CONTEXT-AWARE SUPPORT FOR ASSISTIVE SYSTEMS AND SERVICES

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Abstract

An assistive living system that gives our elderly population the comfort and confidence necessary to remain independently in their own homes is essential for enhanced longevity. Ambient Assistive Living technology that provides intuitive and context-sensitive support presents researchers with additional challenges. This paper describes the development of an ambient framework augmenting and extending the open source framework OpenAAL with enhanced reasoning, intelligent monitoring of the person and decision-making capabilities. It briefly describes an “Ambient Assistant” application that will showcase the capabilities of the framework. The aim of this research is a complete framework with fully interoperable components such as multi-parameter sensors.

1 Introduction

There is a very strong need to support ambient assistive living technologies in the home, Turner et al. [15]. Age UK [1], in a recent study for the Department of Work and Pensions reports that nearly a fifth of people living in the UK today are expected to celebrate their 100th birthday and more than 10 million of the UK’s current residents, the equivalent of 17% of the population, are expected to live until they are at least 100. As the population ages, elderly people are more likely to suffer from reduced mobility, disability and mental health problems such as memory impairments. According to statistics published by the Alzheimer’s Society UK [3], there are currently over 750,000 in the UK with an age-related cognitive illness and this figure is estimated to reach one million by 2025. The financial cost to the government of illnesses such as Alzheimer’s disease and Dementia is 20 billion pounds each year whilst family carers save the economy an additional 6 billion pounds plus per year looking after their loved ones at home. With figures and costs predicted to rise in the future it is important to develop successful Ambient Assistive Living (AAL) solutions which can help people stay independent in their homes for as long as possible thus reducing avoidable entry into hospitals or care homes. The definition of Assistive Technology (AT) taken from the Alzheimer’s Society and The Foundation for Assistive Technology (FAST), [5, 3] refers to ‘any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increases the ease and safety with which the task can be performed’. It ranges from the simplest calendar, clock and pill-boxes to high tech solutions such as satellite navigation tracking systems which can locate someone who has wandered. Developing and applying AT within the home that can adapt and intelligently react to the users contextual needs is an extensively researched area. In spite of the significant research most AT on the market today requires the end user to adapt their behaviour to suit the limited intelligence or capabilities of the assisted living device or system, Wichert, [16]. This is inadequate if we are to successfully support the social care of today’s elderly population. This paper highlights the main challenges associated with assisted living technologies and describes the unique approach taken in this research to overcome these challenges. This research aims to address the challenges of existing frameworks by augmenting and extending the open source framework OpenAAL which was developed by Wolf et al., [10] with enhanced reasoning, intelligent monitoring of the person and advanced decision-making capabilities. The extended framework namely AMiCA (Ambient Middleware for Context-Awareness) will interface with sensor technology such as the Vicon Revue [15] to model the user’s behaviour and their environment to develop advanced reasoning and intelligence for an AAL application. It also briefly describes an AAL “Ambient Assistant” application for assisting older adults with activities of daily living. This work provides an attractive characteristic in that it offers a supportive environment for both inside and outside the home without relying on a large supporting sensor infrastructure, which means it can be easily deployed in a range of contexts and locations without any structural modifications or additions. Hence new classes of ubiquitous AAL applications and devices can be developed with the framework thus enhancing the range of useful assistive technologies for older adults in the future.

2 Assistive living technology

The Royal Commission on Long Term Care, [11] report that enhancing the social care of our elderly population can be achieved through the preferred strategy of aging in place. To date fulfilling the requirements of this approach has been difficult due to the diverse needs of this social group. Enabling an elderly person to remain in their own home has been shown to enhance their quality of life, as reported in the findings of a systematic assessment of the social, ethical and privacy issues involved in ICT and Ageing by the EU Senior
In view of the diverse challenges in assisted living, this research aims to benefit many people through improved home care and support by providing a complete framework which will support dynamic context-aware services and systems for use in an assistive living environment.

2.2 Addressing the challenges

Developing an efficient framework from scratch is a significant task, mostly due to the length of time involved and level of expertise required to design and develop an efficiently generic system. A practical alternative is the adoption and improvement of an existing middleware platform. Based on the timeframe and scope of this research, the OpenAAL [9] framework with additions such as an enhanced intelligent reasoning module, a dynamic inference module and an activity prediction module will add the missing functionality required to build context sensitive applications for all AAL domains. The AMiCA framework is a multi-layered design with intelligent reasoning and decision-making support. This approach aims to seamlessly and opportunistically provide the connectivity required by services of highly dynamic environments such as AAL clients. By delivering appropriate context-aware services at the appropriate times, new classes of ubiquitous AAL applications and devices can be developed thus increasing the quality of life of an increasing elder population. The key components within the AMiCA framework are the environmental sensing layer, the sensor integration layer or sensor fusion layer, context management layer, the application logic layer and the service layer. Figure 1 outlines the intelligent context reasoning-based approach, within the architectural framework. The lowest level of the architecture consists of new and existing sensors in a person’s home environment and other relevant context sources. To enable the dynamic integration of context sources, it is essential to keep all the sensing separate from the other layers. Hence details related to data acquisition of the various types of sensors are hidden and can be dynamically discovered as and when required.

At the lowest level of the system direct and indirect context is sensed using the Vicon Revue and if necessary other desirable sensors such as Java Sun SPOT’s and Parallax ultrasonic sensors. The users existing assistive technology systems such as telecare systems etc can also be incorporated into the framework. This will address integration issues found in existing frameworks. Systems which are interoperable and can co-exist with other plug and play devices offers another unique aspect to this work as yet there are no acceptable standards in this area. The sensor integration layer combines the data that has been acquired by the sensors and other relevant context sources and intelligently groups the data together. This approach simplifies application development by promoting reuse of software properties. Additionally this higher-level context data can be more easily inferred as a result of intelligently managing the data at this lower level. Data which can be easily inferred, will also address a key challenge within
A cloud-based assistive living application, namely Ambient Assistant (AA) will be developed to validate the efficiency of the framework. The application will be cloud-based thus promoting true ambient intelligence. In addition, the creation of such a highly adaptive and context-aware cloud-based assistive living application will provide support for successful active aging in our society.

The key components within the multi-layered AMiCA architecture are:
- Sensing mechanisms
- Sensing integration layer
- Context management layer
  - Intelligent reasoning module
  - Inference module
  - Activity prediction module
  - Contextual shared data store
- Application logic layer
- Service registry
  - Cloud data store

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2.3 Sensing using the Vicon Revue

The majority of the context data collected in this research will be sensed using the Vicon Revue. The Revue is a small lightweight, wearable device that passively captures the persons’ day-to-day activities as a series of images and sensor readings [4,6]. In our research the Revue image data is mapped against actual locations both inside and outside the home and is used to monitor the user’s activities on a daily basis. The Revue’s image mapping data although created inside and outside the home by somewhat different means uses key reference points and their associated tagged images for intelligent monitoring of the person. This background mapping data can now be used in two main ways. As the GPS-enabled Revue is not available at this time, we have used a Sony Ericsson k850i mobile device which is GPS enabled to capture images for real-time monitoring. The first way relates to real-time monitoring of the persons’ behaviour from the incoming images and uses these images to determine if the person is coping sufficiently well or needs immediate prompting regarding their expected daily routine via an intelligent “Ambient Assistant” application when indoors. If they are outdoors and are not following their expected daily routine (e.g. they are half a mile from home, when their ‘meals on wheels is arriving’) then they can be proactively prompted via a voice based prompt from a mobile device. The second way of using the image data is to use the data gathered over a period, say a month/year to determine the lifestyle behaviour of the person and evaluate if they are carrying out their activities to an acceptable standard – e.g. less time spent outside the house or shorter distances travelled may indicate a deterioration in their mobility. This history profiling requires intelligent processing of the collected image data and sensor readings to enable meaningful results to be obtained. For example the persons’ behaviour can be profiled with regard to expected daily/weekly/monthly behaviour changes and using rule-based reasoning and intelligent techniques to determine
change in lifestyle or deterioration in health related activities recognised. The data acquired to date is integrated into the AMiCA framework and an intelligent user interface application and voiceXML based mobile prompting system will be developed to test the context-sensitive user requirements of the system design. In addition a communication link to the family carer/helper via a text message will be incorporated in to the design and if major deviations from the persons’ expected behavior have occurred during monitoring the carer will receive communication. This work provides an attractive characteristic in that it offers a supportive environment for both inside and outside the home without relying on any supporting sensor infrastructure, which means it can be easily deployed in a range of contexts and locations without any structural modifications or additions.

2.3 ‘Ambient Assistant’ Application

The proposed ‘Ambient Application’ (Figure 2) will showcase the unique contributions of the enhanced middleware platform. The application will offer the user a fully interactive touch-screen companion on a screen appropriately placed inside the home and also on a mobile device. The application will prompt, remind and locate the person if they are lost and generally offer comfort and support.

3 Conclusion

Ambient frameworks for assistive living environments have particular requirements not present in other domains thus presenting many challenging problems for the researcher. It is widely accepted that a standard middleware platform is needed if proactive context-aware support is to be realised. As a result new classes of applications, technologies and services will be delivered and the current state of the art will move forward. This paper has presented AMiCA, an ambient middleware framework for supporting the development of context-aware applications. It is based on a multi-level intelligent reasoning approach where dynamically sensed context can be represented, reasoned, adapted and utilised. By providing this level of intelligent decision-making, innovative and intuitive assisted living solutions can be developed thus supporting and enhancing the quality of life of our aging population.

References

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