Virtual Carer: Personalized support for informal caregivers of elderly

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ABSTRACT
Due to the progressive ageing of the world population, new care models are required to maintain elderly's quality of life. These models should include the informal carer (IC) who usually lacks of skills and knowledge to develop assistance tasks. Therefore, support in decision making and informal carer empowerment are crucial to prevent and reduce the burden and stress suffered in the elderly care provided. This paper describes the Virtual Carer system aimed at supporting IC with a set of recommendations adapted to problems suffered in the activities of daily care developed or in daily activities of the older adult. The activities are detected by a set of sensors deployed in older adult's home or a questionnaires to be filled by the IC. The recommendation are sent to IC by means of text messages or email as well as learning videos accessible from e-learning system. As example, a particular use case of the Virtual Carer has been presented to show the information process of problems in IC's sleep patterns.

CCS Concepts
Human-centered computing → Ubiquitous and mobile computing → Ubiquitous and mobile computing theory, concepts and paradigms → Ambient intelligence

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Keywords
Informal carer ict support; personalized recommendation; ambient assisted living, elderly care.

1. INTRODUCTION
Nowadays, the progressive ageing of population makes necessary a personalized care to maintain the older adult's quality of life. The consequent demand of elderly care implies the development of new care models which place the informal carer (IC) as one of the main source of care delivery [1].

The medium-long term care of elderly requests thoroughly the IC involvement (usually the spouse or a close relative), who runs the risk of developing symptoms of depression, stress or fatigue while his/her social, work and economic life can be negatively affected [2]. Moreover, in many occasions the IC is not adequately prepared to face those difficult situations, so he can suffer a great lack of self-confidence. As a consequence of the high psychological burden experienced by IC, an adequate support in care task performance is required to reduce their stress [3]. In addition, the ICs have a wide range of social and care needs apart from psychological support: learning and education; information and care recommendation; social interaction; leisure activities; and work-life balance [4].

On the other hand, the employment of Information and Communication Technologies (ICT) can provide informal carers with new solutions and approaches to satisfy their demands of attention and support [5]. In addition, every IC has particular characteristics which must be considered in the technological solution provided. The ICT services aimed at IC support can be classified into: a) technologies that allow older people to stay at home without continual care support, relieving pressure on carers; b) tools that give remote access to information and training about caring-related issues, such as websites and online training materials; c) personal support and social integration that provide

social, emotional and peer support, social networking systems for peer support and volunteer call networks (mobile, internet); and d) online tools for coordinating care tasks from formal sector and informal and family employed carers, respite, and information sharing [6]. In particular, ICT services aimed at providing a remote access to information about care subjects allow IC to enhance their assistance skills and to increase the sense of security in its performance.

The "Virtual Carer" service described in this paper has been developed in the iCarer project. The project proposes the design and development of a platform aimed at supporting informal carers for reducing their stress level and improving their quality of life. To detect the IC's stress level at an early stage, the iCare platform monitors the psychological status of the IC as well as the activities of daily care (ADC) performed. Then, a set of recommendation are provided to enhance the IC's status considering the problem detected. Moreover, iCarer offers an eLearning service for content sharing and management allowing the IC to enhance those ADC which implies a burden to him.

2. RELATED WORKS

Personalized support for IC implies a key element for maintaining the quality of life of the older adult assisted. In particular, information about care process becomes relevant in IC support and can be associated to monitoring services, alarms and activity reports of the IC and older adult [7].

As example, the eHM Dementia Portal (eHM-DP) [8] is focused on the IC empowerment offering decision support system, personalized data of the older adult's status, and information about care task and IC's health status. The portal implements a knowledge management subsystem to provide personalized health recommendation considering IC's profile and situation.

Moreover, CareNet project [9] proposes an interactive platform which covers IC's needs offering information and guidance of the care process. CareNet promotes an efficient communication between health professionals and IC improving the coordination of care tasks. In addition, CareNet allows to create information tags to catalogue the information and improve the knowledge management in the IC support.

Hossain et. al. [10] present a system for capturing the activity of daily life of older adult by employing monitoring sensors. Next, by applying a set of rules to data monitored, the system is able to determine the kind of support to the older adult and inform the IC about it.

The Virtual Healthcare Neighborhood [11] provides ICs with a set of learning modules about the dementia care area. The modules cover IC's sleep problems, social relation support, and strategies for IC empowerment. The contents are delivered through an interactive blog with social network functionalities and learning videos.

The iCarer platform proposes an advance on the systems introduced providing the IC with personalized recommendations considering their status and care tasks developed as well as the activity of daily life of their older adults. The activities of daily life are detected by a set of sensors deployed in the older adult's home. Apart from the recommendations, iCarer offers learning contents to enhance the IC's status and care provided. As well, the activity of older adult assisted is considered in the learnings content provided to the IC. Finally, iCarer promotes the social interaction of the IC by means of a forum where they can share experiences.

3. VIRTUAL CARER DESCRIPTION

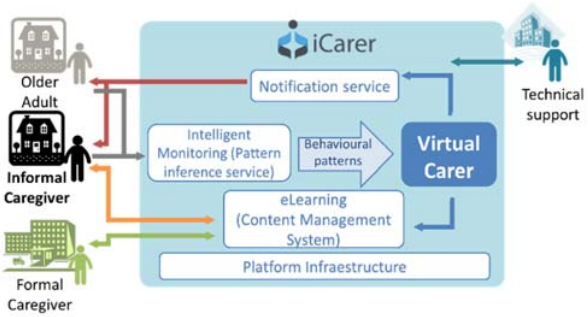

Figure 1: iCarer platform

As Figure 1 shows, the Virtual Carer service is a key element in the iCarer platform [12] because it generates personalized recommendation to ICs depending on their problems, as well as the older adult situation. Following the data flow shown in Figure 1, the behavioural patterns are inferred by applying rules to data of older adult's daily activities captured by home sensors in the *Intelligent Monitoring – Pattern Inference Service* module. Moreover, this module provides IC with a set of questionnaires in order to assess his level of stress. Next, Virtual Carer receives the patterns inferred and detects if a problem exists. If so, a set of instant feedbacks are sent to the IC informing him of the problem and offering a possible solution. Then, the solution is provided through a learning videos accessible in a *Content Management System*, or by means of an email or a phone text message sent by the *Notification Service* module.

In order to create the instant feedback, the Virtual Carer is composed of three phases shown in Figure 2. This three steps methodology consists of extracting the problem's valuable features to create the recommendation (*Input analysis*). Then, the problem's characteristics are processed and a set of metadata is generated to provide the IC with a personalized solution (*Mapping service*). Finally, before sending the recommendation, this is composed considering the previous metadata and the receivers are identified (output creation).

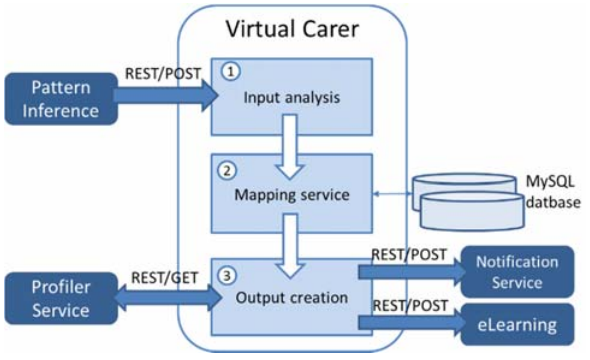

Figure 2: Virtual Carer performance phases

The Virtual Carer system is deployed as a web service to which can be accessed by means of a Representational State Transfer (REST) interface. Thus, by using a post-http request the Virtual Carer will receive the IC's problems detailed in a JSON file. When the problem is received, the recommendation to be provided is inferred by employing a set of queries in a MySQL database where tags of problems and solutions are stored. Next, the recommendation is

described in a JSON file and it is sent to other platform's components through a REST interface.

3.1 Input analysis

The "Input analysis" module is aimed at processing the problem information received from the Pattern Inference service. The information received in JSON file include the following tags: "`DateInferred`" for the timestamp when the problem is inferred; "`Location`" to indicate the place at older adult's home where the problem happened; "`Owner`" to show the user who suffer the problem (older adult or informal carer); "`ProblemLevel`" refers to the problem severity; and "`ProblemKeyword`" and "`ProblemMetadata`" for describe the kind of the problem. Below, an example of IC's sleep problem is depicted:

```
{"DateInferred": "2015-07-21T15:46:00.000",
"Location": "Bedroom",
"Owner": "JOHN-1547-TEST-1234",
"Type": "Problem",
"ProblemKeyword": "Sleep",
"ProblemMetadata": ["Start time below norm",
"Duration below norm"],
"ProblemLevel": "Intermediate"}
```

As two values ("`High`" or "`Intermediate`") are considered in "`ProblemLevel`" tag for describing the problem's severity, the Virtual Carer establish a workflow, shown in Figure 3,depending on the values. If the problem has a high severity, the recommendation is created immediately in order to be sent directly to IC. On the other hand, if the value is "`intermediate`", the Virtual Carer will store the content of "`ProblemKeyword`" and "`ProblemMetadata`" tags. Then, at the end of the day or in a 24 hours period, the recommendation is inferred with the metadata stored.

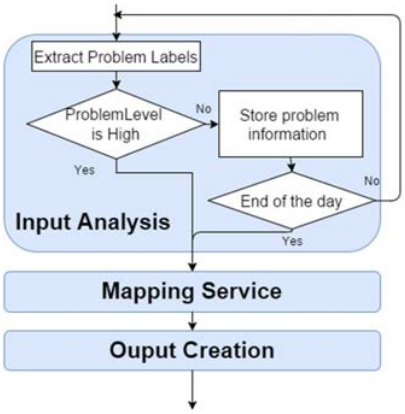

Figure 3: Processing problem workflow considering "ProblemLevel" tag

3.2 Mapping Service

When the problem's information is processed, the tags' contents are sent to "Mapping Service" module where a set of rules are applied to create the recommendation which will be sent to the IC. The rules applied are based on a pair of relational database named "`ProblemTable`" and "`SolutionTable`". Considering the "`ProblemKeyword`" and "`ProblemMetadata`" tags, the mapping service obtain a new value defined "`ProblemIssue`". This value is employed in the "`solutiontable`" data base to extract the metadata, defined "`SolutionTags`", needed to create the suitable recommendation. As example of this process, the Table 1 shows the metadata "`SolutionTags`" as well as values of "`ProblemMetadata`" and its correspondent "`ProblemIssue`" associated to the value "sleep" as "`ProblemKeyword`".

3.3 Output Creation

When the recommendation's metadata have been obtained, the information to be sent to notification and e-learning service is created in the "Output Creation" module.

In addition, this module is responsible to decide the receivers of the information. For that purpose, the tag "`owner`" is processed in order to detect if the problem is suffered by an older adult or an informal carer. In case of an older adult, the module will employ a http get message and request to the "Profiler service" who are the ICs responsible in order to send them the recommendation about how to solve the problem occurred. On the other hand, if the problem belongs to an IC, the recommendation will be sent directly to that IC.

The content of information sent to notification service is composed of: the receiver of the information, the timestamp when the problem occurred, the type of message, and the metadata ("`solutionTags`") correspondent to the recommendation. The e-learning service receives the same kind of information though the recommendation's metadata are substituted by the content of tag "`ProblemKeyword`". Thus, e-learning content provided to IC are related to problems of a specific field (in the example, contents would be aimed at improving the sleep patterns).

4. DISCUSSION AND CONCLUSIONS

The role of the informal carers has become essential in the maintenance of the older adults' quality of life. Therefore, the decision making support and IC empowerment are a key aspects to reduce and prevent the burden and stress suffered by the assistance provided. In particular, the personalized provision of information by using ICT technologies is one of the best benefits appreciated by the IC because it implies a personalized support in care situations and a time reduction in searching information [2].

This paper describes the performance of a personalized IC support system named Virtual Carer. The system provides the IC with a set of recommendation adapted to possible problems which can be suffered by IC during the activities of daily care development, as well as problems occurred in the daily activities of the older adult assisted. Therefore, the behavioural patterns employed to detect a problem are coming from a set of data provided by sensors deployed in older adult's home; or a set of questionnaires aimed at the IC. With the problem's information, The Virtual Carer will decide which is the most suitable information to solve the IC's or older adult's situation.

As many ICs say stress and burden suffered is due to anxiety, depression feeling and sleep problems [11], a particular use case of the Virtual Carer has been presented to show the information process of problems in IC's sleep patterns.

Finally, the Virtual Carer system introduces a progress to other IC support solutions due to the provision of personalized recommendations adapted to problems detected either in the IC's status or in the daily activities of the older adult. In addition, Virtual Carer offers these recommendations by means of simple notifications and e-learning contents. This approach placed the ICs

Table 1: Correspondence between "ProblemIssue" and "SolutionTags"

		ProblemMetadata						
	ProblemKey word: **Sleep**	*Frequency above norm*	*Frequency below norm*	*Duration above norm*	*Duration below norm*	*None Activity*	*Start time above norm*	*Start time below norm*
ProblemIssue	*Sleep Frequency*	-Regular Schedule -Bed Ritual						
	Sleep Duration			-Regular Excercise Routine -Wind Down Body -Mind Relaxing -Forget Problems				
	No sleep					-Visit Doctor		
	Sleep start time						-Regular Schedule -Bed Ritual	

in the centre of the system because they become into the receivers of any support considering their status and older adult's activities.

Furthermore, the iCarer project will be validated considering exclusively problems related to older adult's sleep problems and IC's stress. Therefore, the Virtual Carer's performance could be improved whenever other IC's problem will be considered (diet, physical activity, etc.)

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] E. Pérez-Castrejón and J. J. Andrés-Gutiérrez, "AAL and the Mainstream of Digital Home," in Bio-Inspired Systems: Computational and Ambient Intelligence, Springer, 2009, pp. 1070–1082.

[2] S. Carretero, J. Stewart, and C. Centeno, "Information and communication technologies for informal carers and paid assistants: benefits from micro-, meso-, and macro-levels," Eur. J. Ageing, vol. 12, no. 2, pp. 163–173, Jun. 2015.

[3] K. I. Stajduhar, L. Funk, and L. Outcalt, "Family caregiver learning—how family caregivers learn to provide care at the end of life: A qualitative secondary analysis of four datasets," *Palliat Med*, vol. 27, no. 7, pp. 657–664, Jul. 2013.

[4] V. Fuchsberger, "Ambient assisted living: elderly people's needs and how to face them," in *Proceedings of the 1st ACM international workshop on Semantic ambient media experiences*, 2008, pp. 21–24.

[5] European Health Telematics Association Report, "Sustainable Telemedicine: paradigms for future-proof healthcare", Sustainable Telemedicine Task Force, 2008.

[6] S. Carretero, J. Stewart, C. Centeno, F. Barbabella, A. Schmidt, F. Lamontagne-Godwin, and G. Lamura, "Can technology–based services support long-term care challenges in home care? Analysis of evidence from social innovation good practices across the EU CARICT Project Summary Report," Institute for Prospective and Technological Studies, Joint Research Centre, 2012..

[7] A. S. Hwang, K. N. Truong, J. I. Cameron, E. Lindqvist, L. Nygard, and A. Mihailidis, "Co-Designing Ambient Assisted Living (AAL) Environments: Unravelling the Situated Context of Informal Dementia Care," *Biomed Res. Int.*, p. 720483, 2015.

[8] S. Schaller, V. Marinova-Schmidt, J. Gobin, M. Criegee-Rieck, L. Griebel, S. Engel, V. Stein, E. Graessel, and P. L. Kolominsky-Rabas, "Tailored e-Health services for the dementia care setting: a pilot study of 'eHealthMonitor,'" *BMC Med. Inform. Decis. Mak.*, vol. 15, p. 58, Jul. 2015.

[9] S. L. Fenton, H. D. Covvey, D. W. Mulholland, D. D. Cowan, J. Shamian, and B. Schroeder, "A Web-Based Communities of Practice Support System for Caregivers," in *Medinfo 2007: Proceedings of the 12th World Congress on Health (medical) Informatics, Pts 1 and 2*, vol. 129, K. A. Kuhn, J. R. Warren, and T. Y. Leong, Eds. Amsterdam: I O S Press, 2007, pp. 993–996.

[10] M. A. Hossain and D. T. Ahmed, "Virtual Caregiver: An Ambient-Aware Elderly Monitoring System," IEEE T. Inf. Technol. Biomed., vol. 16, no. 6, pp. 1024–1031, Nov. 2012.

[11] C. Fowler, T. Haney, and C. M. Rutledge, "An Interprofessional Virtual Healthcare Neighborhood for Caregivers of Elderly With Dementia," *JNP-J. Nurse Pract.*, vol. 10, no. 10, pp. 829–834, Dec. 2014.

[12] P. A. Moreno, J. L. Garcia-Pacheco, J. Charvill, A. Lofti, C. Langensiepen, A. Saunders, K. Berckmans, J. Gaspersic, L. Walton, M. Carmona, S. Perez de la Camara, R. Sanchez-de-Madariaga, J. Pozo, A. Munoz, M. Pascual, and E. J. Gomez, "iCarer: AAL for the Informal Carers of the Elderly.," *Studies in health technology and informatics*, vol. 210, pp. 678–80, 2015