Perceptions of the Elderly on the Use of Wireless Sensor Networks for Health Monitoring

Chris Secombe
University of Technology, Sydney
PO Box 123
Broadway NSW 2007
c.secombe@gmail.com

Robert Steele
University of Technology, Sydney
PO Box 123
Broadway NSW 2007
rsteele@it.uts.edu.au

Wayne Brookes
University of Technology, Sydney
PO Box 123
Broadway NSW 2007
brookes@it.uts.edu.au

ABSTRACT
This study examines the perceptions and thoughts of the elderly community on current sensor network designs for health monitoring. The majority of research to date has focused on development of the wireless sensor network technology for health care applications; this study instead focuses on the perceptions of one group of users of such technology – the elderly. As user acceptance is a key issue in system deployment, issues and ideas arising from current sensor network designs are put to the elderly, aiming to involve them in the design process. By conducting focus group sessions with elderly participants and interviews with a health care professional, this study sought views on the nature of monitoring preferred by elderly people, and their preferred modes of interaction with such a system. Some interesting and surprising findings from these focus groups include a general preference for an embedded sensor implementation versus a wearable or ambient implementation, the expressed need of the elderly to have some ability to control/interact with the sensors and the general positive level of support for the idea of sensor-based health monitoring.

Author Keywords
User-centred technology design, Geriatric health care, Wireless sensor networks

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. J3. Life and medical sciences.

INTRODUCTION
For approximately the last decade, there has been widespread recognition that a worldwide population shift will see effective and efficient elderly care becoming an increasingly important issue, as advances in medicine and falls in morbidity rates result in an aging population.

Extensive research has shown that as people grow older, they experience a steady decline in their cognitive, sensory and motor control functions (Hanson et al. 2001; Fozard 1997, Czaja 1990, Ogozalek 1994). As Fozard (1997, p. 43) points out, these functional declines can result in tasks that seem simple to the young becoming difficult for the elderly; such as using a television remote control. Because of these functional declines, elderly people steadily become less able to look after themselves safely; and as a result, many elderly people are moved into retirement homes or other institutional care facilities. Approximately 5% of people over the age of 60, and 20% of people over the age of 80 live in institutional care (Czaja 1997: cited by Mynatt et al. 2000, p.65). Studies have shown that many elderly people would prefer to live at home, but they simply cannot, as their ability to look after themselves safely is doubted.

Wireless Sensor Networks are one theorised solution, which has significant promise in providing an effective, scalable product to respond to an increasing demand for elderly care and elderly independence. These sensor networks consist of a collection of sensors, also known as motes, which can be used to monitor their surrounding environment and relay their readings onwards to provide useful aggregated information.

A significant amount of research has been conducted on various aspects in this field; however, most research seems to focus on the technology itself, rather than the patient’s perceptions of the technology. For example, Perrig et al. (2002), Karlof et al. (2004) and Di Pietro et al. (2003) focus on the algorithms and computations involved in maintaining sensor network privacy, but the importance of privacy to a patient using sensor networks is not discussed or is not known.

The aim of this study is to provide information, data and present conclusions on what elderly people themselves perceive of current sensor network designs; opening up a channel of feedback between the technology designers and the intended users.

This study examines perspectives on the concept of sensing-based interaction and the challenges in designing user interfaces that are acceptable to the elderly. This study also provides an investigation of wearable sensor, embedded sensor and ambient monitoring implementation methodologies, and reports findings on elderly perceptions of sensor technology; by examining their perceived concerns. This is a socio-technical study, which brings together researchers’ designs and elderly perceptions to form a view of the usability and acceptability of sensor networks for elderly care.
BACKGROUND
The majority of sensor node technology is produced and sold by Crossbow Technology Incorporated, in their MICA, MICA2/MICA2DOT and MICAz range (Crossbow, 2005). Intel Corporation are also developing sensor node hardware, but these are not available for commercial sale, and are only used in their own research laboratories (Intel Corporation, 2005). Sensor nodes are currently quite expensive as they are a developing technology, with the newer nodes ranging from around $USD100 per sensor node upwards (Crossbow, 2005). Current sensor nodes are typically around the size of an Australian 10c coin, with a larger sized base station that they report back to, which can then relay information onwards to a computer network or call centre.

METHODOLOGY
This study has used qualitative methodologies, including observation, interviews and focus groups. The centre of the study was a series of two focus groups. Focus groups were chosen as they allow for the free-flow of ideas and comments from participants, and minimise any impacts of observer influence on the group. The focus groups followed a semi-structured design, with participants introduced to the concept of sensor networks for the elderly, and being given the chance to first raise issues that they foresaw on their own, and then any issues that had not been raised but had been identified in existing research were brought up and discussed.

Two focus group sessions were conducted, with the first being not only a forum of ideas, but also a pilot for the second focus group. The first, pilot focus group consisted of 5 elderly people, with all participants aged 65 or older. The gender distribution of this group was 3 females and 2 male participants. The group were presented with the concept of motes for elderly care, and were shown an actual Crossbow MICA2DOT mote to give them an idea of what they looked like and current sizing of sensor nodes. They were given a chance to bring up issues that they foresaw on their own, and we also discussed the topics identified in existing literature to gain and document participant comments on issues perceived by researchers.

The second, main focus group was conducted two weeks after this first focus group. Ten participants were invited to participate in the second focus group; however only 8 participants arrived on the day. Of these 8 participants, the gender distribution was equal, with 4 men and 4 women present. Again, all participants were aged 65 or older. The focus group consisted of the same introduction to elderly care and technology concepts, and the participants were also shown a Crossbow MICA2DOT mote for reference. The focus group was carried out in largely the same fashion as the first group, except that the group dynamics were slightly different due to the larger group size. However, the larger number of participants allowed for a wider range of opinions. Barrett and Kirk (2000) have noted the challenges for focus groups of the elderly, but we felt our approach fairly captured the views of these groups.

Results from both focus groups were analysed, with key points noted and a study of the intersection of where the two groups agreed and where they disagreed. Common words, themes and concepts were grouped together for further analysis.

After analysis was complete and preliminary conclusions were drawn, the data and the findings were taken to a member of the health care profession for further validation. The health care professional was a carer from Hammond Care Group, who has been working in elderly care for over 25 years and volunteered for this study. Each point from the data analysis was checked with her, to see whether or not she had observed the behaviour or preferences that the elderly had stated, in her professional carer career. This cross-validation was conducted in order to ensure that the elderly were being both truthful and realistic in their focus group responses.

Study Limitations
This study, through qualitative methods, provides strong indications, with considerable consistency and validity, of the thoughts, concerns and perceptions of the elderly on current sensor network designs. However, as this study does not use any quantitative or statistical measurements, no statistical significance can be drawn for the findings.

The results of this study are limited by several geographic and cultural factors. The study is certainly limited to Australia, as results may vary around the globe due to cultural factors, monetary factors and various states of the current public health system.

All of the participants in both focus groups of this study seemed to possess a reasonable awareness and intelligence in regards to their current situation in life, their surrounds, and the concepts discussed. Asking less cognitively able people may result in differing answers.

The participants in this study, whilst all being above the age of 65, were generally in the age range of 65-80. A focus group consisting of participants with a higher average age may potentially give differing results. Similarly, asking a younger demographic may also yield different results as younger generations are perceived as more familiar with technology.

A significant limitation of this study is the fact that sensor network technologies are still being developed. Precise technology factors are unknown, such as the sizing of sensor nodes, battery size and life expectancy, exact sensing capabilities, as well as any costing and subsidisation. This study is limited to concepts – without exact details of the technology, a complete solution cannot be presented to the elderly, and as such, any answers received are based on the participants own assumptions of the technology. What the study does present, however, is feedback on each of the major theories and alternative methods of sensor network design and implementation currently being developed in the research community.
**STUDY FINDINGS**

Findings from the study are broadly classified into two main areas: Implementation Approaches and User Interaction.

Three different kinds of implementation approaches were presented to the focus group participants for their feedback:

- Wearable sensors;
- Ambient monitoring;
- Embedded sensors.

On the topic of user interaction with such systems, the responses from the focus group participants have been classified into three main areas canvassed in this study:

- User awareness and dealing with ambiguous readings;
- Situational awareness;
- Ease of use.

The following two sections present these findings in detail. Within each section, current research is examined first, followed by a summary and analysis of the findings from the focus groups and interview conducted.

**IMPLEMENTATION APPROACH FINDINGS**

One of the challenges in the field of health monitoring is to determine how sensor networks can best be deployed to serve the elderly. Balancing interface, usability, technology and cost considerations to determine the best method of implementing sensor networks in a home elderly care situation is difficult. Ideally, the implementation allows the patient to maintain a full sense of independence whilst being minimally aware of the sensors’ presence. There are currently three main approaches to implementing sensor networks for health monitoring: Wearable Sensors, Ambient Monitoring and Embedded Sensors.

**Wearable Sensors**

*Existing Research*

Wearable sensors are those which are typically embedding in clothing or clothing accessories, and are the size of a MICA2DOT mote or smaller. Ideally, wearable sensors are embedded in such a fashion that they are not readily visible to the user. According to Mikkonen et al.’s study (2002, p. 117), the elderly themselves suggested the idea of using a wristband to provide security services in case of emergency, and stated that they would feel safer if they had a security wristband.

Pentland (2000) also carried out a study on wearable sensors, or “Smart Clothes” as it is termed in his research. Pentland (2000, p. 43) points out the benefits of using wearable sensors for medical applications, and claims that through the use of accelerometers and tilt sensors, sensors networks can distinguish between when a patient is sitting, standing and walking. Pentland (2000, p. 43) also claims that biosensors can be used to indicate levels of mental arousal in a patient, although exactly what the term mental arousal describes is not defined. The author emphasises the value of having a mounted camera from the user’s point of view, as it can approximately determine what the user is looking at.

Suzuki & Doi (2001) conducted a study using wearable sensors to provide a portable health care monitoring system, titled “Lifeminder”. The Lifeminder system was equipped with a pulse wave sensor, accelerometer, camera and microphone. According to Suzuki & Doi (2001, p. 127), the pulse wave sensor detects changes in blood flow by using short wavelength irradiation of a section of the patient’s skin, and a photo-diode to detect the reflected light. The camera was mounted to the pocket, and microphone to the patient’s shirt. Suzuki & Doi (2001) used the pulse wave sensor to detect when the user is stressed, as stress causes a significant change in pulse rate. Upon detection of a high stress situation, the sensor network would take a photo using the camera, and synchronise it with the voice recording to provide an overview of the situation at hand to an external observer.

The idea of measuring pulse rate to determine exactly when a problem is occurring is a feasible idea; however, if the user is unconscious, such as after a fall, their pulse rate will only elevate in the moment of falling, and slows rapidly once unconscious. The program correlating the sensor data could watch pulse levels, as well as sudden spikes and falls to detect emergency situations.

**Findings & Analysis**

The perceptions of the focus group participants of wearable sensors were mixed. Initial responses were that most participants don’t mind the concept of wearing sensors in their clothes, but most were quick to point out perceived flaws, such as not wearing clothes in the shower when elderly are susceptible to falls, and simply forgetting to wear the sensor.

The idea of having wearable sensors as an accessory, in a watch, ring or necklace met with more enthusiasm. The sensor watch concept, proposed in Mikkonen et al.’s (2002, p. 117) study was the best received, with all participants concluding that it was the best of the wearable accessory options. However this approach is not flawless, as it limits what can be measured, and as some participants pointed out - not everyone wears their watch in the shower.

A few participants compared it to a hearing aid, which has beneficial outcomes, but it must be remembered, and that you simply may choose to wear it or not wear it depending on your mood that day. Participants pointed out that elderly people may not wear it simply because they want to rebel. Female participants also expressed concern about social implications of wearing a sensor. Male participants, whilst acknowledging the issue, did not find this to be as much of a significant concern. As one female participant commented, motes should be designed “so that everybody doesn’t say ‘Look at that woman, she’s wearing one of those things’.” This example has been illustrated by the participant’s comments on current panic alarm systems, which some
deemed as too obtrusive, and therefore would refuse to wear them.

Overall, the general attitudes of the focus groups towards
the idea of wearable sensors were quietly apprehensive. They indicated a willingness to wear them if they were
sanitised to be a practical solution, but wary of the
fallacies of this method that they themselves perceived. Unless the problems of remembrance, rebellion and
obtrusiveness can be overcome, this study would suggest
that elderly people would resent the technology and not
fully utilise this implementation method.

Ambient Monitoring

Ambient monitoring is a method which involves placing
sensors around the environment to be monitored, rather
than on the user themselves. In a home aged care
scenario, this would typically involve placing numerous
sensors throughout a house that track the actions of the
user and detect emergency situations.

Existing Research

Mynatt et al. (2000) claim that ambient systems
implementations are more reliable than wearable systems
such as Lifeline (VitalCall in Australia), as they do not
require direct user action in the case of an emergency.
Mynatt et al. (2000, p. 68) claim that the strengths of
ambient implementations lie in the fact that they are less
intrusive than wearable systems, and that the “out of
sight, out of mind” maxim is highly valuable, to avoid an
Orwellian “Big Brother” scenario.

Pentland (2000, p. 38) also conducted a study using
ambient monitoring, and points out that it can be hard to
pinpoint a user’s location without having a sensor on the
body, as the human body takes various shapes depending
on its stance and profile; the human body looks vastly
different when lying down compared to standing up or
bending over. As discussed above, this can be overcome
to some extent in a wearable implementation with
biosensors and tilt sensors; but in a strictly ambient
implementation, the reliable detection of a human is much
more difficult, especially without the use of a camera.

Findings & Analysis

The concept of ambient monitoring met with slight
indifference from the focus group participants. They
expressed concerns about having sensors placed around
their own home. The main concern that both groups
raised, was that it would be more expensive than the other
methods (Wearable & Embedded), as they imagined a
larger number of sensors would be required to equip a
whole house rather than a single person. It is unknown if
this would actually hold true in an actual implementation,
but the logic has merit.

One group expressed a moderate concern about radio
waves travelling throughout the house and affecting one's
effectiveness, whilst the other group did not seem fazed by this.
Whilst from a technological standpoint, radio waves are
generally not regarded as a significant threat to a person's
health, the perception of possible harm may be
encountered when dealing with the elderly, who are less
accustomed to the myriad of wireless devices on the
market today.

The participants were also quick to point out their
perceived flaws in this approach – what happens when
you go outside? Amongst the scenarios brought up in
these focus groups were scenarios such as working in the
garden, hanging out the washing, or going shopping.
However, participants from both groups also pointed out
on their own accord, that generally speaking, if you are
outside and you have an accident, someone will notice
you or be able to hear you. Whilst this is not an optimum
solution, it does raise questions on existing ‘Smart
House’ and ambient methodology solutions.

One group suggested that the use of both embedded and
ambient methods would also be acceptable, and pointed
out that a hybrid approach may solve a number of
perceived problems.

Neither group were particularly concerned with the idea
of “Big Brother” watching them. As one participant
commented, “I don’t care what it finds, if it saves my
life”. However, when presented with the idea of the
sensor nodes also utilising a camera to verify situations,
both groups unanimously rejected the idea, dismissing it
as too intrusive.

Embedded Sensors

Embedded sensors are sensors which are typically
embedded under the skin. Whilst current mote technology
is still too large to realistically implement this, it is
envisioned that the sensor nodes, like all technology, will
become smaller over time. It is an underlying assumption
of this approach that future sensor network nodes must be
as small, or smaller than a grain of rice in order to make
this approach feasible.

Existing Research

Existing research tends to treat the concept of embedded
sensors as a sub-category of wearable sensors, as in a
sense they are still being worn and face similar
challenges. There is limited research directly in this area,
but this area has several adjacent fields with similar
concepts. Embedded sensors for aged care are similar in
concept to RFID implant monitoring, which has already
been deployed with limited success in some
environments, such as border control and warehouse
monitoring in Mexico (McHugh, 2004). However, the use
of embedded technology to monitor a person's health has
significantly different requirements to those of tracking
warehouse stock.

Findings & Analysis

The results here were somewhat surprising, as like other
researchers, we had expected fierce resistance to this idea
on the grounds of privacy, civil liberty and intrusiveness.
However, this was not the case. Both groups expressed a
strong acceptance of the concept of embedding sensors
under the skin.

Surprisingly, the initial comments of both groups were to
compare the idea to the microchipping of dogs. Even
though the concept of ‘microchipping’ humans has
aware of the sensors, and the technology is in the classification, as the user is ideally only peripherally fall into the background, human to computer interaction. Sensor networks typically or ba

Buxton (1995) proposed a matrix of computer pioneering work on integrating periphery and context. classification classifications, such as those proposed in Buxton’s (1995) characterised by the use

Human USER INTERACTION

obtrusive, and is change for change’.

However, if we see something that is useless, and appears to hold true for sensor networks. Simply put, as long as the value was obvious to them. The networks based on the fact that it’s a new technology, as other health care options exist. The elderly enquired about how you would even know if the battery was running out, and if it had to be removed, would they have to ‘cut it out’. The participants main concerns were with the pain of insertion and removal, and maintenance of the battery and chip, rather than the concept of having a sensor embedded in their body.

When asked directly about whether or not they had any issues with the concept of being ‘chipped’, the answer was a fairly strong ‘no’ with both groups. As one participant commented on the issue, “When you get old you stop caring about that kind of stuff. If it’s quick and painless and the benefits are there, I don’t see any reason not to (be chipped).”

After the results above were obtained, the participants were presented with the idea that embedded sensing technology may be similar in concept to pacemakers. The elderly indicated that this was a fair comparison in their minds, with the exception that pacemakers are generally only used as a last resort, whereas sensor networks are seen as elective, as other health care options exist. The elderly are typically considered as being daunted by new technology. However, participants from both groups indicated that they would not discriminate against sensor networks based on the fact that it’s a new technology, as long as the value was obvious to them. The concept that elderly will readily accept technology but discriminate based on perceived value (Hanson et al. 2001, p.5), appears to hold true for sensor networks. Simply put, as one participant commented, and all participants agreed “If the thing is good, and it works, then we go for it. However, if we see something that is useless, and obtrusive, and is change for change’s sake, then no. Not interested”.

USER INTERACTION FINDINGS

Human-computer interaction taxonomies are sometimes characterised by the use of foreground and background classifications, such as those proposed in Buxton’s (1995) pioneering work on integrating periphery and context. Buxton (1995) proposed a matrix of computer-human interaction, which classifies interactions into foreground or background interactions, and human to human or human to computer interaction. Sensor networks typically fall into the background, human to computer classification, as the user is ideally only peripherally aware of the sensors, and the technology is in the ‘background’ of their consciousness.

User Awareness & Dealing with Ambiguous Readings

Existing Research

Dey & Mankoff (2005, pp. 54-55) claim that situations with ambiguous sensor readings will ultimately arise, and that a need for context-awareness and mediation exists. Once an ambiguous situation arises, there are essentially two choices: to prompt and question the user to receive input regarding the ambiguous reading, or to calculate and choose the most likely option. It is important for sensor network applications in health care to interact in an appropriate manner with the patient, to minimise lifestyle disruptions. In order to best serve the patient, the sensor network must be aware of the patient’s needs.

Three of five questions from Belloti et al.’s (2002, p. 417) “five questions” paper identify issues related to user awareness, which are pivotal to providing an effective interface for aged care. Firstly, the user must be aware that the system is in a working state, and secondly that the gathered medical information is processed correctly. Lastly, there must be a mechanism for verifying and correcting any mistakes. However, this is difficult in reality, as one of the distinguishing features and strengths of sensor network medical applications is their potential for transparency to the patient, to achieve a feeling of independence.

The result is a seeming paradox, where the user must be aware that the system is working, yet also be consciously unaware of the sensor’s presence. A balancing act between safety and usability must therefore be undertaken in sensor networks for elderly care, as either extreme is undesirable.

Findings & Analysis

When the participants were asked about the concept of prompting, their general consensus was that it should prompt you only if it’s sure it has an error; that a balance must be struck as the machine should not prompt you for ‘one-off’ readings, rather only for persistently ambiguous readings that may indicate an equipment fault.

When presented with the concept that the technology may occasionally get it wrong, the participants responded with a general feeling of disdain. As one participant commented, “Well I think if it picks you up in two places at once, that’s its fault. I don’t think it should interrupt you – it should get its act together”.

All participants agreed that the technology should interrupt you if it suspects it has an error, but they were split in opinion on how this should be done. Some thought a beeping sound was better, whilst others wanted a screen. Again, even with the idea of a screen, opinion was divided on where it should be, some thought it should be in the kitchen, others in the lounge room (on the television screen), others thought it should be on you – integrated with wearable technologies such as a wristwatch or pendant.

When asked about whether the technology should be “out of sight, out of mind” or “prominent”, the participants gave mixed responses. Some participants expressed a desire to know that the technology was present and
working; whilst others said they would rather have it installed and then forget about it. Some said that they would know subconsciously that it was there, and have peace of mind whilst going about their daily lives, whilst others expressed a desire for information on the technology to be readily accessible, to have its working state displayed on a screen – the same screen that could be used to convey error messages, battery status, ambiguous readings and medical alerts. Others suggested no screen, but that you could call up the monitoring centre if you wanted to check. Opinion on this issue was split; there was no general consensus, and opinions varied on a personal basis.

When asked about how the technology should act in an emergency, the responses were largely uniform. The majority of participants voted that it should attempt to call you, and send an ambulance if no response is received, as health is of paramount importance. Whilst all agreed that erring on the side of caution is preferable, balance must again be found, as illustrated by one participant with the comment that “I don’t want it sending an ambulance if I’ve scraped my knee”. Others suggested that if you could be contacted and you insisted that you were alright, it should attempt to contact the next of kin rather than sending an ambulance service.

Many participants expressed a concern about whether or not the system will work outdoors, and about how it will communicate if you are away from the home.

### Situational Awareness

#### Existing Research

As pointed out by Fogarty et al. (2005), there are unresolved issues surrounding foreground prompting in sensor networks; including that of not only context awareness, but also social and situational awareness. As the authors demonstrate, computer applications are currently unable to determine how socially acceptable it is to interrupt a human at a particular time. The alternative is to require users to update the device manually, such as in the case of mobile phones, which are equipped with a silent mode to designate when it is not appropriate to interrupt the user. However, as realistic mobile phone usage demonstrates, users often forget to inform the device of their status, resulting in interruptions at inopportune times. Additionally, they frequently forget to update their status after the social situation has passed (Belloti 1997; Belloti & Sellen 1993; Fogarty et al. 2005).

Social awareness is classically a human trait, as Hatch (1987; cited by Fogarty et al. 2005) points out, it is a combination of body language and initial reactions to interruption that allow humans to gauge whether or not it is socially appropriate to interrupt someone with a piece of information. Not all authors have equal faith in context-aware systems, as Belloti & Edwards (2001, pp. 197-200) claim that systems will not be able to always correctly sense context. They support active mediation and prompting methods based on the logic that no technological entity can make more socially responsible decisions than the user themselves. The authors also point out that the challenge of incorporating social aspects into technology leads to a high risk of context aware applications irritating the user, leading to lower usability.

Suchman (1987: cited by Bellotti & Edwards 2001) attributes the difficulty in constructing socially aware applications to the supposition that humans themselves make unpredictable context decisions, whereas technology is invariably systematic.

#### Findings & Analysis

When this issue of social awareness was raised with focus group participants, they saw it as something they should be able to control. They wanted a “can be interrupted” mode, and a “can’t be interrupted mode” (with the exception of emergencies). When the issue of remembering to update your current mode came up, they still favoured this approach, suggesting that updating it could be as simple as pushing a button. Others suggested making it an automatically timed mode for sleeping, although this may have issues as people sleep at different times. Some participants felt strongly about this issue as they believe it to be one aspect of having control over it, and wished to have that perceived right. Although responses on actual ideas for implementation varied slightly, all participants expected that the motes should have different modes for social awareness that indicate how appropriate it is to interrupt at a particular time. As one participant commented, and all agreed, the technology shouldn’t be “Waking you up to see if you’re dead”.

#### Ease of Use

#### Existing Research

Ease of use is a major determinant of user acceptance for new technology. This holds especially true for the elderly demographic as they have specialised design requirements. The elderly are a demographic that are generally not considered to be technology-literate, and as such, any technology designed for them must be simple to use and not require an understanding of technical concepts. Appropriate interfaces are a major factor in determining ease of use, which impacts on technology acceptance.

Monk et al. (2004) points out that technology at home has a huge market potential, but reinforces that the technology must be easy to use. Monk et al. (2004, p. 1073) attribute this to the fact that as people are not being paid to use the technology, they will not typically be willing to undertake training to use something in their own homes.

#### Findings & Analysis

Ease of use was a significant concern to the focus group participants, as they stated that ideally they wanted to be able to interact with the system in some capacity.

The focus group participants from both groups, stated that they want some training in how the system works to be given when it was installed, to the extent that they would be able to understand how to interact with it. The example that one group gave, was that one participant had recently purchased a DVD player, but had no idea how to use the
remote, and would have liked it if the person who installed it for them also took the time to show them how to use it. One group rated this training requirement as “absolutely essential”, whilst the other saw it was important, but not critical to the system's success.

Both groups expressed a desire to not only have the person installing the sensor take the time to explain it to them and show them how to interact with it, but also wanted some form of manual to accompany the technology. One group noted that the language used in the manual should be easy to understand, as past experience of the participants found that understanding technology manuals to be problematic. Both groups perceived the manual as an important tool in using the system as it allows them to have a system reference, rather than relying on memory alone.

This willingness to be trained was a surprising result. However, when this was checked with the health care professional interviewed as part of the study, she categorically denied that elderly people are typically willing to undertake training to use something that is deemed as elective. She stated that in her professional opinion, the elderly may indicate a willingness to undertake training, but in reality that willingness is not there, and that even if they are shown how to use the system, they will quickly forget.

The health care professional is quite likely to be correct in this case, and as such, any sensor network system should not require any training, or have any interaction method more difficult than a button, or an “on/off” switch. However, there is still perceived value to the elderly user in explaining the system basics when it is being installed, and to provide a manual. This user training may or may not be effective, but it will offer the user peace of mind that they have some level of support and reference there.

SUMMARY OF FINDINGS

Conclusive Findings

As this study encompasses a sizeable amount of data on varied aspects of sensor networks, there are many small conclusions that can be made about each aspect. The conclusions summarised below relate to user perceptions of the interfaces for wireless sensor networks.

- The elderly see an embedded sensor methodology as preferable to ambient or wearable monitoring. Their main rationale for this decision is that they will not have to actively remember it, it has the potential to continue working outdoors, and other people will not know that they are wearing it. This view was validated by the health care professional.

- The elderly expressed a strong desire for some level of control over the system. The level of control may be limited, but they wanted to have some control over it, or to at least to have the illusion of control.

- In order to obtain the small level of control that the elderly desire, they must be able to interact with the sensor system in some fashion. This interaction method must be fairly simple, such as the use of a single button or switch.

- The elderly believe that this technology should be for emergencies only. The participants believed that the system should have one function and one function only – to call for help in the event of an emergency.

- The elderly strongly rejected the use of any camera, video or still, in sensor network designs.

- Overall, the elderly perceive sensor networks as a workable solution to the current health care situation. Whilst they had concerns about some aspects of sensor network design, they could not identify or foresee any ‘show-stopping’ factors that would severely limit their acceptance of the technology, except for cost.

Inconclusive / Interesting Findings

This section summarises the aspects of sensor network technology the elderly participants could not reach a consensus on, and outlines other interesting side-issues that arose during the focus group sessions.

- The elderly were split in opinion on how to actually interact with the system, in order to gain the control they expressed a desire for. Some desired a screen, others beeping noises, others wanted a small device such as a watch with the status information on it.

- Opinions were also split on what level of control the user should be able to have. Some participants thought full control, including the ability to turn the system on or off, whilst others thought minimal control was desirable, but just wanted to know that the option of control was there if they desired it.

- Opinions were also split on whether the technology should be of background or foreground prominence. Some participants desired to know the system was active and working; others expressed a desire to have it installed and then forget about it.

- The elderly participants expressed a desire to undergo some form of training in the system. They expressed a desire to have someone show them how it works, and to leave them with a manual for after they have left. However, the health care professional disagreed with this point, as she was of the belief that even if elderly people express a desire to be trained in the use of a device, they will not do so in reality.

CONCLUSIONS

This study has investigated the perceptions of the elderly community on current sensor network designs. Although the findings of the study were broader, this paper focuses on the participants' opinions on the form the technology might take, and the modes of interaction that elderly users might use to engage with the technology.

The challenge in designing such technology is that the elderly users demand some level of control over the system, but at the same time don't wish to have extensive interaction with the technology itself (such as remembering to switch it on).
Control was a recurring theme amongst the participants in the study. Various levels of controls were desired from different groups and individuals, but all participants expressed a desire for some level of control over the system. A lack of control was perceived to be somewhat an affront to their decision making ability and to be undermining their intelligence.

One of the primary findings of this study that the elderly perceive sensor networks as a viable solution to health monitoring, on the condition that the issues of control and usability are suitably addressed.

REFERENCES


