. Moving to a smart home was not their purpose, because they did not know about the existence and the facilities in it. The smart homes were simply offered because it was their turn on the waiting list.

A general comment of many residents was that moving into a new house with different functions, such as switching the house 'on/off', automatic lights, intruder alarm, etc. was extra difficult. They would have preferred a gradual introduction of the new functions after they had been accustomed to the house.

For couples the passive alarm was not desired yet. In these cases the installers programmed this application off. For the single person households in most cases the maximum time for inactivity was desired at 4 hours. This was due to the fact that some persons do not move out of the chair for 2 - 3 hours or longer. In the first month of their stay in the new house, many persons forgot

to switch the house 'on/off', which resulted in many false alarms for either inactivity or intrusion. After a month in most apartments the number of false alarms has been reduced to zero. But many residents still do not like the extra handling. They are forced to think about it all the time and that does not contribute to the feeling that a smart house does everything automatically.

Another aspect of importance is that most residents want to keep the control over their house. They want to overrule automatic functions or alarms. It is also a fear that the house is not accessible or usable if the electric power fails.

In the layout of outlets and buttons and the programming of functions the installers are still making mistakes. This makes the applications not understandable or not usable. For instance, if an infrared sensor is not well positioned, the whole system is not working if the curtain is covering the sensor (Figure 9). In other cases (Figure 10), two of the same cords or buttons are too close to each other, which gives high risk on accidentally wrong use of functions. Sometimes, the buttons are simply put on the wrong place in the planning and layout (Figure 11). In the mean time these mistakes have been improved to better solutions, but better buttons or optimal placing of outlets are not always possible.



Figure 9. Poorly mounted passive infrared sensor close to and often behind the curtains



Figure 10. Two bed cords too close to each other: one for active alarm, one to switch off the lights

Despite the aforementioned shortcomings there is an overall feeling of safety and security among the residents of the demonstration projects. One feels protected and has a guarantee on follow up if something happens. Those residents who still feel well and active do not want all applications to be active from the beginning. They are very satisfied with the options in the house in case they really need them.

BARRIERS TO OVERCOME FOR SUCCESSFUL WIDESPREAD INTRODUCTION

During 2001 and 2002 the Dutch demonstration projects haven't been followed by similar initiatives all over the country. The Netherlands is leading in this particular area in Europe. In Scandinavia and Great Britain initiatives with smart homes for demented persons are coming up. In Germany, France, and Belgium some degree of home automation can be found in the homes of private owners. In Italy, recently a nation wide programme for telemetering has been started. With telemetering the energy companies are able to read the gas- and water meters remotely, so without visiting each house. This could further enhance interest in home automation as well.

Still, the introduction of smart home technology has been very slow in the past 5 years. There are many factors that account for the fact that smart home technology is in its infancy.

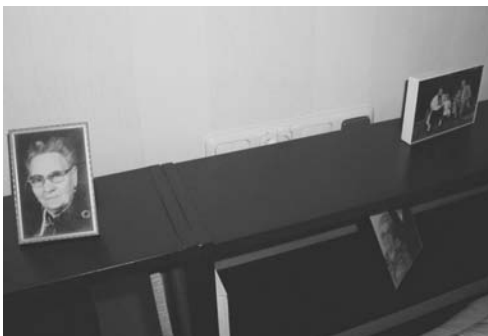


Figure 11. The buttons are almost behind the bed furniture

First is that its possibilities are unknown by both consumers and professionals such as architects, housing associations, housing constructors and even the small installation companies. This means that the end-users, the residents, do not ask for smart home technology. Architects still design houses with an electrotechnical infrastructure, such as has been the case for more than decades. Housing associations are becoming aware of the possibilities, but do not know where to go and how to start the process of implementing smart homes.

Second, the cost for something, which is not tangible or visible and has not a clear contribution to increased quality of living, has been a major barrier for really starting implementation. The demonstration projects revealed that installation of a bus-system and coupling subsystems to it including the programming is not an easy task. It requires new software skills and integration of different disciplines from what most installers have. Therefore, the implementation has been quite laborious and thus expensive. The bus-systems themselves are still quite expensive, because not many have been sold. The investments have to be earned back. Special applications, such as electronic locks were also very expensive. As a consequence of competition, however, prices are decreasing gradually. This is also the case in some bus-systems. Furthermore, wireless and power line solutions are coming up, which tend to be cheaper. All together, the costs of home automation with 80 % of the applications as have been described above, vary between Euro 5000 and 10000. The wide variation is due to the different proprietary solutions and the more standardised building control systems.

Poor layout and bad interfaces, such as have been installed in the demonstration projects, are not favourable for fast introduction of smart home technology. Installation companies have to be trained and educated in man-machine interaction and basic aspects of

human factors.

Another serious barrier for widespread introduction is the lack of knowledge at electrotechnical installers. In fact, it is not a single discipline anymore, which is desired: a system integrator is needed, who can integrate the disciplines of electrotechnique, telecommunication, ICT, safety, care technology and audio-visual techniques. This requires new skills, which many installers do not have already. Many futurologists talk about plug and play technology in the near future, but current problems with bridging and programming desired applications does not make this realistic for the near future.

THE SMARTEST HOUSE OF THE NETHERLANDS

The Smartest House of the Netherlands is a new demonstration house of the Smart Homes Foundation (Figure 12-13). It is fully equipped with all kinds of networks in the application domains, such as have been mentioned in the introduction. Its first aim is to raise awareness among the visitors, both professionals and consumers, about the possibilities of smart homes. In a 2 - 3 hours' visit the various applications are demonstrated and explained. The house combines smart technology with energy saving and sustainable energy sources. Also, the house has been made that flexible and demountable that it can be transported in parts to other regions in the country. Finally, the house is

barrier free, which means that everyone, also those with mobility problems can enter the house and live in it.

The house also serves as a development platform for the co-operating companies. New ideas are worked out between the companies and tried out in the house. Regularly, people live in the house for a short while and give feedback. The house is no house of the future, but contains many networked functions and scenarios which enable new lifestyles and ways of living. It is not particularly focussed on older people, but the applications described in the demonstration projects are also present.

FUTURE DEVELOPMENTS

Future developments are of course technology driven and related to economic growth. Internet, broadband, and wireless are three keywords that keep telecom, PC, software, consumer goods, entertainment and infrastructure companies busy now and for many years to come. Market developments in general have not been as fast as had been expected before the collapse of the Internet hype and slow implementation of 4-G wireless telephony. Nevertheless, there is a continuously growing interest of the consumer for broadband Internet at home, working and learning at home, TV on demand, interactive games, and digital photography all distributed in the home.

Some key factors can be identified in the further technical development of smart homes.



Figure 12. The Smartest House of The Netherlands



Figure 13. Terrace and back of the Smartest House

First, a proper electrotechnical infrastructure and flexible solutions in infrastructure are minimal requisites. Although more wireless solutions will arrive (WLAN, wireless ADSL, etc.), electrical outlets and wired accessory points will always be needed. Moreover, transfer of video and other broadband transfer of data still have the highest quality, security, and reliability if wires are used. The houses of the past decades are not prepared for new wires and outlets. So, structured wiring in existing dwellings is still a problem, if one does not want to open walls and do intensive retrofitting. Newly built houses should be pre-wired and provided with as many outlets for energy, TV, music, data, etc. as is possible. The ideal situation is the use of skirting boards, such as used in office buildings. More and more companies offer in-house skirting boards with nicely designed plug-ins, which enables all desired connections at any place.

Other important factors are the growing importance of the PC and PC networks in the home and digitalisation of TV. PC and TV will gradually merge. If broadband, with more than 10 Mb/s, has reached the house, it will become possible to watch real-time movies etc. on any screen or PC. On the other hand digital TV will make it possible to get TV on demand, information on demand, and videophone with persons in the outside world. This will further enhance and intensify communication to persons living far away or simply the community in the direct environment. In the next generation of (demonstration) projects with older people Internet and broadband connection will be realised, which will enable new applications in the information and communication area.

TECHNOLOGY AND ETHICS

Special attention is needed for demented persons. With broadband connections it is tempting to use video cameras for permanent surveillance of demented persons. Here ethical dilemmas and issues arise. First, there is the importance of consent. Although many people with dementia are capable of giving

informed consent, or proxy persons may do so, this is not a straightforward matter in all cases. In order to give consent, it is generally understood that a person should have the information required; be able to make a decision; understand the implications of the decision. But people with dementia are not all able to give consent every time it is required.

If for example cameras are introduced for surveillance of demented persons, it is very helpful to use the 'three Ps' approach in order to find answers on ethical questions. They are: Perspectives, Principles, and Paradigms. Perspectives refer to the approach of considering what might be the views of all people involved about the proposed action and the consequences of not taking the action. Four principles can be applied: respect for the autonomy; beneficence (doing one's best for the person); non-maleficence (not harming the person); justice. Paradigms can provide reference situations where ethical issues may be clearer and against which to evaluate the appropriateness of a particular solution in the case in question. Since the number of people with dementia will increase enormously in the next decades, special attention for the living arrangements of this group is growing. Furthermore, it is appreciated that demented persons should also be able to live with dignity and privacy as long as possible. This means that group living (own bedroom and common kitchen) is introduced in northern-western European countries. At the same time smart home technology is considered, not only to the benefit of the persons with dementia, but also to support and alleviate the work of the caregivers (family members and paid workers). It is argued here that not all technical solutions should be applied without considering ethical dilemmas.

CONCLUSIONS

Real smart homes with all network islands and possible applications are limited to demonstration houses so far. Home automation has been implemented in thousands of

houses world wide, but is still in its infancy. Several economic and socio-cultural factors will cause changes in society which are favourable for a breakthrough of smart home technology. There are also important technical drivers, such as Internet, broadband, and wireless solutions.

The question in the title of this paper is not easy to answer. Yes, older persons and in many cases also older people with minimal pension, have been the 'test' group for starting demonstration projects with home automation in the past years. They had clearly articulated needs and wishes. The implementation of the first generation of demonstration projects, with emphasis on safety and security, care and comfort, has shown that mistakes in human interfacing and layout still occur and temper the enthusiasm of many residents. Overall there is feeling of

satisfaction and security among them.

Other factors still account for the slow progress: costs, lack of standardisation, and missing skills of installers. The Internet, broadband, and wireless are key technologies in an irreversible move to further introduction of smart home technology, but the question is at what speed. It is virtually certain that in the near future all houses will be connected to the electronic highway. It is logical to expect that these houses will be smart by virtue of networking of all devices and equipment in order to get maximal benefit and fun. The benefit and usefulness has been demonstrated in homes where older people live. From this point of view, yes, older people have paved the way.