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SHINESeniors: Personalized Services for Active Ageing-in-Place

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I. OVERVIEW

Singapore faces a major challenge in providing care and support for senior citizens due to its rapidly ageing population and declining old-age support ratio. The concept of Ageing-in-Place was introduced by the Singapore government [1] to allow older people to live independently in their own homes and communities so that the need for institutionalised care will only be utilised when necessary. We have three fundamental questions that this project will answer:

1. How to make community care services effective through innovations in care delivery?
2. How to lower the cost of service delivery and improve productivity of caregivers, by leveraging information and communications technology (ICT)?
3. Can we quantify such productivity gains?

SHINESeniors, or Smart Homes and Intelligent Neighbours to Enable Seniors, is a SMU-initiated effort to make community care services effective through innovations in care delivery by leveraging on Information and Communications Technology (ICT). It aims to create sensor-enabled homes in support of ageing-in-place. The sensors, installed in the homes of seniors, can help community volunteers to better monitor, support them and respond in a timely manner to calls for help or falls. Through SHINESeniors, it is hoped that the cost of care delivery will be lowered significantly given the lower reliance on manpower.

We are creating sensor-enabled homes for a liveable public housing community that supports active ageing-in-place for senior Singaporeans. Specifically, we aim to:

1. Design and develop a sensor-enabled home composed of fixed and mobile sensors customised for older people living in the public housing flat
2. Deploy and benchmark the customised sensors with commercially available sensors
3. Capture and analyse the living patterns of older people and detect abnormalities from 100 homes
4. Design and develop a care model that includes a personalised care plan and an escalation protocol for each resident based on their daily living patterns
5. Develop a reference architecture for sensor networks and Internet-of-Things for smart homes

We are developing and deploying an integrated sensing and sense-making platform for the elderly (see Figure 1). It is composed of a sensor-enabled home (1) with fixed and mobile sensors which monitor the environment (air quality, noise levels, temperature, humidity, etc.) and the older person (non-movement, fall detection, physical activities, medication adherence, mobility patterns, etc.) in a non-intrusive manner. This enables a connected smart home that senses and communicates real-time data to a home care platform (2) that allows remote and continuous monitoring of the elderly's medical condition and behaviour patterns, and also performs 'sense-making' to detect anomalies (e.g. falls) or unusual patterns (e.g. waking up every hour to go to the toilet). Based on the living patterns of the older person, a personalised care plan and an escalation protocol (3) are developed so that appropriate intervention can be done at different thresholds. We are leveraging on the strengths of the Internet- of-Things (IoT) (4) and applying them in the home environment to support older people as they age actively in place.

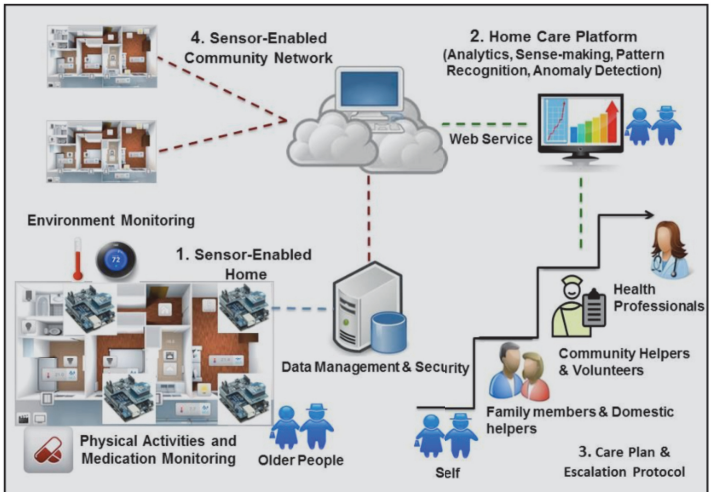

Figure 1 – Design for Sensor-Enabled Care

II. APPROACH

Smart homes and sensing technologies have been the focus of research efforts worldwide [2,3,4,5]. Existing approaches to home-care delivery as a service platform have largely remained as single use-case scenarios, bottle-necked by a lack

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of real-world deployment scenarios and systems. Similar initiatives taking place around the world, such as the Hub-of-all-Things (HAT) project based in Warwick, United Kingdom, are still conceptual, with no deployment experience [6]. Existing healthcare monitoring product companies, such as the Essence Group, do not yet have an end-to-end view of healthcare delivery, and may not encompass intelligent processing to determine patient contexts and habits [7]. A more recent innovation is the Sen.se connected home devices that enable data collection with a cloud-based Open.Sense.se platform that makes sense of the gathered data [8]. This is a generic platform for tech-savvy users and is not yet specialised to the home-care domain.

Our system aims to serve as the first demonstration of end-to-end elderly home-care in Singapore using wireless sensor networks integrated with a healthcare services platform, in a connected smart home that provides reliable sensing and data delivery mechanisms and inter-operates with existing device and wireless radio technologies. This will be different from existing solutions because it offers a complete package from data capture, to analysis and eventual intervention. It digresses from traditional home care monitoring systems that provide an alert for every acute abnormality detected. These systems promote habituation and eventually become highly intrusive for the individual. Rather, our system monitors the trends in the activities of an individual and only intervenes when there are significant deviations from their normal patterns. For example, a conventional medication reminder system would alert a patient to take the medicines at each and every designated time. This may cause alarm fatigue [9], which makes the patient ignore subsequent alarms. With our solution, we monitor the patient's pattern in taking the medicines and let the system learn the habits of the patient (who may not take the medication on time or may miss one dose but is able to take subsequent doses) to set acceptable thresholds. Only when these personalised thresholds are reached will an intervention be triggered through SMS reminder or home visit. Aside from medications, we will also look at patterns related to the individual's mobility within and outside the home, electricity and water consumptions, social interactions, and activities of daily living. Upon gathering these data, we then do sense-making to discover interesting patterns in their behaviours that may identify certain needs or affect their well-being.

III. STATUS

The project is in the first year of its three year span. An initial version of a complete end-to-end solution depicted in figure 1 has been installed in 50 senior citizen homes under our pilot testing community. Data is currently being gathered on the fidelity and reliability of the in-home sensors. A care response protocol has been designed and implemented to provide timely intervention. We have also performed basic data analytics on sensing data using SMU's self-developed algorithms to find out the elderly's basic living patterns (e.g sleep quality and medication adherence) for further research on personalized services at a later stage.

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