Balancing sensors and seniors: introducing sensors sensitivity, human sensors and future-self goals

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Abstract. Being monitored at home as an independent and fit elderly person for the sake of illnesses onset prevention poses big challenges in the design of a meaningful sensors system. In this paper we discuss how a critical understanding of seniors' felt experience around a predictive sensors system was gained through fieldwork and experience prototyping. Starting from the fieldwork insights, several disruptive opportunity areas for the design of such monitoring systems are elicited and deployed into future scenarios, which explore the possibility of sensors sensitivity attunement; the introduction of the human sensors and the personal setting of future-self goals. The proposed concepts challenge current mainstream research on active ageing, ICT solutions for the elderly population and AI as a black box disjoint from human experience, opening up to a complete new perspective of seniors as agent of their sensors monitoring system.

Keywords: Sensors; elderly; machine learning; experience prototyping; people-centred design.

1 Introduction

Sensors systems have been greatly developed to support the independent life of elderly people in their homes and to reduce the need of moving to nursery homes. A new research trend has emerged in which domestic sensors systems are being designed to detect meaningful deviations from normal life patterns in the home thanks to artificial intelligence, and in particular machine learning. Deviations from specific daily patterns, such as individual gait speed, may help to detect tendency towards an unhealthy status in the near future and suggest preventive actions. A preventions driven sensor system shifts the design focus from elderly users who have already experienced ageing watershed events and recognize the need to be taken care of, to capable seniors who wish to keep on living independently and to be able to do their favorite activities [1]. From a medical point of view, we refer to this group of functional elderly as fit elderly [2] versus frail ones who have been already experiencing critical life course events compromising their independence, resiliency and confidence in their own capabilities.

In this paper I will reflect on the experience of the Helicopter project, an AAL funded project, which focuses on a domestic sensors system for the prevention of ageing related illnesses [3]. We have been conducting extensive fieldwork in The

Netherlands and in Sweden to meet real persons representing the "fit elderly" group. Our aim was to gain a deeper understanding of what being a fit elderly could entail nowadays in each person's own context of ageing [4]. We went to them with an eager willingness to dig into their felt experience [5] on domestic sensors systems and to unfold their own projections on what a sensors system would look like and behave like to be meaningful to independent seniors. In the following paragraphs, I report the most insightful stories we collected during the fieldwork with several seniors we met and I proceed from them towards the emergence of opportunity areas for design which disrupts mainstream assistive elderly research and technology assumptions.

2 Felt experience around sensors monitoring

During the fieldwork we met several fit elderly persons at their own homes and stayed with them half a day. Our visit started with an open interview about themselves, slowly opening up towards their context of ageing and their network of relationships. In order to cast some light on their own mental model around a monitoring sensors system for elderly, we tried to suggest possible usages of sensors in connection either with their daily activities or with the care relationships they already had in place as either beneficiaries or caregivers. In the following paragraphs, the stories of three persons we met are walked through, and three fundamental insights are unfolded.

2.1 Domestic tension

Olle, 73, Sweden. Olle lives with his wife in a residential area of the city of Skövde. He is very engaged with an elderly organisation for retired people and by attending it he has gained a deep understanding of elderly people's daily concerns. He is committed to support the older neighbours in keeping an independent lifestyle. For this reason, he tries to check on them in unintrusive and pleasant ways, such as bringing them the post, visiting to read the newspaper together or just exchange a few words when they meet. Olle is very positive about a sensors system monitoring his daily routines and behaviours for his health and wellbeing, but his wife is completely against it. This is what he reported to us:

"Even if I would like to be monitored by sensors at home for my own good, I live with my wife and she is not comfortable thinking she is being tracked."

The couple doesn't show any alignment about the adoption of such monitoring technology at the moment. This may be because if on the one side Olle has already actively engaged among the "frail" elderly community as a kind of caregiver, and thus developed a general awareness of the challenges brought up by the ageing process, on the other side his wife is not, or simply doesn't want to face the issue right now in her period of "fit elderliness". This suggests to us that fit elderly of the same family can have different opinions about sensors according to their own awareness of the ageing

pitfalls and feel not equally comfortable in being monitored at home, thus creating domestic tensions and "aut-aut" situation about the sensor use.

2.2 Analogic monitoring

Seija, 69, Sweden. Seija lives by herself in the countryside of Skövde, while her daughter and grandsons live in Stockholm. She has a very close friend, Arne, who lives next to her and they usually see each other during the day. She has been living all her life independently, but now that the onset of age-related illnesses become a threatening possibility, she starts feeling negative about it and thinks that cohabiting with another person would provide the benefit of taking care of each other. She was confident about a domestic sensors monitoring system because it could give her some peace of mind and could be economically efficient. Anyway, she stated clearly that the human contact behind the system should always play a major role.

She always carries her mobile phone with her. It is a way for her to keep connected with her family and friends and it could help in emergency situations, even if she believes it would not be the ultimate solution for that. She reported that once she happened to save her friend Arne by detecting from an unusual lighting pattern in his house at night that something was not ok with him, prompting her to act:

"Arne's behaviours tell me and our neighbours if he is feeling good or not: if he is all right, during the morning his car is never at home because he is visiting friends; at night he never keeps the lights on. In fact, the night he was about to get a stroke, I was warned by seeing the light on in his bathroom."

And to strengthen her analogic monitoring activity over Arne, she continues:

"Every morning I bring the newspaper to Arne. In this way I am checking if he is feeling all right and if everything is okay."

The critical event she witnessed about Arne seemed to make Seija more sensible to the risks that can be linked to living a later life by herself. This is the reason why she would entrust herself to a domestic monitoring technology in the future, as long as any human intervention/supervision in the system was always conceived as equal or even primary to technology. As a fit elderly, she took responsibility towards her frailer peer Arne and appointed herself to monitor on him from a distance and through ritual check-ins. Thanks to her great knowledge of Arne's routines she could easily detect any deviation from his standard behaviour. This suggests us that people living in the same community can have the expertise and the willingness to act as human sensors for monitoring people they know, acknowledging the strategic role of analogic monitoring performed by humans as both an AI augmentation and humanization [6].

The idea of analogic monitoring makes particular sense to the fit elderly group of people for the following reasons:

- Fit elderly can in first person recognize that enacting as human sensors requires no special effort, being just a matter of peripheral attention. More over it can be personally rewarding. Frail elderly instead may be inclined to think of themselves as a society burden, thus considering themselves not worthy of such care by people around them.
- Fit elderly can feel responsible towards their frail peers and society. They take action themselves in order to unload the younger people of the elderly burden.

2.3 Taking agency and risks

Seija, 69, Sweden. When fit elderly Seija was explained that the sensors system we were thinking of would have monitored her 24/7 in order to predict any possibility she would get ill in the future, she couldn't really understand it. Any discontinuity of data would increase fallibility into the system feedback, thus possibly exposing her to an increasing risk of incurring in the unlucky onset of ageing-related illnesses. The sensors systems she could relate to worked differently as they were just sending alarms in case of fall or if the person him/herself was deliberating pushing a button on a bracelet or pendant. This is what she said to us:

"If it's some kind of surveillance, like a camera pointing at me, I don't want it in my life. But, if it is myself choosing to push a button, then it could be a good thing."

Our machine learning powered system was too unrelated to her established mental model of sensors system for elderly independence, mainly because of two reasons: she was aware of most popular, commercial monitoring systems for frail elderly and, as we were expecting, she had no clue of the technological development into AI and predictive technologies. She was ignoring why, as a fit elderly, she could benefit from being monitored 24/7 even if not suffering from any illnesses at the moment. Our half-day meeting was too short to have any impact on her mental model. We believe that Seija may represent a large number of fit elderly people that may simply reject predictive sensors systems in their early introduction because they cannot easily understand the reasons why it could be a valuable option for them. The acceptance of such a sensors system may require a kind of cultural training, a latency period which would last exactly the time taken for machine learning to become mainstream. People first need to understands "why" machine learning have such a 24/7 functioning requirement, then, when the system becomes conceivable in their mind, they can have the freedom to evaluate either to accept it in their life or not. Until that, being the research in this field at the very beginning of its experimentation with actual people, we need to acknowledge that fit elderly do not see any need for being monitored 24/7 until they experience some life-threatening event or go through an ageing watershed.
This suggests to us that independent and active elderly want to be in control of the sensor system, even if this may mean putting their life at risks.

2.4 Elective monitoring for future-self goals

Gunnar, 85, Sweden. Gunnar lives by himself in his apartment since his wife passed a couple of years ago. The way he usually spends the day is regulated by the weather outside. He can visit his wife's grave or go grocery shopping. He is really keen on keeping his interests and passions in his late life, such as reading, going to the opera and theatre. When we explained that a predictive sensors system could help him look after himself in the future and possibly detect if any ageing-related illness could affect him, he shifted the focus of the discussion from health to his own capabilities, saying:

"Looking after myself for the future means keeping on doing the things I like."

This suggests to us that fit elderly consider as priority to them in the future to keep on doing their routines and to perform activities they like before thinking of any illnesses prevention, maybe because their good health condition detaches them from any bad thought about possible ageing pitfalls. Even if it was too far away for fit elderly Gunnar to draw himself any direct connection between the possible use of sensors technology and his future-self goals, the insight we gained was to switch our focus from daily life monitoring for illnesses prevention to elective monitoring for the achievement of personal future self-goals.

3 Disruptive Opportunity Areas

One or a group of insights can detect a broader space where new design solutions can be conceived and explored. In the practice of People-Centred Design, we call that space an "opportunity area" [3]. By delimiting an opportunity area from the emerged insights, the researchers manage to reach a second stage of abstraction from the fieldwork data which sets the stage for the action prompted by the insights to happen. Crafting the way opportunity areas are formulated is an important moment in our process because each opportunity area statement will stand as the rationale behind any further development of the project. In the formulation of the opportunity areas of our Helicopter project we, as team of people-centred design researchers, realized that we would end up disconcerting the rest of the project partners (manily electronic engineers, artificial intelligence developers and medical doctor) because our insights questioned the already established framework of the project. Taken-for-granted constant and undeniable monitoring of activities and illnesses prevention came out weakened by our fieldwork, as well as the introduction of analogic monitoring could be perceived as not fitting in a logic of machine learning. Nonetheless, we decided to pursue our People- Centred Design process and put all our effort into boarding the rest of the team in our design journey, which would definitely evolve the nature of the project we started with.

To be truthful, the following opportunity areas are not the only ones created for this project. For the sake of this paper, we report exclusively the ones derived from the insights described in the previous section and which represent a disruptive approach.

1) Sensor sensitivity as negotiation between members of the household. The sensing ability - "sensitivity"- of the sensors can be modified during the day by each inhabitant, according to how comfortable they feel being monitored in that moment. Sensors sensitivity can be negotiated among them, as an act of tolerance, mutual responsability and caring.

2) Sensor sensitivity as dynamic lifelong attunement. Fit elderly want to be in charge of their health and the "risk" they can handle daily. Monitoring for active and independent seniors shouldn't be conceived as a passive sensors network watching on the people 24/7, but as a dynamic system adjusting to the sense of need and motivation that the seniors perceive day by day.

3) Neighbours as human sensors. Neighbours who know the elderly routines well could act as human sensors and integrate their analogic monitoring activity with the formal monitoring performed by the sensors system.

4) Sensors to track future-self goals. Fit elderly want to keep on doing the activities they like and that belong to their routines while ageing. The sensor systems should help them keeping their routines and encourage them to keep on practicing the activities they enjoy the most.

4 New design concepts and experience prototyping

The emerged opportunity areas set for us unexpected innovation challenges to design for. As usual in our studio practice, a brainstorming session was organized which led to the generation of new concepts for our on going sensors project. Experience prototyping sessions [7] were also organized to test our concepts with real people in their context.

4.1 Future-self concept

It focuses on keeping yourself aligned with your future-self by a customised sensors network which detects your activities/routines and triggers domestic interfaces to motivate you towards the achievement of your goals.

Scenario. As soon as the user enters the service, she/he is asked to take pictures of preferred activities she/he would like to keep on doing when ageing, as future-self goals. The engineering team will receive the activities list and will come up with customized sensors to equip the user with, which track how the user actually performs them over time. The user will receive the sensors at home and will be instructed on where to place them. A domestic interface will be also sent to him, visualizing back to the user how well she/he is fulfilling her/his goals (Fig. 1).

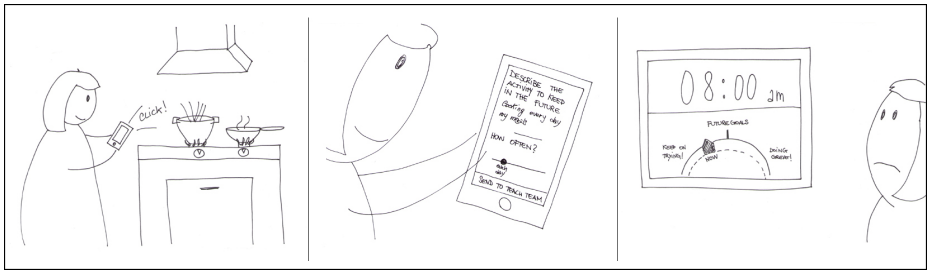

Fig. 1. Future-self goals scenario. On the left, the user takes pictures of her favourite activities as future-self goals. In the middle, she describes on the app her aimed engagement with those activities. On the right, the interface at home shows back the actual alignment with set goals.

Fig. 2 and 3: The future-self goals cards.

Experience Prototyping. The Future-self concept shifted the focus of the Helicopter project from illnesses prevention to the fullfillment of personal life goals. No standard

set of sensors would be required, but customised ones would be engineered according to each elderly list. When presenting this concept to the electronical engineers, partners of the project, they were worried about the project being jeopardized by our excessive adherence to the People-Centered Design process. They couldn't envision how the extreme sensors customization could be handled and engineered, so we decided to run an experience prototyping session. The future-self goals collection involved fit elderly participants from Italy, The Netherlands and Sweden. They were asked to take a picture for each personal goal of the future, describe it and indicate how often they would like to keep on doing the described activity. The respondents came up with very different goals, ranging from cleaning activities in the house to entertainment ones around the city they live in. A set of cards was made out of the collected goals with the picture and description for each goal (Fig. 2 and 3).

As a following step, the set of cards was used with the electronical engineers during a workshop. We asked them to select three future-self cards from the set we brought and to build paper prototypes of customised sensors for monitoring those specific person's goals (Fig. 4).

Fig. 4. Experience prototyping with the electronical engineers.

Sensors template from paper were provided by us as well as additional workshop material. The participating engineers successfully manage to envision different kind of sensors for the elderly represented in the cards, despite the peculiarity of each future-self goal.

Thanks to this experience prototyping session, the engineering team managed to tinker with real people monitoring wishes. Moreover, their hands-on, low-fidelity prototyping activity proved to them the technical feasibility of the Future-self concept. As a result, the Future-self concept got accepted in our project by all the rest of the team as a strategic component of the service we were building for fit elderly.

4.2 Human sensor concept

It focuses on involving a neighbour in the elderly monitoring system as her/his human sensor. The neighbour would identify peculiar behaviours and routines of the specific elderly person and remotely monitor them, thus becoming an integral part of the monitoring system.

Scenario. The user receives the sensors packet at home and can start placing the sensors around, following the instructions. Among the shipped sensors, she/he finds a special one in the shape of a puppet, labeled as the "human sensor". The instructions explain the user that the human sensor is a special component of the system. The user needs to appoint a person she/he knows and who lives close by as the human sensor. The human sensor will monitor peculiar user activities from a distance that otherwise would be impossible to monitor with the rest of the technological system. The user will select a neighbour and invite her/him to become her/his human sensor. The human sensor puppet will be handled to the neighbour upon acceptance of his role, and thanks to the information reported on the puppet, the just appointed human sensor could download the monitoring app to start performing her/his job. Firstly the app will ask her/him to list a series of activities that she/he happens to attend from a distance about the paired elderly. Later, the human sensor could go back to the app and log any observation related to those activities, if any. The information gathered by the human sensor will converge to the data collection performed by the technological sensors system and will feed its predictive logic (Fig 5).

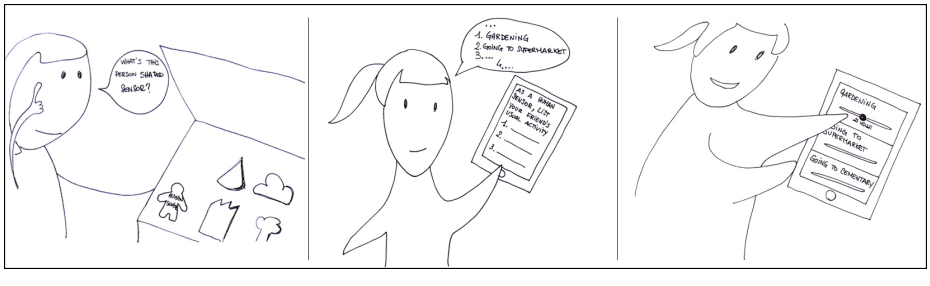

Fig. 5. Human sensor scenario. On the left, The puppet shaped as a "human sensor". In the middle, the just appointed human sensor lists the activities to monitor on the human sensor app. On the right, the human sensor logs activities attended from a distance.

Experience prototyping. The Human Sensor concept was prototyped with Dutch elderly people by using early prototypes of our envisioned sensors system. Among the technological sensors, we introduced the elderly to the special "human sensor". For the prototyping session each elderly was equipped with a puppet-shaped human sensor and a log book (Fig. 6). We asked the elderly to take some time to think about the person to invite as human sensor and then, we instructed them to formalize the human sensor investiture by handling to the accepting person both the puppet and the log book.

A couple of elderly people thought that the most suitable human sensor for them was their respective spouse and they didn't have to think much about that. One investiture happens in front of our eyes soon after handling the puppet and the book.

Fig. 6. The human sensor puppet and the log book given to a participant.

Fig.7. The elderly participant with the list of activities compiled by his human sensor.

On the other hand, another participant was doubting that any neighbour living close by would be able to list activities about himself and be so kind to burden about logging them. When we left, we were not sure he would complete the task we asked for, but we could feel to have provoked his thoughts. The day after, we met again and he was thrilled to show us a piece of paper with a hand written list of activities which was compiled by his neighbour the night before (Fig. 7).

Surprisingly, soon after we left the day before, he reported to us that he visited his neighbour and explained him the human sensor concept. The neighbour confirmed him that he knew lots of his routines and that could easily monitor from a distance for some of them. Actually, he recognized that he was already kind of acting as a human sensor for him in a spontaneous way.

This experience prototyping session showed us that the human sensor could be a successful way to humanize a monitoring sensors system. It could be pleasant from the elderly perspective, and at the same time rewarding and effortless from the neighbours' point of view.

4.3 On/off sensor concept

It focuses on the possibility for the inhabitants of the house to switch on/off the sensors according to their preference, all the times they want.

Scenario. The inhabitants of the house do not share the same feelings about being monitored at home by a sensors system, so the sensors are provided by an On/Off button which could be freely pushed as many times as desired by each house inhabitant. Inhabitants would be informed that the inconstant flow of data would increase the fallibility of the system and that incorrect medical prediction could be generated, exposing the inhabitants themselves to potential health risks.

Experience prototyping. We build a room sensor which was monitoring temperature, humidity and motion and had an On/Off button. We gave it to an elderly participant who was living with his wife, the latter being against sensors monitoring, yet accepting to take part in this experiment. We asked the participant to place the sensor inside a room they equally used and he chose the kitchen. Over the one week experiment, the wife never switched off the sensor, preferring not having any contact whatsoever with it.

This experience prototyping session brings us to future iterations of the experiment. What if we could visualize the potential health risk related to different sensitivity ranges of the sensors network? How would fit elderly attune their monitoring system to suit their perception of risks while ageing? Possibly in the near future we will investigate deeper on this topic and fuel our critical debate on monitoring technologies and elderly agency to take risk on their health.

5 Conclusions

This paper aims to show how high-tech solutions for elderly people need to go beyond general stereotypes on the chronological ageing process and be confronted with the felt experience elderly have about the technology created for them. Moreover we would like to encourage design researchers to challenge ICT research programs on elderly people, questioning mainstream innovation directions that are taken for granted and embracing technological paradoxes, such as the infusion of a human touch into AI. Through a People-Centred Design process, we identified disruptive opportunity areas, such as sensors sensitivity, human sensors and the future-self goals, that eroded the technological assumptions on which our initial project proposal was based.

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