Enabling e-services based on affective exergaming, social media and the semantic web: a multitude of projects serving the citizen-centric vision for ICT in support of pHealth

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Abstract

Recent studies and workshops have stressed the fundamental importance of providing harmonised health and social care services that meet the extended needs of the individual, taking into account diversity in need, preferences, ability and support. For a real caring society, the notion of "information sharing" becomes clearly crucial when communication and interaction in health care is needed. This paper revisits recent funded projects undertaken by our team, in view of the so-called coordination of planned activities for elderly/disabled care and independent living support. Three development pillars are taken under consideration herein, namely, affective exergaming services for seniors/disabled, social media and the semantic web. Outputs from a multitude of projects are then used to provide evidence of how issues recently encountered under the so-called blue line dimensions are tackled; these are technological interoperability, semantic integration, modern interfaces, people needs/expectations and societal incentives. As the latter synthesize a con-temporary puzzle of personalised health care approach, this paper provides an innovative perspective of interlinking developments and outputs of research in view of improving healthcare.

Keywords:

Affective computing; exergaming; ambient assisted living; social media; semantic web; linked data; big data; Education; Medical; carer support; personalised healthcare;

Introduction

Cognitive, communication and social impairments are amongst the largest problems of today's European healthcare and economic development. For instance, autism and dementia are among the most significant deficiencies that are associated with hospitalization, extensive and continuous treatment and/or lack of daily functionality and independent living.

European demographic surveys reveal that the number of people aged 65+ has nearly doubled during the last four decades and it is expected that Europe will have around 173 million people aged 65+ by 2050. Realising the critical issues of our ageing society, different initiatives have developed comprehensive RTD roadmaps for active ageing by consolidating and extending existing and emerging technological solutions in close interaction with relevant stakeholders [1]. There has also been a growing focus on the value of ehealth and telecare interventions for improving quality and cost-effectiveness of care for people with long term complex health and social care needs [2].

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Moreover, in a report on the EC Public On-line Consultation, conducted back in 2008 [3], "Health and Social Care Systems" as well as "the Ageing Population" were rated as among the few most important societal challenges requiring ICT innovation over the next decade. In the same report, "Web based services" were identified as the main business applications to drive ICT developments in the next decade, while the notion of integration of subcomponents and systems also seemed to be a key aspect for future ICT developments likewise.

Undoubtedly, we live in a world in change. The following table summarises some of the past and present facts for the ageing society and its web technology support.

Table 1 - Ageing Society and the Web: Past and Present Facts

Id	Past	Present
1	World of people as usual	Ageing Society
2	"Pathetic" use of web (web1.0)	Collaborative/dynamic (web2.0)
3	…of growing information & content	Media/Information rich
4	Data and Information highly unstructured	less unstructured, and linked data / big data (web3.0)
5	Limited non-pharmaceutical trials	Numerous interventions
6	Unfriendly technologies	More user friendly
7	Limited evidence based interventions	In request/need of evidence; evidence builds up slowly but surely
8	Separated ICT from other technologies	Fusion of technologies at user end / integration

In such an environment, the obvious challenge for any government has been to propose ways to extend provision of health and social care services for citizens, while at the same time as improving their quality and reducing costs. Large scale randomised controlled trials of tele-care and e-health have recently demonstrated that these technologies can support quality and efficiency improvements if they are implemented properly [4]. On another front, designers are using inclusive design techniques to find out what older and disabled people find difficult when using current products and services and to incorporate those findings into social services [4].

But according to the Ancient Greek theory of mankind, humans consist of the triptych "Body, mind, soul/psyche". So, how can contemporary technology and research exploit this

fact? Is there a scope for introducing the notion of emotions into the design of social services? Can they play a role and prove to be useful in ageing or in assistance to disabled?

Recent reviews on affective medicine [5] and the growing research interest worldwide for this new domain provide an affirmative answer to the aforementioned questions.

In tandem to the above views, the society has witnessed the explosion of social media and their inevitable incorporation in health care and social support. However, the use of all kinds of technological artefacts for electronic and mobile health, and personal health systems generate an ever increasing amount of data, recently denoted as "big data" [6].

So, the aim of this paper is threefold. First to re-examine recent research outputs and current research developments undertaken in funded projects; second, to collate the developed therein enabling e-services along the notions of emotion, physical and cognitive training, gaming, social networking and the semantic web services; finally, through this multitude of projects, to synthesise a vision of sustainably serving the citizen through the use of ICT, thereby supporting the key role and prospects of personalised health (pHealth).

Materials and Methods

A recent analysis by the Casemix project, has identified five (5) major issues, which are key factors when considering a holistic approach of the delivery of health and social services. Jacob Hofdijk used the notion of "a Hug and a Kiss" to illustrate that the systems in question are mainly to improve the quality of life [7]. The notion of "blue line dimensions" was coined in to model this approach. These dimensions are technological interoperability, semantic integration, modern man-machine interfaces, people needs and expectations and societal incentives. So in essence, the concept of the Blue Line, was engineered to link the different dimensions created and provide the base to link people, systems and approaches [7].

Horizontally to this concept, three technological development pillars are taken under consideration herein, namely: (i) affective exergaming, that is emotion and affect fused with physical and cognitive exercises through computer games; (ii) social services for seniors and disabled through social media; (iii) the integrative and interoperable role of semantic web services in exploiting the richness of big data.

This paper uses the following funded projects, listed in Table 2, as a vehicle in touching upon the aforementioned dimensions.

Table 2 - Funded research projects under consideration (co-ordinated by the author)

Id	Project Name and website	Key Objectives/Goals
1	Affection, (kedip.med.auth.gr/affection)	Develop the scientific basis for emotion detection from multi-modal data; demonstrate avatars and services that exploit emotion recognition
2	Autism (kedip.med.auth.gr/autism)	To create a web based game like communication platform facilitating an emotional (responsive) avatar
3	STHENOS	to develop human-centered computers, which will be able to understand the human state (identity, emotions and motions) using audio-visual and biological signals. Use them in the form of assistive computing systems which support aged/disabled/chronic patients
4	mEducator, (www.meducator.net)	Create two technological frameworks one based on mash-up technologies and one based on semantic web (linked-data) services in order to allow for an effective searching, retrieval and sharing of educational resources
5	Long Lasting Memories (LLM), (http://www.longlastingmemories.eu/)	Provide an integrated ICT platform which: combines state-of-the-art cognitive exercises with physical activity; prove through pilot trials that this is effective against age related cognitive decline.
6	USEFIL	Assist elderly living alone while inspiring feelings of safety, self-confidence, security; encourage elderly to become/remain socially involved; Enable unobtrusive data collection, security and privacy & Intelligent classification of data, emotion detection, trending & Medical professional involvement through a robust Decision Support System
7	DISCOVER, (http://www.discover4carers.eu)	To create a new service to deliver digital skills training for carers; integrate the existing systems and provide access to rich digital skills learning experiences. It tackles 3 main issues: increased digital competences and engagement of social inclusion actors (carers); increased use of ICT solutions for delivering social support and care; and raising the profile of social inclusion work.

The analysing view

Pillar 1: emotions and affective exergaming

We have previously touched upon the role of emotions. Affective computing (AC) is the scientific discipline that is concerned with emotional interactions performed with and through computers. It is defined as "computing that relates to, arises from, or deliberately influences emotions" [5]. Perhaps one of the most significant issues within AC is the underlying relation between emotions and human health, both mental and physical. Moreover, as human emotions may be expressed and communicated through various channels like text (contextual information), audio (speech), face expressions and body gestures (visual) and internal physiological changes (blood pressure, skin sweating, etc.), one could effectively use such communication tips and realize contemporary interactions through multimodal sensing and expressing of affect. It is generally true, that if something makes people happier, they would like to use it frequently; at the end of the day, it is good for human health. It also true that regular physical exercise, significantly improves physical functioning of individuals at any age. Engagement of elderly individuals in regular physical exercise programs has demonstrated improvement in cognition and psychological well being among other benefits [8].

So, if one has robust scientific methods and tools to study emotions (detect, recognise, classify, identify its origin etc) (Table 2: Affection and Sthenos projects), then it is easy to explore different ways of exploiting the emotions; for example, one can imagine its subsequent fusion with systems like avatars (Table 2: Affection and Autism projects) and devices like physical activity equipment (Table 2: LLM project) or interactive Smart TVs or slate tablet PCs (Table 2: USEFIL project).

For the activities to become even more attractive to users projects like the above use the notion of digital gaming, supporting user experience informed by principles of gameplay, narratives and simulations. A serious game is most widely understood as a digital game having purposes other than pure entertainment (sometimes called edutainment=education + entertainment) [9] or exergaming= (physical) exercise + gaming [10].

Pillar 2: social services for seniors and disabled through social media

A social network constitutes the collection of interpersonal ties that individuals maintain and that provide them with several possible benefits, such as the augmentation of self-concept, fostering of feelings of belonging, and the provision of cognitive guidance and tangible assistance in fulfilling the tasks of daily living. Online social networks currently lie at the research frontier with respect to older persons and usability. There are technical barriers to entry that must be levelled. Beyond that, specifically with respect to social networks, there is a cultural context that needs to be understood.

Experience provides evidence that the main reason for the older or a disabled person's exclusion so far from ICT advances, is associated with the fact that they do not or cannot use to the same degree IT and communication technologies which are used by mainly younger or healthier/normal people. This is mostly attributed to the fact that these tools are too difficult to be managed or understood by older persons. Coining in the aspect of ease of use interfaces in the form of avatar agents (Table 2: Affection project) or a sensible level of emotional touch (Table 2: LLM project) has been found to be beneficial.

Moreover, it is true that virtual communities (i.e. groups of people connecting via web) are beginning to form in relation to disease or illness. However, a classification of online social networks is still missing with respect to the functionality/service available via these individual social media tools. Interventions or studies that attempt to extrapolate how different 'affordances' offered by various social networks are associated with specific needs of groups of patients are still missing. This affects the mode of interaction as well. By utilising social media as a health management tool one could reflect on this and improve the approach (Table 2: Sthenos and LLM projects).

Moreover, other forms of social media and particularly semantic wikis have been lately been used by different online health related professional and educational services. Semantic wikis further extent the usual notion of a collaborative Wiki with the incorporation of "semantic technologies" (i.e. the notion of exploiting and enriching existing navigational links with symbols that describe their meaning, that is semantic annotations [11]. Capitalising on such technologies, recent research endeavours have allowed for and presented contemporary tools designed to aid doctors and patients in identifying interventions commonly associated with specific attributes (e.g. diagnoses) [12] (Table 2: mEducator project). In that way activities needed to implement and document care as provided to the individual patient may be entered into a portal through a "Wikipedia-like" web-based tool that provides methods for organizing thought processes for clinical decision making, or delivery of individualized patient care, or simply support of the carer through guidelines (Table 2: DISCOVER project).

Pillar 3: semantic web services in exploiting the richness of big data

"The era of Big Data has begun" [6]. A multitude of scientists from different disciplines are clamoring for access to the massive quantities of information produced by and about people, things and their interactions. The semantic web was developed to provide a "smart" solution to this end, that is for linking and searching data and resources. This takes place through the connection of structured data that arise either from an application or from primary descriptions of data, i.e. Linked data [13]. Emphasis has now been shifted on the connectivity of knowledge, information and resources. Resources from different repositories may now be connected and related. To this extend the mEducator project (Table 2) [14, 15] has upgraded resource sharing, retrieving, re-using and repurposing to the era of semantic web while maintaining key assets of the social web/media. In this way, like in the case of semantic wikis, web resources may be linked with information from non-pharmaceutical healthcare interventions (for seniors or disabled) or even with more formal/clinical interventions/trials or even drug trial results. By maintaining collaborative technologies (web 2.0) in the loop (see Table 2: mEducator), the user sharing experience is fostered.

Figure 1 is attempting a collating view of Table 2, as well as, the afore-described details, in an illustrative and synthesising manner. For instance, the obtained background scientific knowledge on emotions (Affection, Sthenos, Autism) may be exploited for the integration of emotion or person status/situation detection (USEFIL); and result into a suggested feedback or prompting for an intervention (LLM); enriched with knowledge and experience sharing in terms of

educational semantic material (mEducator) will end up at a library of experience for caregivers where the caregivers will act both as the educator and as the learner/student (DISCOVER).

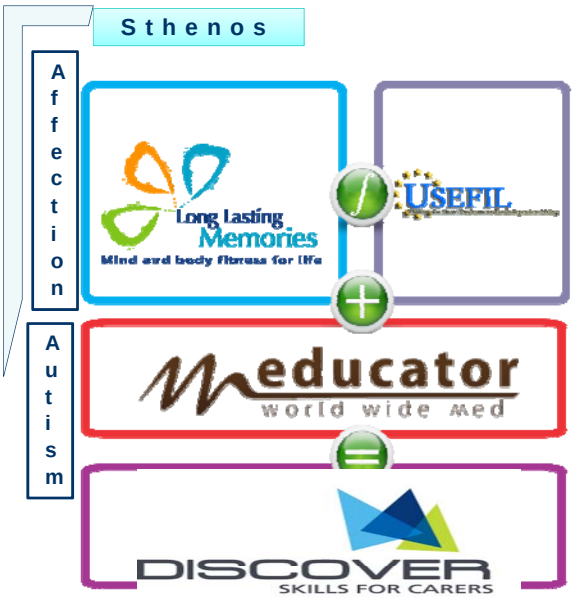

Figure 1 - A synthesised view of the projects

The synthesising view

The newly released eHealth Action Plan aims at addressing and removing different barriers for the applicability of e-health and tele-care. It clarifies the policy domain and outlines the vision for eHealth in Europe, in line with the objectives of the Europe 2020 Strategy and the Digital Agenda for Europe [15], and addresses the following operational objectives:

-achieving wider interoperability of eHealth services;

-supporting research, development and innovation in eHealth and wellbeing to address the lack of availability of user-friendly tools and services;

-facilitating uptake and ensuring wider deployment;

-promoting policy dialogue and international cooperation on eHealth at global level.

Although there is one-to-one correspondence between the above mentioned Blue Line dimensions, there is an obvious overlap. But let us attempt to itemise these dimensions again in Table 3 and link them with the advances, developments or impacts the afore described projects have brought about.

Table 3 - Relation of projects to Blue Line dimensions

#	"Blue Line Dimension" [7]	Project Attributes / achivements considered
1	technological interoperability	Development of modular (and open) architectures; XML based web services; scalable solutions
2	semantic integration	Use of ontological schemata; semantic annotations of collaborative/dynamic (web2.0) data and information; semantic web services; linked data principles
3	modern man-machine interfaces (or else humans and society)	Media/Information rich multi-modal interactions; affective interfaces; human like avatar interfaces
4	people needs and expectations	Inclusion principles; emphasis on improving quality of life through measured interventions
5	societal incentives	Start from personal incentives; design systems that make people happier and more sociable; measure effect through trials and indices

For instance, there is common belief regarding the beneficial role of physical activity on mood, anxiety and depression. Several studies have attempted to improve the socioemotional skills of older people and to neutralize their negative feelings through physical activity intervention programs. Despite reporting an antidepressive and anxiolytic effect, they failed to come to a definitive conclusion due to the lack of a concrete methodological framework. In the LLM project, the system design followed but also the pilots deployment has provided evidence for a wide acceptance of the system by its senior users, as well as, effective end results against depression and its associated cognitive decline [16, 17, 18]. The following figure is attempting to illustrate the above synthesis by linking the blue line dimensions to the various projects we have been involved.

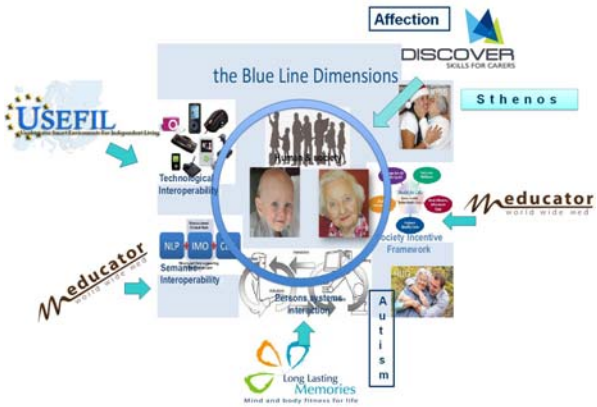

Figure 2 - A synthesised view of the projects along the five (5) blue line dimensions

Discussion

This visionary paper has attempted to demonstrate that innovative and contemporary technological approaches (the three pillars used in the analysisng view) may give rise to systems that serve the society in the prescribed (by formal policy documents) way.

It is obvious that a closer look at the societal needs and a more detailed analysis of the problem under consideration is going to provide the scientific community with many key recipes for the future advancement of personalised health systems.

Key issues to consider every time, and in view of the above descriptions are the following though:

1. There exists great tools /enabling technologies available, but are they marketable, sustainable and effective ?

2. How does one filter which of them is suitable for his/her needs? This is where one needs scientifically sound methodologies to measure the impact in all different aspects (health, business, technically etc)

3. It is usually the proper combination of technologies/interventions that may be innovative but also more effective. The excellent results produced by the LLM project example provides a useful example and tutorial on how one could adjust effectiveness measures according to needs.

4. pHealth systems need to create measurable added values but also synergies between different disciplines.

5. There is always a dilemma between innovation versus simplicity and/or application of known systems. Moreover, there is always a fight or dilemma of doing business or science (especially in recent recession and financial crisis times). Key solution to this end though seems to be (stemming from our current from experience) that exploitation of scientific and technological innovation may lead to proper (and sustainable) business solutions which may in turn fight against recession effectively.

Finally, if some advice is to be drawn on how to address the issue of the incentive based policy changes that are much needed nowadays to redesign health and social care provision and really emphasise it person-centered prospects, then that could be first based on a holistic approach. That is, one needs to consider contemporary tools to initiate the process of change (paradigm changes); in addition one should also follow technology changes (continuously) with transparent user utterances, while allowing for easy access, flexible (customisable) and easy to use systems. last but not least, a key concept remains the constant need to evaluate extensively. To this end, trials/interventions with measured outcomes would provide the necessary evidence much needed for pHealth systems today.

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