Establishing a Collaboration between Care Providers and Engineers

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***Abstract*—Although a lot of research effort has focused on the development of new technologies that support healthcare professionals, only a small fraction of these developments penetrate the healthcare market. The reasons for this are multi-factorial, but in our opinion a major problem is the lack of cooperation between engineers and care providers during the early research phase. An improved collaboration between engineers and care providers would ensure that the developed products better match the needs of the care providers and hence facilitate the marketing of the developed product. To improve this collaboration throughout the entire research phase, a new strategy is presented in this paper. An important step in this strategy is the incorporation of an engineering lab within a nursing facility, which is set-up during the project 'Ingenieurs@WZC'.**

I. INTRODUCTION

As babyboomers age, the demand for long-term specialized elderly care increases. In the future, there will simply not be enough care providers to accommodate this demand. To alleviate the growing burden placed on both informal care givers, such as family members and neighbours, and professional care providers a lot of research effort has been invested into the development of technology to facilitate elderly care.

When conducting a literature study to summarize the available techniques, it becomes apparent that a large variability is present both in application areas as well as in the used sensor technologies. Some common application areas include fall detection [1]–[3], fall risk estimation [4]–[6] and the monitoring of activities of daily living [7]–[9]. For all these applications, a wide variety of sensors is used such as cameras [1], [4], [10], accelerometers [2], [11] and radars [12].

Although this literature study showed that the number of papers concerning assistive technology for elderly listed in the Medline database has significantly increased in the last decade (see figure 1) and that research facilities can produce a long list of success stories, new developments are seldom introduced to the healthcare market. Furthermore, when the developments are introduced into the healthcare market, these new technologies often have very limited success. A lot of new developments are not able to overcome the so-called 'valley of death' even after the first proof of concept is successful.

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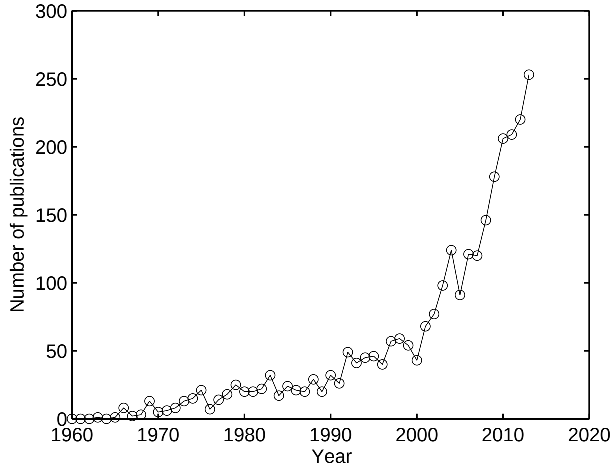

Fig. 1. Number of published papers concerning assistive technology for elderly per year as listed in the Medline database

According to Chan et al. [13], this is mainly due to the technology push approach. This approach is often the driving force behind research projects, rather than a demand-pull approach. Combined with the lack of precise studies concerning the needs of different stakeholders, both care givers and care receivers, this causes a lot of user disappointment when the introduction of new technology does not meet all of their expectations.

Although the lack of extensive studies concerning the needs of users is certainly an important issue, it is however our opinion that the causes of this inability to breach the valley of death are multi-factorial.

The problem often lies in the very limited tests which are performed to validate the new technology. For instance, for fall detection this is often done through simulations where an actor plays different fall scenarios in a lab environment without taking into account the challenges of a real-life environment [1]. The different fall scenarios are furthermore often very different to actual fall incidents such as the ones observed in Vlaeyen et al. [14]. Both shortcomings result in a reduction of the accuracy of fall detection systems when introduced in real-life settings, which in turn will lead to a limited usability of the technology.

Even when new technology is validated in a real-life setting, this is often done in very small test groups. This only gives an indication that the technology is useful but it provides no clinical proof. Due to this lack of large clinical trials, companies are often hesitant to take the proposed technology into production. Care givers are also often reluctant to adopt the technology without these trials.

Moreover, the perceptions of the researchers concerning the needs of the healthcare sector are often the driving force behind the research. Feedback of care providers is seldom included during the research phase. The developed technology is therefore not always sufficiently tailored to the needs of the healthcare sector [13].

Finally, due to the wide range of available technologies with the previously mentioned shortcomings, care providers are rather skeptical towards the adoption of new technologies. As previous experiences with assistive technology were often met with limited success, care providers are often hesitant towards the adoption of new technologies.

It is therefore important to involve care providers in the entire research process. By involving care providers, the developed technology will better fit the needs of the healthcare professionals facilitating the penetration of the healthcare market for the resulting developments.

The 'Ingenieurs@WZC' project therefore aims to establish an active collaboration between engineers and care providers by installing an engineering lab in a nursing home. Although a similar collaboration was successfully implemented in Missouri [15] in an independent living facility called TigerPlace, this is, to the best of our knowledge, not yet the case in Europe.

In the remainder of this paper, related work is discussed in section II. This is followed by the action plan to establish this collaboration which is discussed in section III together with a description of the first use cases aimed to test this active collaboration. Section IV discusses the main advantages of this active collaboration which is followed by a conclusion.

II. RELATED WORK

To the best of our knowledge a similar collaboration has only been established in one other eldery care facility namely TigerPlace in Missouri where an active collaboration is set-up between computer engineering, health informatics and nursing [15].

TigerPlace, a senior-living community opened in mid 2004 a few miles from University of Missouri Campus, was designed to promote the independence of older adults. It comprises of three different 'neighbourhoods'. The first neighbourhood consists of 32 ageing-in-place apartments and the second, added in 2008, of 23 similar apartments. The third neighbourhood, added in 2011, consists of five nursing units which house 17 residents each. Two of these nursing units are for long term care and the other three focus on rehabilitation [16].

The main goal of the TigerPlace project is to design and implement research, education and practice opportunities while integrating TigerPlace into the University of Missouri Campus and the Colombia Community. Over the years it has become a venue for interdisciplinary research aimed to improve the lives of older people. Through brainstorm sessions and focus groups, the concept of TigerPlace was conceived. Continuous communication between all stakeholders now ensures that the performed research remains demand-driven [15].

III. METHODS

In order to establish this active collaboration between engineers and care providers, through the installation of an engineering lab in a nursing home, an action plan was composed for the first two years of this project. Three major work packages were defined to reach this goal, which are discussed hereafter.

A. Short term collaboration set-up

As this type of collaboration is unique in Europe, the basic collaboration strategy needs to be determined during this work-package. A short-term format will be designed to ensure that the information transfer from care providers to engineers and vice versa starts as soon as possible. Although this work-package is scheduled at the beginning of the project, it will be an iterative process to find the format that works best for both engineers, care providers and inhabitants.

Due to the incorporation of the engineering lab in the nursing home, informal contacts between care providers and engineers will follow naturally. However, formal meetings will still be necessary. During this work-package, a format will be devised for these structural meetings between care providers and engineers.

Moreover, during the different use-cases (discussed in section III-B) residents of the nursing homes, their families and other care providers will be asked to provide feedback. To gather this feedback several formats are possible such as questionnaires, focus groups and one-on-one interviews. The best format will be chosen depending on which research question to be answered. A first focus group with elderly and their family will for instance try to answer the question on how to persuade older persons to test the technology in their own environment.

B. Use-cases

To explore the knowledge transfer between engineers and care providers, three use-cases were defined: a fall prevention use-case, a fall detection use-case and a malnutrition use-case.

1) Fall prevention use-case:
Fall prevention is a major concern in both nursing homes as well as in the homes of elderly. An accurate fall risk estimation can hence be an important aid in the prevention of fall incidents, which is why the first use-case focusses on automatic fall risk estimation techniques. Several methods to automatically assess the fall risk of a person are already under investigation by several research groups [4]–[6]. Different gait parameters such as gait speed [4], step length and step time [17] are often included in this research, but biomechanical balance measures such as postural sway [5], [18] are sometimes evaluated as well. Although these parameters have been proven by clinicians to be predictors of fall incidents, it has at this time not been shown which parameter is the most useful to measure in which setting. Gait parameters could for instance be more important to measure with active older persons who are still living in their home environment whereas postural sway could be a better measure in a nursing home setting.

This use-case not only focusses on determining the best parameter to measure in each setting but will determine which information to present to care givers, when to give this information and how to present it.

Another important factor that will be considered is the type of sensor to use. Both wearable and contactless sensors are used in academic settings and both will therefore be included in this study.

The input of nurses, informal care providers and older persons themselves will provide important information to answer these questions. All stakeholders will therefore be steering the direction in which this line of research will be taken. The first steps in this direction were already taken by setting up a clinical study concerning the assessment of the fall risk of an elderly person together with the nursing home, the expert center falls and fracture prevention and the engineers.

2) Fall detection use-case:
The second use-case concerns fall detection systems. Although a lot of research effort has been focussed on fall prevention, falls remain a major problem, both in the home environment of elderly as well as in nursing homes. It was deemed important to evaluate current state-of-the-art detection methods in real-life. To this date, several fall detection methods are available on the healthcare market and research on new and more effective fall detection strategies is still ongoing [1]–[3]. Both state-of-the-art research fall detectors and fall detectors available on the healthcare market will be installed in the nursing rooms of several residents. The different methods will not only be evaluated on sensitivity and specificity, as is done in most literature, but also based on the experiences of care providers, older adults and their families. The experiences of these three groups will be gathered during co-creation sessions. This use-case will give the engineers an insight in what is still needed to develop a fall detection system which is acceptable for the target audience while still being technically sound and therefore creating the opportunity for a further improvement of current fall detection systems. Moreover, care providers will gain insight in what is technically feasible, ensuring that the expectations of the care providers match with the technical possibilities.

3) Malnutrition use-case:
The last problem we will try to tackle is malnutrition in elderly. Malnutrition of elderly is a problem both in home and in nursing home settings. Moreover studies have proven that 60 to 85% of elderly living in a nursing home are at risk for malnutrition. As this can lead to a diminished muscle strength and wounds that poorly heal, it is important to implement preventive strategies [19]. An important step in this prevention is to monitor the ingestive behaviour of persons at risk. After this, behavioural modification strategies can be put in place. Existing methods rely on questionnaires and diaries to provide an overall view of the ingestive behaviour of a person [20]. Maintaining these diaries and questionnaires is however very time-consuming for the care-providers, who are often more occupied with the direct care of the older person. They therefore have insufficient time to fill in these reports, often resulting in incomplete or erroneous reports [21], [22]. There is therefore a need for a system that can automatically identify the specific patterns of food intake [23].

At present, most research concerning food intake monitoring is focussed on patients suffering from dietary and obesity problems. Older persons however often require different approaches for this monitoring. Research concerning sensor systems to monitor the ingestive behaviour of older persons is however very sparse and commercial systems are even sparser. This use-case will therefore provide a starting point in this research area. Different sensors used to monitor food intake will be tested, both on technical soundness as well as on usability in this specific set-up. Feedback provided from all stakeholders will again be used to steer the research in the direction of a technically sound and workable sensor system.

C. Long term collaboration

As both care providers and engineers have different backgrounds, they essentially speak another ”language”. It is expected that both groups will need some time to find ways for positive communication and constructive collaboration. Lessons learned from this project will therefore be used to construct a long term structural collaboration between care providers and engineers. This long term collaboration could be in the form of new projects with both care providers and engineers, but could also be in the form of additional support for local companies currently exploring the healthcare market. The lessons learned will moreover be published so that other researchers can be inspired to set-up similar collaboration structures.

IV. DISCUSSION

In this paper a new strategy is presented to improve the collaboration between engineers and healthcare professionals when developing technology for eldery care.

Although it can be perceived that there is a match between the TigerPlace approach and our approach, there are also some important differences. Firstly, the majority of the residents in TigerPlace are active older persons who are still in relative good health. In contrast, the majority of the nursing home residents often suffer physical and or mental disabilities and therefore have different needs than the TigerPlace residents.

Next, the intensive collaboration in TigerPlace between computer engineering, health informatics and nursing was initiated by the Sinclair School of Nursing who perceived that technology could possibly assist older persons age in place. The initiative for the presented collaboration was instigated from the engineers who perceived a need for more input from all stakeholders in the research process. It is therefore likely that not all nurses who will come into contact with the ’ingenieurs@wzc’ project are convinced of the usefulness of the integration of the technology in their nursing home resulting in the extra difficulty of getting all nurses on board.

Lastly, at this time no nursing school is involved in the presented research project. This is however desired in the future to provide extra input in the research project.

Due to these differences some approaches used in TigerPlace may not be suited for our set-up. Gathering user feedback from the older adults involved might for instance need a different approach than in TigerPlace.

There are several advantages to this proposed strategy for the different stakeholders involved in this project.

Advantages for the engineers include the possibility to test drive the developed technology in a real life setting for longer periods of time with more participants thus acquiring accurate information regarding the performance of their developments in a real life environment. Moreover, due to the interaction between engineers and care professionals, engineers can now make a better assessment of the acceptability of their technology by the different stakeholders and can therefore steer their research when needed.

Advantages for the care professionals include the introduction of technology supporting them in their care for their clients. By giving them the opportunity to provide valuable feedback on the introduced technology they can steer the research in a direction which will enable the development of new technologies which will better fit their needs.

Although the direct advantages for the older persons and their families who will partake in this project are relatively small, their contribution to this project will enable the engineers to develop technologies tailored to the needs of the elderly in the future.

Finally, the presented set-up will provide students across different specialities with the opportunity to get involved in multidisciplinary research projects. This set-up will enrich both students and other researchers who will learn to look beyond their familiar research field thus enabling them to come up with better solutions for the multitude of problems associated with ageing.

V. CONCLUSION

In order to increase the marketability of new healthcare technology an intense cooperation between engineers and care providers is needed. To facilitate this cooperation, an engineering lab will be established in a nursing home. A first test-run of this collaboration will be done with the fall detection use-case. Lessons learned from this use-case will be used to put in place a strategy that facilitates a long term collaboration between care providers and engineers.

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