SELIES – SUPPORTING ELDERLY LIFE THROUGH INTELLIGENT EMBEDDED SYSTEMS

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A rapidly growing elderly population in Sweden as well as in the rest of the world imposes a need for ambient assisted living technology. To better tailor the technology to the elderly needs, understanding about the users' context as well as their intention is desired. Likely, future systems are worn ubiquitously embedded in everyday objects and are interoperable with other devices in their surrounding. The operation is human centered and special concern to the user privacy needs is taken. Two main aspects of this are explored further in this project, the analysis of human movements through accelerometer based "motion primitives" and the aspects of integration of hardware components, functions and services in a platform to support applications.

1. Background

The rapid aging of Europe's population poses new problems to be addressed in the near future. According to the World Health Organization Statistics [1], about 1.6 million of Swedish people (17% of total population) are aged 65 or over. Projections show that in the next 40 years, the largest part of population growth will be among people aged 65 and older.

In future years, the increased number of people aged 65 and over will exert great pressure on the healthcare system to treat age-related problems. These problems comprehend different aspects of physical, social and cognitive wellness as well as assistance from professional or informal caretakers.

Most age-related problems demand long-term, expensive treatments which weigh upon society as a whole. To cope with economic limitations of the available resources, the traditional health care system has been shifting its attention from medical facilities to home-based medical assistance.

2. Technical Motivation

Great part of technological development aims at creating intelligent systems to aid humans in performing certain activities. The success and effectiveness of these systems are correlated with their ability to perceive, interpret and interact with the environment. The comprehension of movements can provide important information about what is happening in the surroundings (context awareness) and consequently, information about what actions need to be taken. Therefore an artificial conceptual system, capable of coding and decoding physical movements, is of primary importance.

To make solutions appealing, practical and useful outdoors, poses several challenges; light-weight and ubiquitous, robust and embedded in devices normally worn such as shoes, bracelets or jewelry and wrist watches. Thus utilizing modern MEMS sensors built can lead to products of low cost and less obtrusive operations. Currently, the accelerometer is the main candidate, due to its low cost and power consumption and general applicability [2].

When dealing with small and portable sensors, the volume of the power source represents a significant portion of the device's total size. Thin-film batteries, for example, are small (less than 0.5 millimeters), of customizable shapes and flexible form factor. However, reducing the size of the power supply should not compromise the energization of the embedded system. For instance, medical sensors and smart tags, powered by small batteries, should work from several months to many years.

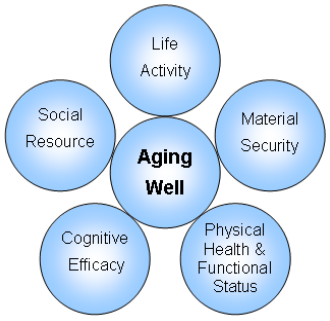

Figure 1 Aging well is multifaceted, different needs and solutions are required based on these viewpoints.

3. Aging Aspects

Elderly quality of life refers to all aspects of aging. To better understand all that is involved in aging, elderly life can be divided into *Life Activity*, *Material Security*, *Physical Health and Functional Status*, *Cognitive Efficacy and Social Resources* (Figure 1), explained in more detail in the next sections.

Life Activity – Quality of life and daily activities are strongly correlated. A healthy lifestyle can be achieved through incorporating light physical activities in the daily routine, for example, gardening, walking the dog and taking the stairs instead of the elevator. Unfortunately, with age come a decline in physical condition, eventual falls, fear of falling and other factors that conspire to a sedentary lifestyle. A tailored exercise routine could help

restore some of the benefits of physical activity and maybe inspire a more active lifestyle.

Physical Health and Functional Status – Some of the most common geriatric problems are hypertension; visual, auditory and respiratory impairments; and loss of muscle strength and balance [3]. The loss of lower limb muscle strength, balance and sight often lead to falling. Falls are the main cause of death from injury among older people. Although other factors, such as loss of cognitive function and medication, are also related to falls, studies have shown that an improvement in physical condition may reduce the probability of one falling. Therefore, strengthening exercise routines may effectively prevent e.g., falls [4].

Social Resources – Reduced functional ability, decline in health status and fear of falling often because the elderly to stay at home, leading a secluded and sedentary lifestyle. The lack of social interaction has a devastating impact on the quality of elderly life. Commonly, feeling lonely and isolated from family and friends escalates to depression. Exercise routines may help deal with this problem by inspiring social interaction. Furthermore, physical activity causes the brain to produce more endorphins, substances essential to mental wellness [5].

Cognitive Efficacy – Social interaction is also important when maintaining good cognitive functions throughout life. Studies show that the more the person feels lonely, the more likely they will develop cognitive problems, e.g. Alzheimer's [6]. Other problems related to cognitive function are dementia, delirium and forgetfulness.

4. Intelligent systems challenges

One important challenge of recognizing human behaviors is to understand the current activities as well as activities performed over time. The development of intelligent ambulatory monitoring systems and smart living environments is important when considering the aging of society and its implications. Here, the main aspect is the use of human motion analysis as a tool for supporting elderly life and suggests a new "motion language" approach to such task. More specifically, the concept of "motion primitives" which is an effective technique to automatically decompose human activity into building blocks which belong to an "alphabet" of elementary actions. Current attempts are based on motion capture data [7] only possible to use indoor in limited settings. Figure 2 is one example of how actions can be divided into primitives. Here, each primitive is represented by a shade of color. The data analyzed for this work was obtained from two 3-axial accelerometers, placed on each ankle of a person.

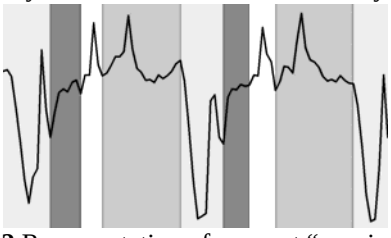

Figure 2 Representation of concept "running" from motion primitives - accelerometer placed on ankle.

5. Embedded systems challenges

To achieve the desired behavior of systems including humans in the loop, require special solutions. To ease the burden on application programmers and to share common resources for optimized solutions benefit from abstracting hardware and functions provided by hardware such as communication and sensing.

Some of the vital areas which require special attention in systems involving humans are; dependability, security, information privacy, robustness to changes in the environment and operation as well as energy efficiency and awareness.

6. References

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PARTNERS AND STATUS

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The two PhD students are part of a university research school; *Research school in entrepreneurship and health*.

PUBLICATIONS

[I] Sant'Anna, A., W. de Morais, N. Wickström,"Gait unsteadiness analysis from motion primitives", submitted.

[II] de Morais, W., A. Sant'Anna, N. Wickström, "A wearable accelerometer based platform to encourage physical activity for the elderly", submitted.