Ambient Assisted Living Buddy

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Abstract: The research area of ambient assisted living is concerned with providing required assistance to elderly and/or disabled people in order for them to get through their everyday tasks and chores in an easy and safe manner. This usually makes use of hardware and/or software solutions in relation to the virtual / senior companion field of study. Additionally, ambient assisted living exerts a number of tools and resources specifically developed as technological aids for an ageing population. This project looks at the possibility of improving someone's quality of life through the use of an ambient assisted living prototype solution. By combining vital research aspects from the fields of: ambient assisted living, technological aids for the aging population, and senior / virtual companions, this project explore the development and evaluation of such a software solution, the Ambient Assisted Living Buddy (AALB). This implies that the AALB manages to work correctly as a concept to ambient assisted living. Furthermore, this project proved that the possibility of improving someone's quality of life through an ambient assisted living solution can be effective and has a high potential.

1 INTRODUCTION

As the human body advances in age it is commonly observed that the body gets weaker and more fragile making it more accident prone and having everyday life tasks gradually harder to complete. Bearing this in mind, the sole driving force of this project was to create something that delivers an environment for a better and longer lasting life. This environment is to be provided via the fully operational Ambient Assisted Living Buddy (AALB), which seeks to research whether an interactive monitoring system raises hope in delivering an improvement upon the current style of life.

1.1 Scientific Question

The principal aim of this dissertation was to be able to come up with a sensible and well supported answer to the scientific question,

Can an assisted living system (the AALB) improve someone's quality of life?

Through this, the concept and implementation of the AALB started to take shape, with the notion of managing to supply a sensible scientific solution.

1.2 Aims and Objectives

The primary objective of the AALB project is to provide the construction for an interactive system aimed at aiding the elderly and disabled to cope better with their situation.

The AALB will be installed and integrated with a user's personal mobile phone thus allowing the ease and extended ability of real-time monitoring and user prompted actions. The most vital aspect of all of this project is that it is kept simple to use, thus implying that an old person with no real idea of the present technological advancements can utilise it just as well as a geek and an expert. The three main goals are:

1. The aim was to review the current situation of the elderly with respect to technological aids.
2. The design and implementations of an AAL, complemented with a series of vital design decisions. This was highlighted through the methodology.
3. An assessment of the output results of this research was carried out through system evaluation, while the potential for further developments was realised under Conclusion & Future Work.

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2 RELATED WORK

Ambient assisted living is the concept and idea of utilising various number of ICT and/or technology related aspects in order to better the quality of life of certain specific particular people. This primarily focuses on aiding the elderly and/or disabled people in managing to deal with fulfilling their everyday needs through activities, chores, and entertainment. Thus, in turn, such technologies and computer related breakthroughs ease the life and job of said conventional personnel whilst managing to maintain a more pleasant experience for the effected elderly and disabled alike. Finally, this area proves to make the users lead a more independent life where less support from the usual caretakers and family relatives is required. The solutions to this area of research are designed and implemented with key aspects such as, a user-interactive feature, and its integration with the everyday routine. Both of these are very powerful and take into consideration that in most cases the user suffers from impairments such as hearing difficulties and lack of eye sight. By managing to accomplish all of this, the resulting solution helps in ensuring the simple yet vital characteristic of doing so much with so little effort.

2.1 Assistive Technologies

The formal strict definition of an Assistive Technology (AT) device is given as,

> *"...an umbrella term for any device or system that allows an individual to perform a task they would otherwise be unable to do or increases the ease and safety with which the task can be performed."* (Cowan and Turner-Smith, 1999); (Beech and Roberts, 2008)

This definition is seen to describe what an AT actually is and not really what it promises to achieve in its methodologies and deliverables. Perhaps a more goal oriented definition which focuses on the AT's ability to ensure the peek amount of independence for the elderly, is shown hereunder,

> *"AT is any product or service designed to enable independence for disabled and older people."* (King's Fund, 2001); (Beech and Roberts, 2008)

Moreover, the term AT goes over a distinct number of devices that vary from, simple assistances to move about, to complicated computer oriented medical devices. Current persisting advances and breakthroughs in technology bring, to the ATs, a new amount of promising possibilities that it is now their best chance of working in achieving and realising their goal. These ATs, through the utilisation of aiding assistance and notification facilities, now have the better chance of allowing the elderly people to live a longer self-sufficient life from their own personal home. (Brignell et al., 2007) (Blaschke et al., 2009) (Williams et al., 2013)

Having said this, the currently available and soon to be released ATs fall under one of the following arrangements, according to their specific prominent task: (Doughty, 2004); (Beech and Roberts, 2008)

- Technologies which offer a sense of assistance to individuals aiding them in any chores.
- Receptive technologies that aid the individual to handle hazards and raise an alert.
- Preventative technologies that keep the user away from hazards, while triggering an alert.

2.2 Technological Aids for the Aging Population

The main idea of this research area revolves around any kind of technology-oriented aid that is observed to have the possibility of leaving an impact on the quality of life and the life expectancy. It is important to note that the approach is concerned with the possibility of an improvement and not actual certainty; thus the potential enhancements and aids looked at do not have a definite guarantee of appearing in the imminent future.

In the light of this project, these technological aids incorporate new means of providing assistance and support to elderly and disabled people, which have been made possible through recent technological development and breakthroughs. This assistance and support comes as a methodology of reducing or completely eliminating the current most frequent accident types and dangerous situations. In doing so, it must first be established whether such accidents and scenarios could be reduced or eliminated, and how any positive accomplishment will effect life quality and expectancy.

2.3 Virtual Companions and Software Agents

Virtual companions and software agents take a lot of distinct forms, hence properly defining them comes out as a general statement which collectively includes every possible form. This general statement defines an agent to simply be a software component with some special features, and a virtual companion to be nothing more than various collaborative agents

working together. This is regarded as being the prevailing common structure for a virtual companion, having the diverse software agents collaborating together and making up for all of the available system functionalities and capabilities. (Spyros et al., 2009)

Understanding an entire virtual companion comes down to proper explanation of the underlying software agents, which are sub-dived according to their specific task completion abilities. (Spyros et al., 2009)

2.4 The Elderly Population Today

As times progress and advances are made in the development of medical and technological aids, elderly people are somewhat assured that they are able to live a longer life. This quickly results in an increase in the percentage of old persons which make up the entire population. As a matter of fact, European countries have undergone a swing in their population composition, with this percentage increment taking its full effect (Parker and Thorslund, August 1991). A logical fact is that, growing older results in an increase in chronic health difficulties. These chronically ill patients add up to three quarters (75%) of all the healthcare's expenses and revenues. (Spyros et al., 2009).

Having established this scenario and situation, a conclusion is now drawn that something must be done so as to improve the quality of life of an elderly person and to make him/her feel more secure and content. In fact, first hand feedback from the elderly people who already make use of some kind of AT solutions reported some clear had facts. These essentially include (i) an improvement in the ability of taking a decision; (ii) a stronger sense of security; (iii) more prominent freedom; (iv) an impression of oversight and governess; (v) enhanced conditions of life; (vi) preservation of the competence in staying at home; (vii) less of a handful to the people taking care of them; (viii) a boost in the aid specifically towards persons suffering from abiding health complications; (ix) diminishing in the number of mishaps, mostly falls, which occur at home. (Beech and Roberts, 2008)

2.5 Similar Systems

Fall Detection / Sensor Aiding. This branch covers systems which are observed to make use of some sort of sensors, with a fundamental focus in either detecting a fall or tracking a location. These such similar and relevant systems are namely, Fitbit (Fitbit Inc., 2014), iFall (Sposaro and Tyson, 2009), Detecting Human Falls with a 3 axis Digital Accelerometer (Jia, 2009), and Sensor Aiding of HSGPS Pedestrian Navigation (Mezentsev, 2005)

Home Care Companions. This division goes over systems which were built as virtual companions, but have their main driving force focused on providing special home care support. These are, HEARTS (Spyros et al., 2009), Virtual Carer (Sernani et al., 2013), and HOMIE (Kriglstein and Wallner, 2005).

Dialogue / Conversational. This section explores solutions which have the capabilities of managing a dialogue scenario, as well as, closely mimicking human comparable conversations. With relation to the AALB, such a system is the Senior Companion (Pinto et al., 2008).

Other / Miscellaneous. The final category in comprised of only one system, namely 'Google Now' (Google, 2012) which has a distinctive nature of both functionality and deliverable aims.

3 METHODOLOGY

When it came to developing a system project, it was first very important to properly establish the reason for which the system would be developed. In doing so, a problematic scenario is initially identified and then system planning and construction could take shape around this scenario and thrive to deliver a proper solution. Following from this, the primary AALB's driving force was born and a clear picture of how the prototype would deal with the problem was set up.

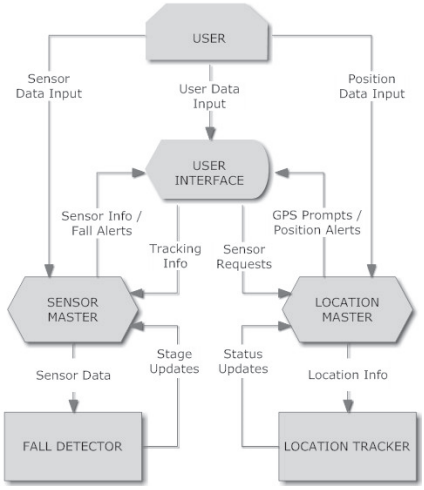

Figure 1: System Diagram.

Vitally, strong attention is given to the User Interface (UI), monitoring sensors and actuators, and environmental re-actions in order to deliver a simple to use yet fully functional system.

The AALB is a mobile application available on the android operating system, which is based upon the following three core aspects:

1. Presenting information at the right place and at the right time
2. Offering a clear, understandable and easy to use interface for certain everyday tasks
3. Collecting information directly and indirectly from the user, producing the best possible scenario output.

More specifically, the system utilises an array of sensors along with the simple voice and touch commands, in order to harvest the necessary input data from the user. This captured data is then processed in accordance to the particular scenario and situation, and a corresponding user desired output is produced. Figure 1 below depicts all this as the system's internal structure and workings.

With regards to the actual system and interface, this will take a similar approach to what was observed in the Google Now system, but with more focus on elderly and disabled people rather than everyday users and technology geeks.

A number of sensory inputs will be utilized to gather additional information to aid a better understanding of the appropriate and relevant output.

The sensors that are expected to be present are:

- Gravity Sensor: Measures the gravitational forces.
- Linear Acceleration: Measures the forces of acceleration, excluding the gravitational forces.
- Location Sensor: Tracks the location through GPS.

In terms of functionality and the actual information, this will vary according to the scenario changes indicated by the numerous sensors.

The living buddy promises to provide the functionality of, (i) Understanding the user voice input; (ii) User programmable notifications and alarms; (iii) Watching over the user and potentially informing some external entity in the case of an arising danger; (iv) Brighten or dim the light just by speaking to the device; and (v) Display a weather and news report with a click or voice command

The system's design is considered to be in the best way in terms of both, code understand-ability, and system overall performance. This includes, (i) Threads that enabled simultaneous task running without hindering system performance; (ii) Stage variables which allowed different system checks at different situations; and (iii) Error reporting and alarm handling including alarm calling routines with respect to the state variable.

The idea of this design is that every function is able to perform on its own and only "bothers" the system UI in the case of an error, or upon a request for user input data.

4 RESULTS AND EVALUATION

Apart from the usual testing procedures, a public evaluation was conducted. The respondents for the public feedback analysis attended a social meeting known as GRUFAN made up of nurses, elderly and their relatives.

All of this gave me a total of around 26 people, with age groups varying from 10-25 to 65+, a diverse number of capabilities and a wide variety of distinct living scenarios. For the scope of testing out the AALB, the gender was considered as irrelevant and thus was not even recorded.

The user stories are a couple of thought out scenarios that the AALB is expected to be used in. This inspects the specific situation the AALB will mostly be useful at, whilst also identifying any lacking features with respect to the situation. Primarily, the system is aimed to be used on a mobile device and thus different mobile environments are compared to highlight some of the limitations with respect to this criteria. Secondly, exploration is done with regards to a person's need for support or living habitat. There are a total of nine (9) user stories, divided up into two categories, mobile oriented (first 3), and living environment and support (the rest); as seen hereunder:

1. Prohibited mobile device use
2. Use of mobile device without carrying it around
3. Use of a mobile device and carrying it around
4. Living alone at home
5. Living with relatives but can manage alone
6. Living with relatives and requiring their assistance
7. Living at home with someone's assistance
8. Not living at home but can manage alone
9. Not living at home and requiring assistance

For each of the user story scenarios, the AALB was evaluated and findings were made with respect to the most effected functions.

- Scenario 1: The AALB faired very well in this scenario with all of the vital features functioning.

In fact, more than 80% of the respondents rated the effected functions a 4 or a 5 (out of 5).

- Scenario 2: The major concern of this scenario was the notifications functionality. Positively, over 90% of the results rated this feature to be near perfect with a score of either a 4 or a 5 (out of 5).
- Scenario 3: This utilises all of the functions of the AALB, and thus its evaluation comes down to the analysis of entire system. Overall the system generated a successful feedback and so this scenario has been entirely fulfilled.
- Scenarios 4 - 9: These scenarios utilise the same features, thus requiring AALB testing in its full potential. This performed very well, around 90% of the respondents gave a high rating in the overall evaluation and above 80% gave a high rating in the in depth functionality evaluation.

An overall evaluation questionnaire was used in order to gather basic user information detail, along with the overall system experience. This was divided into three parts, (i) Personal Information; (ii) Daily Activities and Scenario Capabilities and (iii) General Overall System Usability.

With respect to the overall performance of the AALB, the system was greeted very well and positively managed to reach what it was set out to do. Additionally, 95% of the respondents felt an added sense of safety through fall detection and location tacking. On a positive conclusion, just short of 95% of the respondents indicated interest in future similar systems, and the concept of AAL. An in depth functionality questionnaire was used to focus more on sole performance of four system features, (i) Fall Detection; (ii) Location Tracking; (iii) Notification Alerts and (iv) Voice Command Recognition.

Analysing the respondents' feedback, it was observed that the system functionalities performed very well. The great majority of the users gave a score of 4 and above. Moreover, the greater portion of the users agreed that the system features did not seem to lack anything in particular, while others pointed out that the AALB could use something more. With respect to the fall detection, suggestions were mostly related to notifying/ calling a pre-set relative number. Some of these suggestions also mentioned incorporating the GPS location with an SMS alert in order to improve the response time of the alerted parties.

The location tracking feature did not favour one or two specific improvements. In fact, this generated the distinct enhancements of, (i) Tracking past locations; (ii) Audio alarms / notifications; (iii) Stating the units for the input parameters; and (iv) Accuracy. The notifications functionality followed a similar approach with four distinct areas which the users pointed out as requiring further working on. Namely these are: (i) Repetitions; (ii) Location orientation; (iii) Voice message / Read back; and (iv) Important updates / relevant information.

It is also worth mentioning that both the location tracking and the notifications functionalities found users that reported that the specific feature worked fine and did not require any kind of change and/or improvement.

In the end, attention was directed at the future of the system and what this might hold for it, with respect to any additional features that the users feel such an AAL system should have. A prominent 80% of the participants pointed out that some additional features such as voice commands, notifications, etc would make the system better.

Once again, apart from all this, it is worth mentioning that a couple of the respondents simply reported that the system does not require any additional features.

5 CONCLUSION

This project involved research which mainly revolved around the areas of ambient assisted living and senior companions. Both of these areas were discovered to be very vast and wide spread, thus the most relevant of the two was put together to get the basic idea for the development of the project's prototype. In fact, the area of AAL provided for the concept of the project in terms of its required functionality, whilst the area of senior companions provided for the feel of the system and its interaction with the target audience.

The AALB brought with it a number of valuable achievements as well as beneficial and helpful lessons. Both of these are regarded to be among the most crucial aspects of the entire project. The valuable achievements accomplished through this project can be derived from the results obtained through the evaluation of the AALB against user feedback. In fact, (i) more than 80% of the respondents were pleased with the system performance, resulting in an overall average of 4.5 out of 5; (ii) just under 95% of the users indicated an added sense of safety through the fall detection and location tracking abilities; and (iii) almost 95% of the users showed a tendency to use a similar system in the future. All of these positive results proved to

be vital with respect to the scientific question as they all managed to show the great potential of AAL. In fact, the AALB was found to be a valid candidate to suit the needs of a future AAL system.

REFERENCES

Beech, R., & Roberts, D. (2008). *Assistive technology and older people.* Social Care Institue for Excellence (SCIE).

Blaschke, C. M., Freddolino, P. P., & Mullen, E. E. (2009). Ageing and technology: a review of the research literature. *The British Journal of Social Work, Vol. 39 No. 4*, 641-656.

Brignell, M., Wootton, R., & Gray, L. (2007, July). The application of telemedicine to geriatric medicine, Vol. 36 Issue 4. *Age & Ageing*, 369-374.

Cowan, D. D., & Turner-Smith, A. (1999). The Role of Assistive Technology in Alternative Models of Care for Older People. *Royal Commission on Long Term Care, 2*, 325-346.

Doughty, K. (2004). Supporting independence: the emerging role of technology. *Housing, Care and Support, Vol. 7 Issue 1*, 11-17.

Fitbit Inc. (2014). *Fitbit Official Site*. Retrieved from fitbit: http://www.fitbit.com/uk/home

Google. (2012, June). *Introducing Google Now*. Retrieved from Google now: http://www.google.com/landing/now/#whatisit

Jia, N. (2009, July). Detecting Human Falls with a 3-Axis Digital Accelerometer. *Analog Dialogue, Vol. 43 Number 7*.

King's Fund. (2001). Consultation Meeting on Assistive Technology. London, United Kingdom: King's Fund.

Kriglstein, S., & Wallner, G. (2005). HOMIE: an artificial companion for elderly people. *CHI '05 Extended Abstracts on Human Factors in Computing Systems*, 2094-2098.

Mezentsev, O. (2005). *Sensor Aiding of HSGPS Pedestrian Navigation* . Calgary, Alberta, Canada: University of Calgary.

Parker G., M., & Thorslund, M. (August 1991). The Use of Technical Aids Among Community-Based Elderly. *American Journal of Occupational Therapy*, 712-718.

Pinto, H., Wilks, Y., Catizone, R., & Dingli, A. (2008). The Senior Companion Multiagent Dialogue System (Short Paper). *7th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 200)* (pp. 1245-1248). Estoril, Portugal: Padgham, Parkes, Müller and Parsons (eds.).

Sernani, P., Claudi, A., Palazzo, L., Dolcini, G., & Dragoni, A. F. (2013). Home Care Expert Systems for Ambient Assisted Living: A Multi-Agent Approach. In C. Workshops (Ed.), *The challenge of Ageing Society: technological roles and opportunities for Artificial Intelligence* (pp. 1-16). Torino, Italy: Universita Politecnica delle Marche.

Sposaro, F., & Tyson, G. (2009). iFall: An android application for fall monitoring and response. *Engineering in Medicine and Biology Society, 2009. EMBC 2009. Annual International Conference of the IEEE* (pp. 6119–6122). Tallahassee, Florida, United States of America: Florida State University.

Spyros, R., Pirros, T., Aimilios, C., & Sotiris, K. (2009). User Interaction Design for a Home-Based Telecare System. In A. Holzinger, & K. Miesenberger, *Human-computer interaction and Usability for eInclusion* (pp. 333-344). Berlin & Heidelberg, Germany: Springer.

Williams, V., Victor, C. R., & McCrindle, R. (2013). It Is Always on Your Mind: Experiences and Perceptions of Falling of Older People and Their Carers and the Potential of a Mobile Falls Detection Device. *Current Gerontology and Geriatrics Research, vol. 2013*, Article ID 295073. Retrieved from doi:10.1155/2013/295073