# Implementation of Unobtrusive Sensing Technology to support Informal Caregivers for elderly care

Nikita Sharma 1,2

<sup>1</sup> NEDAP, The Netherlands <sup>2</sup> University of Twente (UT), The Netherlands

**Abstract.** There is an increasing worldwide demand for technology- driven assistive systems to support informal caregivers. In response, the present work explores, evaluates and imple-ments unobtrusive sensing technology for monitoring real-time elderly behavior. It conducts a state- of-the-art review to explore advantages and disadvantages of pre-existing unob-trusive sensor systems (USSs) for monitoring human activity and behavior. Next, it devel-ops and evaluates an unobtrusive multi-sensing system for tracing and tracking elderly be-havior. Finally, it prototypes a persuasive communication/coaching platform, which will act as a channel between USSs and caregivers

Keywords: Unobtrusive sensing, Informal caregivers, Persuasive Technology

### **1** Introduction and background

The world population is aging at an alarming rate. By the year 2050, approx- imately 16% of the world's population will be considered as elderly [1]. This rise will be challenging for the available medical care services. Providing care to elderly who are staying alone or are suffering from chronic illnesses can be burdensome for in-formal caregivers [2]. While informal caregiving is required and promoted, its effects on caregivers are detrimental. The literature has delin- eated its impact on physical health, emotional well-being, social life and financial condition of the informal caregivers. A general lack of support for informal care- giving was found, leading to emotional and physical illnesses [3, 4].

Many solutions were explored to help caregivers maintain their well-being and assist them in caregiving process [5, 6]. Sensor-based technology for monitoring physical, physiological, and emotional activities of the elderlies is state-of-the-art [7, 8]. These technology-driven solutions are intelligent in data management, are scalable and enable care from a distance. While efforts are being made to make sen-sor-based systems technologically reliable, discernible attempts are also being made to ensure their user acceptability [9]. Most of these systems are wearable in nature which creates uneasiness, resulting in higher rejection rate from the elderly.

A step further, the concept of using non-invasive/ambient/unobtrusive sen- sors for monitoring daily life activities is novel. Seemingly, UST is a sensor-based tech-nology that detects change in the surroundings without demanding much of user's attention. Research have acclaimed the use of unobtrusive sensors for mon- itoring physical, physiological, and emotional human behaviour [10]. USSs over- comes the drawbacks of wearable sensing systems, resulting in high acceptability with im-proved user experience. While the idea of using USS seems promising, thorough research on its effective implementation is required.

Aim: The goal of this doctoral research is to evaluate USS for optimizing their successful implementation among informal caregivers and elderly. To achieve this, initially the gaps in reallife implementation of USS will be identi- fied. Further, a USS for tracking and tracing relevant behaviors (e.g. nocturnal unrest) of elderlies will be developed. Reliability and accuracy of USS will be tested in lab and real-life settings. Lastly, to disseminate the information of el- derly behavior changes col-lected by USS to (in)formal caregivers, a persuasive online communication

Persuasive 2020, Adjunct proceedings of the  $15^{\text{th}}$  International conference on Persuasive Technology. Copyright © 2020 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0)

platform will be prototyped. While designing this plat- form, a user-centered approach with persuasive technology will be used. This platform can be used to coach both elder-lies and caregivers.

\* Supported by European Commission under Marie Sklodowska - Curie Grant No. 814072

### 2 Research design and Methodology

The research is divided into three major phases - Exploratory, Testing & Evaluation, and, Design. Currently, a state-of-the-art review and preparation for testing and evaluation phase is in progress.

**Exploratory phase:** A state-of-the-art review aims to explore advantages and disad-vantages of existing USSs. The proposed research questions are:

- 1. How is the concept of unobtrusiveness defined and evaluated in existing litera-ture?
- 2. What types of Unobtrusive Sensing Systems (USSs) used for monitoring physical and emotional behavior changes of human adults can be identified?
- 3. What are the opportunities and limitations in terms of feasibility, reliability, accu-racy, and acceptability of identified USSs in lab and field studies?

**Methods:** Scopus, Web of Science (WOS), and ACM digital library databases were used to conduct state-of-the-art review. For searching tittles, keywords and abstracts were used. Studies from the last ten years (2011-2020) mentioning unob-trusive/contactless/non-wearable/wireless sensing systems in monitoring or recog-nizing emotional and physical human behavior were included. Review pa- pers and studies including subjects below age 18 and animals were excluded. This search yielded a total of 2331 papers for tittle and abstract screening.

**Testing and Evaluation Phase**: To understand more issues on practical ap- pli-ance of USS, unobtrusive sensors based on WiFi, mmWave, and depth-sensing tech-nology to measure/detect/monitor human behaviors and activities will be deployed. The research questions are:

- Lab testing with healthy adults: What is the accuracy and reliability of the differ-ent USSs while detecting relevant physical behavior changes?
- Real-life testing in elderly care homes: What is the reliability and feasibility of the designed multi-sensor USS for elderly?

**Methods:** Evaluation of USS in lab settings with participants enacting relevant be-haviours (determined by interviews with informal caregivers) will be per- formed. A-B testing among sensors will also be done. USS will then be deployed in elderly home to test feasibility in daily usages followed by a feedback and interviews with elderly and informal caregivers to get insights on acceptability.

#### Design Phase: The aim is to prototype a Lo-Fi persuasive communication

/coaching platform driven by data obtained from USS. The platform will act as real-time information and feedback channel between USS, (in)formal care- givers and elderlies. The platform will be evaluated for its user experience and persuasive-ness with (in)formal caregivers and elderlies. The research questions are:

• What are the expectations and barriers of (in)formal caregivers and elderlies to-wards persuasive communication/coaching platform integrated with USSs?

• How the persuasive technology can be used in the design flow of Lo-Fi pro- to-type of a communication system for providing the real-time information of elder-lies to (in)formal caregivers?

**Methods:** A mixed method research with participatory development design ap- proach (CeHRes roadmap) will be used for creating the platform. Qualitative and quantitative methods will be used to identify needs and barriers of informal caregiv-ers and elderlies towards such platforms.

## **3** Preliminary Results

State-of-the-art review: At present, abstract screening is in process but a few in-teresting points noted so far. The definition of "Unobtrusive Sensing" varies across the literature. The term is easily misinterpreted and used for both wear- ables and non-wearable technologies. For example, Galvanic Skin Response sen- sors for emo-tion detection, inertial sensors for fall detection etc. were attached to the users body and called unobtrusive systems. Whereas on the other hand sensing systems which require no physical contact and attention like Wi-fi, radar etc. were termed as unob-trusive systems. This requires a more clear definition of "Unobtrusive sensing" con-sidering its importance in the implementation. A major focus is given to fall detection, vital sign detection (heart rate and res- piratory rate) and sleep monitoring in the literature, but a system which can include major relevant activities at once is desirable from both economic and user prospective. The measurement of physiologi-cal activities is done mostly us- ing wearable sensors, which might not fit in elderly health monitoring. Lastly, number of studies with interesting ideas like use of wifi signals to vital signs etc. were marked for unobtrusive monitoring. But they have demonstrated only lab testing which is not informative to estimate the implementa-tion challenges in real life.

## 4 Acknowledgement

I would like to thank my supervisors Dr. L.M.A. Braakman-Jansen (UT), Dr. J.E.W.C. Van Gemert - Pijnen (UT), Dr.P.J.M. Havinga (UT) and Dr. Jan Hendrik croockewit (NEDAP) for their guidance in formulating this research.

### References

- 1. United Nations (UN). World population ageing 2015. 2015.
- Ebru Akgun-Citak et al. "Challenges and needs of informal caregivers in elderly care: Qualitative research in four European countries, the TRACE project". In: Archives of gerontology and geriatrics 87 (2020), p. 103971.
- Lynn Etters, Debbie Goodall, and Barbara E Harrison. "Caregiver burden among dementia patient caregivers: a review of the literature". In: Journal of the American Academy of Nurse Practitioners 20.8 (2008), pp. 423–428.
- Irina Fonareva and Barry S Oken. "Physiological and functional conse- quences of caregiving for relatives with dementia". In: International Psy- chogeriatrics 26.5 (2014), pp. 725–747.
- Andreas Lorenz and Reinhard Oppermann. "Mobile health monitoring for the elderly: Designing for diversity". In: Pervasive and Mobile computing 5.5 (2009), pp. 478–495.
- 6. Sven Kernebeck et al. "A tablet app–and sensor-based assistive technology intervention for informal caregivers to manage the challenging behavior of people with dementia (the

insideDEM study): protocol for a feasibility study". In: JMIR research protocols 8.2 (2019), e11630.

- 7. Mohammed Taj-Eldin et al. "A review of wearable solutions for physio- logical and emotional monitoring for use by people with autism spectrum disorder and their caregivers". In: Sensors 18.12 (2018), p. 4271.
- 8. Srinivasan Murali, Francisco Rincon, and David Atienza. "A wearable de- vice for physical and emotional health monitoring". In: 2015 Computing in Cardiology Conference (CinC). IEEE. 2015, pp. 121–124.
- 9. Franka Meiland et al. "Technologies to support community-dwelling per- sons with dementia: a position paper on issues regarding development, usability, effectiveness and cost-effectiveness, deployment, and ethics". In: JMIR rehabilitation and assistive technologies 4.1 (2017), e1.
- Kostas Konsolakis, Hermie Hermens, and Oresti Banos. "A Novel Frame- work for the Holistic Monitoring and Analysis of Human Behaviour". In: Multidisciplinary Digital Publishing Institute Proceedings. Vol. 31. 1. 2019, p. 43.

4