Methodology for assessing end-user requirements in the Ella4Life project: elders' perspectives about self-monitoring*

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Abstract— The purpose of this paper is to explore elders' perspectives about self-monitoring and using specially developed sensor technology for measuring health indicators. The qualitative research method is focus-groups with guidelines that were designed for understanding elder's requirements about monitoring health indicators. We present them two devices: the first sensor is a device for monitoring of cardiac action potential fixed into an armchair, the second sensor for monitoring vital signs is placed in a bathtub. The people express their needs and expectations regarding the idea of having sensors for monitoring health indicators and body movement in their own house.

I. Introduction

With the rapid growth of the elderly population of the world, rising health care costs have led to an increasing economic burden on governments and people [1]. Also, it is not feasible to allocate a nurse to every home with an elderly resident. Therefore, Ambient Assisted Living (AAL) systems are required to help elderly live independently with remote monitoring of his/her daily activity [2].

In order to live independently, what is better for society, the elderly must be able to undertake daily activities such as cooking, eating, shopping and taking medications. Thus, automatic recognition of activities is an important step to achieve this goal [3]. This process is associated with many real-world applications such as monitoring, assisted living, and health care [4] by informal and formal caregivers.

Activity recognition in health care applications is a process of health monitoring which can be effective to patients' treatment as well as reduction in medical personnel workload, residency in hospital, and after all suggested the better life for people with special needs [5]. Identifying these special needs is difficult and requires a proper approach.

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Smart homes technology, measuring users features and their environment through sensors and store acquisition data streams in a database for machine analysis are one of the possible approach. The collected information, as well as knowledge about the domain and user profile, are used for processing in order to gain health status and inference about the activity of the monitored person [5][6][7]. There are different variety of sensors and classification approaches for these sensors which are presented in [5]. In order to context formalization, it is critical to achieve a clear understanding from considered activities in smart home and its special features in order to proper sensor selection and system design [8]. A possible solution has been demonstrated in [9], where a set of sensors is placed in the home of the elderly, and the collected data are analyzed and an alarm or other action is carried out on this basis to help the senior.

More, new healthcare practices are strengthened by new technologies and innovative devices (mHealth). Continuous monitoring of health indicators is vital for people and elders, in particular, for improving the quality of their life and ageing well. Also, elder people have to benefit from new technologies and use their opportunities. Healthcare devices created/customized for monitoring health condition respond to the needs of elder people and can prevent health worsening and later care dependency in life.

In order to secure the appropriate distribution and utilization of services aimed at elderly service users, a comprehensive assessment of needs is required, including physical, psychological and social aspects. The review and new methods is discussed in [10]. Important role plays the method of obtaining answers, during the face to face discussion or by sending the questionnaires by post. Authors in [11] conclude that nonresponse bias is evidenced when postal questionnaires are utilized in the very elderly population and caution should be used when interpreting health data obtained by this technique.

The innovative project Ella4Life (your Virtual Personal Assistant for home and on the road) aims to facilitate the elders' a healthier and more pleasant life, in more independent and safer situation. It proposes an integrated solution in the form of an application that offer a support elders to do daily activities or stay in contact with doctors or informal caregivers when necessary.

The idea of proposed system is presented in Fig. 1. Anne is an avatar speech controlled, offering daily activities structure, reading the news and video-communication. Emma has a working connection with several e-health self-management solution.
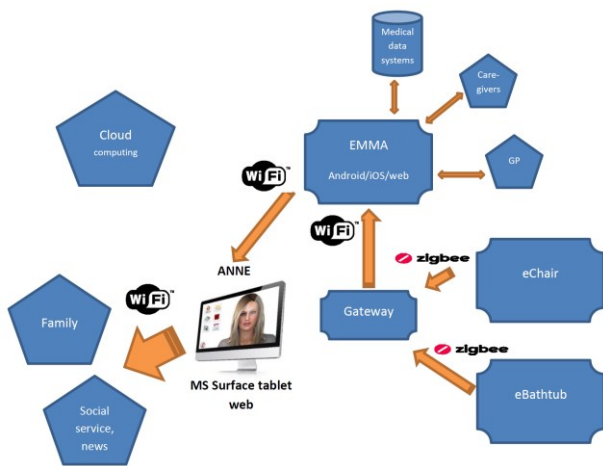
Figure 1. Ella4Life system block diagram - idea

The sensors in bathtub and in armchair are designed for measuring ECG (electrocardiography) heart activity. eChair is a capacitive sensor based system for heart rate and user activity reception while sitting or lying. The basic functionality of the device is to track user heart-rate (HR) and its derivatives (like HR-variability, tachycardia, bradycardia episodes etc.). The measurement does not require additional activity from the user except traditional use of modified furniture – like deep chair or bed. Furniture equipped with sensors can receive electrical heart signal trough clothes and does not require additional action from the user. Additional sensors that can be attached can support information about user activity – eg. if the user is using furniture (presence) and how he is moving on it, etc.

eBathtub system is a supplement to the ordinary acrylic bathtub with elements that supervise the condition of the person who is bathing – Fig. 2.
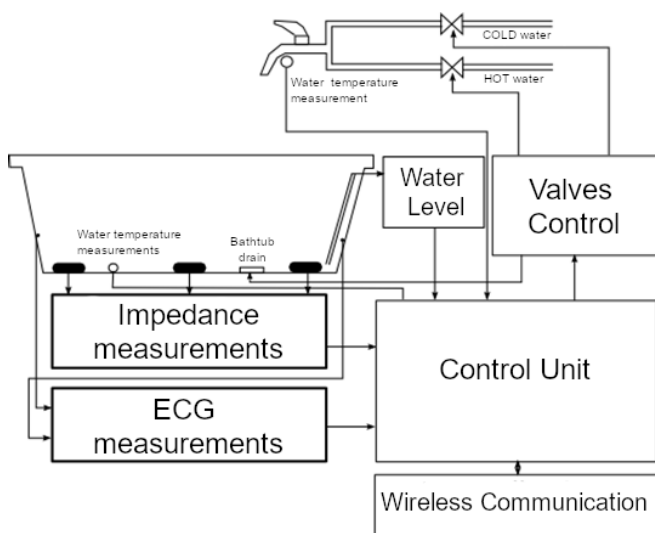

Figure 2. Bathtub safety system – an overview

The device has a temperature control system for water filling the bathtub, water level monitor, outlet valve control system and diagnostic modules that allow to determine the presence of a person bathing in the bathtub, its physical activity and measurement of selected physiological parameters such as respiratory rate or heart rate basing on ECG (electrocardiography) measurements. The advantage of the system is that it can be integrated in an acrylic tub in the bathtub manufacturing phase or implemented as a measuring mat for existing/installed bathtubs - sold as an independent element. The proposed solution allows to increase the comfort of the bathing person by controlling the temperature and water level in the bathtub and its safety through constant supervision of the bathing person's activity. Innovation is based on the use of bioimpedance techniques, characterized by a very good sensitivity of the presence of a bathing person without disturbing its intimacy (no cameras are used in the system).

The Ella4Life system will be using two wireless protocols. For low speed and limited data transfer ZigBee interface (echair and ebathtub to gateway/data hub) and the Wi-Fi interface for other data transfer purposes. The proposed solution integrates three advanced technologies that Anne and Emma already offered and integrating the use of the bath sensor and the e-chair, as a best added value for the target group.

II. METHODOLOGY

One important part of ours work is directed to assess the elder people (as end-user) needs and requirements as an important step of testing the iterative prototypes. Also, analyzing user requirements is necessary to guide the consortium towards the integration of all three elements and create of an integrated solution which is useful, innovative, with a high acceptability.

The quantitative research is tailored for revealing and analyzing elder's opinion when using sensors, in a measurable approach, and method is focus-groups and in-depth interview with guidelines designed for revealing elder's requirements about apps and self-monitoring health indicators. Informations are analyzed for qualitative insights or through numerical comparisons for quantitative results, in a comparative manner. The discussions are strongly guided around integrated solution Ella4Life and targeted on aspects of benefits for health. The focus is to exploit the strengths of each product and obtain a superior product. Data were collected during October – December 2018, in four countries: Romania, Poland, Netherlands and Switzerland.

In the present fragment we select insights about elders' perspectives about self-monitoring and particularly the perception of having sensors for monitoring health indicators and body movement in their own house. We presented them two devices: the first sensor is a device for monitoring of cardiac action potential fixed into an armchair, the second sensor for monitoring vital signs is placed in a bathtub. The people express their perceptions regarding using sensor technology for measuring and monitoring health indicators.

The users are defined as elder within the category 55 years and older, healthy or with a chronic disease or mental condition, willing to benefit from presented solution Ella4Life. We opted for a small group of people because these facilities valuable communication and sustain innovative thinking. Elders were presented the proposed integrated solution Ella4Life and asked to share with us their insights.

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The discussions with end-users revealed important information in relation to the use and design of the proposed Ella4Life solution. Also, we are interested in investigate elders' interest in measuring and self-monitoring the health indicators and body movement in their own house.

III. RESULTS

The respondents: our groups include 8 persons in Romania, 7 persons in Poland, 8 persons in Switzerland and 5 persons in Netherlands. All respondents have over 55 years, male and female, with different levels of knowledge the mobile and app-based technology or internet platforms. The findings from focus-groups determined the partition of respondents into two clusters, as following: one group of seniors who are positive about integrated solution Ella4Life with all presented features (people from Romania, Poland, Netherlands, and Switzerland), and one group of seniors who want to use self-monitoring advantages in daily activities (people from Romania, Poland, and Netherlands). We describe the results as follows.

a) Elderly users from Romania, Poland, Netherlands and Switzerland have positive attitudes and acceptance of using new technologies for improving their lives and particularly in relation to the idea of using Ella4Life in daily activities.

Majority Romanian participants, 7 persons from a total of 8, said they are comfort-able with Ella4Life idea and would be happy to benefit from such a service; plus 1 person who have mixed feelings about the Ella4Life idea. Similar, in Poland, there were 5 persons from a total of 7, who said they feel comfortable with Ella4Life idea and would be happy to benefit from it. Also, 2 persons said they have mixed feelings about the Ella4Life idea and need more information about that concept. The all 5 persons from Netherlands are comfortable with Ella4Life idea and would be happy to benefit from such a service. From a total of 8 persons from Switzerland, three of them were comfortable about the Ella4Life idea and would be happy to test it, also 3 persons said they have mixed feelings about the Ella4Life idea and need more information about. In none of the countries there were not any respondent saying aren't comfortable about the Ella4Life concept (Fig. 3).
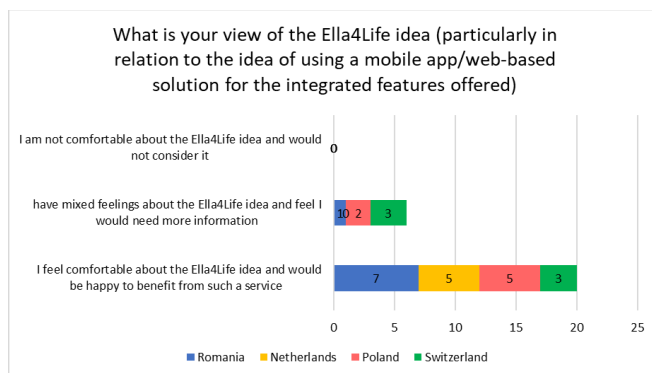

Figure 3. View of the Ella4Life idea

b) Elderly users from Romania, Poland, and Netherlands agreed the idea of having sensors for monitoring their movement or possible incidents (falls, heart attack, lose consciousness etc.) because they are aware of their fragility,

and sensors offer them a sense of security. Interviewed people from Switzerland are sceptic about using of sensors in the bathroom because bathing is no longer desired in old age. So, the elders habits are important.

The simple question "What types of general information / advices would you prefer to see and/or receive through the Ella4Life platform?" is very important for the functionality of the system. If we look at the chart (Figure 4), it is obvious that news, weather information and entertainment as well as neighborhood facts are the most important for end users for all responders. Poles are less digitalized and more based on traditional forms of time organization, planning and spending. They do not see the necessity of such functions as speech synthesis or speech recognition. This may be due to problems with the Polish language of digital assistants.
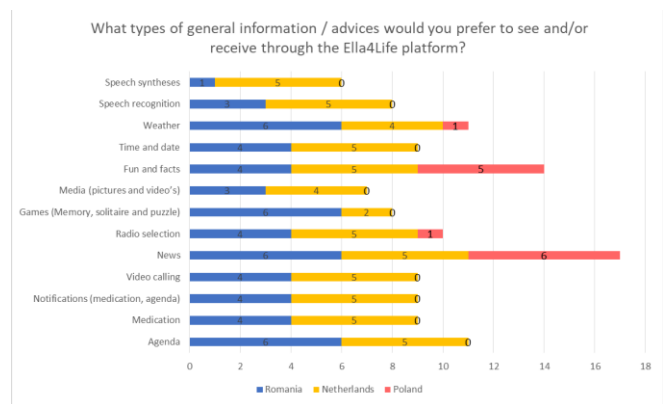

Figure 4. Ella4Life supporting functionalities

Regarding the sensors in the bathtub we obtained a little different conclusion in countries. In Romania many persons appreciate the presence of sensors in bathtub. All 8 persons inquired said they need automatic water cut off and water dump if dangerous conditions are detected and 7 persons want a tool to send alerts. Six of a total of 8 persons appreciated the monitoring activity of a bathing person; and 5 persons are interested in monitoring the water level and water temperature and monitoring heart activity during bathing. In Poland, many persons, 7 from a total of 7, appreciated the characteristic of monitoring heart activity during bathing. Then, 6 persons choose the feature of monitoring the water level and temperature, as well as automatic water cut off and water dump if necessary. A number of 5 persons were interested in automatic triggering and send alerts, the same for monitoring the activity of a bathing person. On the other hand, in Netherlands, a few persons consider their presence important, because they don't use bath but a shower; in fact, just the place is different (Figure 5).

Regarding the presence of sensors in the armchair for monitoring health indicators, we found out that there were many more respondents who appreciate the offered features. Comparative, more respondents (7 in Romania, 5 in Netherlands and 6 in Poland) appreciated that characteristics of sensors for automatic triggering and distribution of alerts. Similar, 6 elders from Romania, 5 from Netherlands and 6 from Poland appreciated the capacity for detecting heart arrhythmias and finally, there were persons who would like data (heart) collected for a long period (7 elders in Romania, 3 in Netherlands and 3 in Poland) (Figure 6).
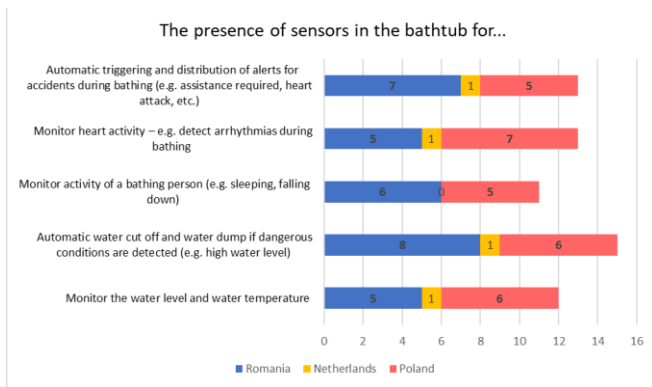
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The presence of sensors in the bathtub for...

Figure 5.   Insights about the presence of sensors in the bathtub (multiple choices)

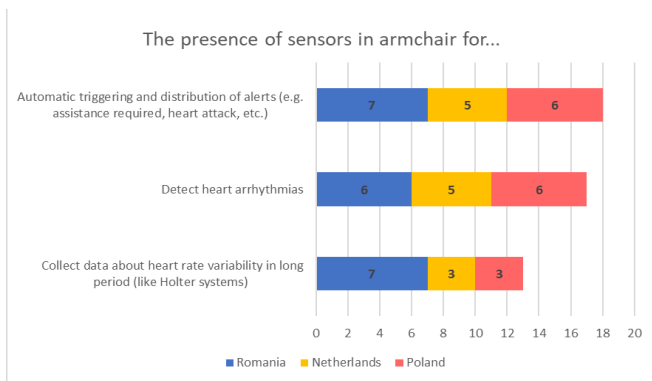The presence of sensors in armchair for...

Figure 6.   Insights about the presence of sensors on armchair (multiple choices)

Reception of information through sensors is appreciated because it ensures a kind of security for people with problems. More sensors for motion (movement) can be located in several places inside house. A „tracking" sensor could be useful to locate people with orientation problems when traveling.

IV. CONCLUSION

If we take care of elderly special needs, now, we will be able to prevent the health worsening and later care dependency in future life. Using new technologies in daily people activities such as self-monitoring of health indicators means a significant help for elders and essential for ageing well as well support them to feel protected. Also, they need monitoring health condition and devices customized in order to respond their special requirements.

This paper advocate for the understanding of elderly perceptions, in terms of attitudes, habits and needs about health and self-monitoring. The results help us to tailor and offer them the best product integrating new technologies and support elders in order to stay healthier and live a more quality life. The results of qualitative research and inquiring elders from four European countries show the diverse elders' perceptions about self-monitoring and using sensor technology for measuring health indicators, even contradictory. The findings determined us to address them as two clusters, as following: one group of seniors who are

positive about the idea of using integrated devices in their daily lives, and one group of seniors who want to use self-monitoring advantages of sensors as daily habits.

Finally, even if elders agree the idea of having sensors for monitoring their movement or possible incidents (falls, heart attack, lose consciousness etc.) at home, because they are aware of their fragility, and sensors offer them a sense of security, they are sceptic about the idea of using it distinctly. In this case, we recommend taking into account the daily habits of elders and tailoring the design of devices, apps, and sensors like echair or ebathtub. We have to create integrated tools and collect measurements during daily activities without seniors' commitment and no effort. What is more suitable, these sensors could be hidden in the structure of the furniture and do not stigmatize the users. Monitoring of information through sensors is valued because it ensures a kind of security for people with health condition.

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