Leveraging Web 2.0 and Consumer Devices for Improving Elderlies' Health

Jaspaljeet Singh Dhillion
Department of Computer Science
University of Auckland
Private Bag 92019, Auckland,
New Zealand
jran055@aucklanduni.ac.nz

Christof Lutteroth
Department of Computer Science
University of Auckland
Private Bag 92019, Auckland,
New Zealand
lutteroth@cs.auckland.ac.nz

Burkhard C. Wünsche
Department of Computer Science
University of Auckland
Private Bag 92019, Auckland,
New Zealand
burkhard@cs.auckland.ac.nz

Abstract

With a growing elderly population in many developed countries, technologies for supporting elderly healthcare are becoming more and more important. As technologies such as the Web and consumer level devices evolve, this opens up new opportunities for telehealthcare. In this paper, we discuss how the paradigm known as the Web 2.0 can be leveraged to develop solutions that are more patient-centric and empower the patients, especially the elderly, to manage their own health from home. We critically analyse popular Web 2.0 health applications and propose a framework for overcoming their shortcomings. Furthermore, we describe how consumer level devices such as off-the-shelf computers and motion sensing input devices can be used to make telehealthcare more accessible and affordable. Devices such as iPhones and the Wiimote controllers can enable patients to perform rehabilitation and prevention activities such as exercises at home. We argue that by combining the potentials of Web 2.0 and new consumer devices, a more holistic approach to telehealthcare can be achieved.

Keywords: patient networks, motion input, telehealth

1 Introduction

The web is becoming the ultimate resource for health information. Evidence from Elkin (2008) suggests that health consumers are increasingly depending on the Web to look for health information. The survey also indicates that most people (75% of the respondents) look for information about a specific condition, disease or symptom. Likewise, Fox (2006) found that 80% of adult Internet users in America (about 113 million people) have searched for health information in 2006. Besides this, people are increasingly moving beyond passive searches to interactive forums, blogs, and other social media. This trend is often referred to as Web 2.0.

Web 2.0 is commonly known as "the web as a platform" (O'Reilly 2005, Anderson 2007) and is associated with web applications and services that facilitate interactive information sharing, rich user experience, dynamic content and user-centred design. Increasingly, more websites are built upon these ideas and are transforming the Web from a simple place to store information to a dynamic place where people regularly gather and interact. Examples of Web 2.0 include social networking sites, blogs, wikis, multimedia sharing sites, hosted services, web applications, mashups and folksonomies. The use of Web 2.0 in healthcare is evolving as more applications and services targeting health professionals and patients are being developed. With that trend, the term Health 2.0 (also referred as Medicine 2.0) is becoming popular.

One of the most significant and current discussions in the healthcare sector is about empowering patients to manage, i.e. maintain or improve, their own health. There has been significant interest of researchers and system designers to develop patient-focussed health systems oriented towards this goal. Some examples of Web 2.0 applications include PatientsLikeMe, CureTogether, DailyStrength, Disaboom, SugarStas, and DailyBurn. These applications provide direct patient support, promote disease awareness, and encourage positive and proactive behaviours to stay healthy. According to Sarasohn-Kahn (2008), online peer support is also attractive to older adults and those living with chronic conditions, particularly if it is delivered on technology that is familiar and convenient.

Likewise, telehealth and telecare solutions are rapidly gaining in popularity because of their promise to use existing health care resources more effectively. They aim to lower costs and enable health consumers to transmit health data to clinicians from home. Onor et al. (2008) indicates that in one of the primary target groups, the elderly, the satisfaction with telecare is significantly higher compared to daycare centers or nursing homes. However, as Dishman (2004) points out, there are fundamental concerns that telehealth systems are mostly focussed on treating disease, rather than preventing it. Many existing telehealth systems, as analysed by Singh et al. (2010a), suffer from high initial costs, cannot be extended by third parties, and require extra costs to add new functionalities. They also do not address the social and psychological needs of the patient.

Recently, Elder Brief (2010) reported on an easy-to-use emotional networking platform developed by Emota, which uses touch screen Internet tablets and picture frames in a cartoon-like format to help seniors maintain closeness and mutual awareness with their loved ones. This product is aimed to tackle isolation, which is a huge issue for elderly people living alone. However, products like this one still exhibit many of the disadvantages pointed out above.

Web 2.0 health applications and services are rapidly gaining attention from patients and professionals, as they have the potential to extend traditional healthcare delivery models, empower patient self-care and provide social support. The increasing numbers of registered members of healthcare websites indicate that patients are starting to manage their health online: independently, with peers, with online affinity communities and with medical professionals. According to Swan (2009), most patient-focused social health networks offer the basic level of service, emotional support and information sharing, for a variety of medical conditions. Most Web 2.0 health applications and services have an emphasis on communication, information sharing and community. The Web has evolved from supporting health information seeking to support health-motivated social communication, and it is time to offer also health applications that support proactive healthcare, i.e. that actively engage users in healthcare activities.

Instead of expecting health consumers to purchase expensive devices to engage them in their own healthcare, we claim that it is possible to provide affordable healthcare to consumers by leveraging mainstream consumer devices. Such devices include personal computers, webcams, iPhones and Wii controllers. Consumers are more likely to use devices they already have with them or in their home to take care of their health, rather than buying special hardware. Furthermore, we claim that the integration of Web 2.0 healthcare approaches with device-supported approaches for proactive healthcare is a crucial step to make telehealth more accessible and more effective for elderly.

To support these statements, we evaluate existing popular Web 2.0 health applications from a patient perspective and discuss their strengths and weaknesses. Based on the results we propose a novel framework for a ubiquitous patient-centric, web-based telehealth system, which is designed to be unobtrusive and enable patients to improve their own health. We believe that such a system will be an important contribution to patient networks, especially for the elderly, to improve health and to address social isolation. Furthermore, we discuss how consumer devices can be leveraged to enable dynamic interaction and exercise for elderly users.

Section 2 motivates the need of Web 2.0 applications that are specifically designed for the elderly. Section 3 reviews and analyses Web 2.0 health applications, which are grouped into 3 categories: health information interchange, social networking, and health monitoring. Section 4 discusses shortcomings of these applications with regard to telehealth for the elderly. We introduce our own approach for building an elderly-freindly telehealth system in Section 5. We discuss in this section how we can leverage Web 2.0 and consumer devices for developing health applications, rather than building a system from scratch. We conclude the paper in Section 6.

2 Motivation

The demographics of frequent Internet surfers vary from region to region. Usually they are assumed to be young, college-educated, middle class, suburban living individuals. However, this perceived demographic description fails to address a section of the population, the elderly, who have a significant impact on online media and social networking. Elderly are usually classified as the age group that generally covers individuals from 65 years upward.

The impact of elderly on the media is somewhat significant, but often does not get the amount of attention that is justly deserved. In a recent report in Generations Online 2009 by the Pew Internet & American Life Project, Jones (2009) states that the fastest growth in Internet use is being driven by the older age groups, starting at 55. Interestingly, the 70-75 year-old age group has increased its Internet use more than any other group since 2005. While just over one-fourth (26%) of 70-75 year olds were online in 2005, 45% of that age group are currently online. Increasingly, elderly users are searching for health information over the web. According to Jones (2009), researching health information is the third most popular online activity with the most senior age group, after email and online search.

However, current research shows that the elderly are not utilizing existing social networking websites such as Facebook and MySpace, as compared to the younger group of users. Findings of Jones (2009) highlight that instant messaging, social networking, and blogging have gained ground as communications tools, but email remains the most popular online activity, particularly among older internet users. Survey results of Fox (2009) show that only 7% of adults 65 and older have posted profiles on online social networks. Statistics from Inside Facebook, by Smith (2010) clearly show that the 55-65 year-old age group represents the smallest group of Facebook users, only 7% of the total user population. Facebook crosses 60 million monthly American users, but according to Smith (2009), they seem to face challenges in retaining older users as fewer users of age over 55 are returning to the site. Most of the Web 2.0 health applications are created for a general audience, meaning that they not designed with elderly in mind.

3 Health 2.0 Today

There is a variety of Web 2.0 patient-focused health applications and services available to health consumers. Some of them successfully empower, engage, and educate their users. As the large and growing number of registered members illustrates, such systems are gaining popularity. As a result, it is importat to look at them and reflect on the services and benefits they provide.

This section analyses some of the most popular web health applications, dividing them into the following groups: applications for health information interchange, which help patients to find health-related information; social networking applications that help patients to communicate with other patients suffering from similar conditions; and health monitoring applications that help users to keep track of their own health.

3.1 Health Information Interchange

One of the characteristics of Web 2.0 applications is the ability to leverage the collective knowledge of its users. Applications for health information interchange do so

with the aim of providing disease-related information, in most cases directly from the people concerned.

These applications are mainly designed to educate patients on various diseases, symptoms and treatments via other patients that have experienced the same health condition. Conditions are often presented with easy-to-understand graphs or charts, which are based on health data aggregated from many patients. Some websites also produce good reports and summaries for patients. They frequently enable patients to connect with other patients, e.g. by posting comments to other patients' health data.

3.1.1 PatientsLikeMe

According to Domingo (2010), PatientsLikeMe is a social networking website with more than 58,000 registered patients as of March 2010. Patients are organised by disease, and share information about treatments and symptoms of various life-alerting diseases, experience with drug side effects, and how to improve their lives. Patients' health records are made available to other users on the site, which raises privacy concerns.

There are free tools for patients to track their medications, symptoms, and health outcomes. The health information is presented with easy-to-read charts that enable members to search for medical profiles that best match their own. The site empowers patients to compare their health progress, treatments and dosage levels with other patients on the network. The site makes money by selling the data to drug companies.

PatientsLikeMe also allows patients to help other patients to deal with their diseases. Patients, especially those experiencing a life threatening disease, can freely and honestly share their sufferings on the website, and other patients can reply and provide emotional support. Hence the site supports lonely users, by making them feel less isolated. Users can also print a "doctor sheet" that summarizes their health progress. However, the main function of the site is that of information aggregation.

3.1.2 CureTogether

According to Domingo (2010), CureTogether is a community based health site whereby patients and researchers come together to share information and help to find cures for some of the most painful, prevalent, and chronic conditions. As of as of March 2010, it has 7,200 registered patients. CureTogether helps people to anonymously track and compare health data, to better understand their bodies, make more informed treatment decisions, and contribute data to research. It started with three conditions (Migraine, Endometriosis and Vulvodynia), and according to Carmichael (2009), it was expanded to support up to 228 diseases as people wrote in to request that their conditions should be added to this ongoing study. It enables patients to connect with other patients that most closely match their health conditions. Registered patients get access to condition reports. The health information is presented with easy-to-understand charts, which are systematically categorised as symptoms, treatments, causes and related conditions.

3.2 Social Networking

Whereas the sites described in the last section focus on health information, the ones described in this section have as a focus the social interaction between their users. Social networking applications provide users with emotional support to cope with their health condition. They allow patients, especially elderly and disabled people, to share their pain and socialise with others on the network. Users can mostly communicate via mail, posting comments and chatting. For house-bound patients, the network provides a social life they might otherwise not have.

3.2.1 DailyStrength

DailyStrength is a social network focused on helping people overcome health and life challenges through advice and friendly support. Over 500 support groups organized around specific diseases are hosted on this web site. Users can find detailed information on treatments and symptoms, in addition to professional and reliable health advice. Users can also describe their experiences and share the successes or failures they have had with different treatments. Tools to set goals and vote on the effectiveness of treatments are available. On the main page users find a list of popular support groups, the latest activity on the website, the latest topics in the "ask an expert" section, a Facebook section, and a DailyStrength store section. The website organizes its content under the main categories of support groups, expert advice, treatment, and people. Users can find links on the bottom of the webpage that target specific issues.

One of the most popular features on the site is a "virtual hug". A member's profile page will keep track of all their friends, messages from other members, their journal entries and all the hugs they receive in their "hug book". The website also contains a chat bar that allows users to speak to each other in real time and perform other tasks.

3.2.2 Disaboom

Disaboom is a social networking website dedicated to improving the way individuals with disabilities live their lives. As of March 2010, it has about 100,000 members. Disaboom gives handicapped individuals a space to make friends, and discuss day-to-day challenges. Furthermore, it helps to locate trustworthy sources for all types of life issues, ranging from rehabilitation advice and pain management to finding jobs or enriching family relationships. Members are provided with tools to blog, participate in discussion boards, and engage in real-time chat.

Domingo (2010) reports that Disaboom is vital for users who are not able to leave their homes or feel alone in their health struggles. Users, while remaining at home, are able to watch movies with one another, chatting online while watching.

3.3 Health Monitoring

Health monitoring sites help users to keep track of health-related parameters, visualize them, and share that data with others. They empower patients to track any progress towards their health and fitness goals. Most of the applications allow access to and input of health data from anywhere through mobile devices.

3.3.1 SugarStats

SugarStats is a web-based blood-sugar tracker and diabetes management system. Users are provided with a simple interface to track, monitor and access their glucose levels and diabetic statistics to spot dangerous trends and better manage their diabetic health. SugarStats enables users to input and access their data via mobile phone, email and Twitter. Users can track blood sugar glucose levels along with the elements that effect those levels such as medication, food intake and physical activity. They can then share this information with health care professionals, family and friends to get further support and advice.

3.3.2 DailyBurn

DailyBurn is an online application dedicated to helping people reach their fitness goals. According to Wauters (2010), it has about 500,000 members. DailyBurn helps users to lose weight and gain muscle by tracking their workouts and the food they consume. The site offers a database of foods, allowing users to quickly figure out how many calories they have eaten throughout the day. Users can input data about their daily exercise regime (number of miles run, bench-press weight, etc.), so they can track their progress over time using graphs. DailyBurn also offers an iPhone application that allow users to track and update their progress through their phone.

Apart from tracking fitness goals such as pounds lost and changes in resting heart rate, users can participate in DailyBurn's social network. Group-designed workouts and challenges give them fresh and interesting goals. Users can plan meals, and keep track of successes and problems in a training journal. Users can find a partner to motivate them, track their results.

4 Web 2.0 and the Elderly

The emphasis of Web 2.0 health applications and services has been on communication, information sharing and community, rather than tackling the bigger challenges such as providing medical diagnosis or treating disease over the web. The latter is much more difficult because it usually requires input from certified experts. However, early diagnosis and treatment of health conditions is a crucial element for elderly people's healthcare.

The applications discussed above are created with a single objective in mind: either to educate patients, to provide social support or to monitor health parameters. None of the popular applications provides all three types of functionalities. However, for a system to be truly effective and have a holistic impact on health, it needs to offer most of the important functionalities such as education, monitoring, diagnosis, rehabilitation and social support. For elderly people, it is often not feasible to work with many different systems, and a single integrated user interface is necessary (Singh et al, 2010a).

Furthermore, the health applications described above are created for people who are comfortable with computers, but they are not suitable for elderly who have special usability requirements. However, elderly are disproportionately more affected with chronic health problems, physical and mental challenges, and loneliness. They could benefit tremendously from the Web 2.0, if it could be made more accessible to them.

The popular websites that encourage a proactive approach to prevent disease, maintain or improve health such as DailyBurn, are not suitable for elderly. General exercises are often too hard for elderly people, and typical health conditions of elderly people require special types of exercises. For instance, patients suffering from Parkinson disease need support for performing hand exercises to improve the mobility of their hands. Active participation such as computer-supported exercise is an important function of elderly healthcare, which is not well supported in today's information-centric Web 2.0.

5 A Telehealth Framework for the Elderly

Based on the shortcomings indentified in the previous section, we propose a framework for a novel web-based telehealth system, *Healthcare4Life*, which is illustrated in Figure 1.

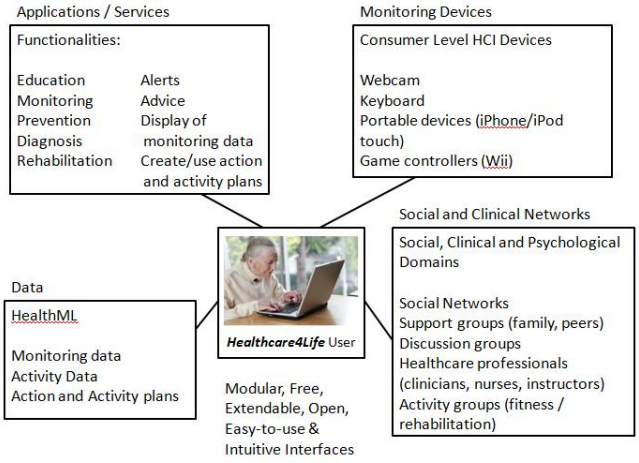

Figure 1: Framework for Healthcare4Life (Singh et al, 2010a)

Healthcare4life is a web-based framework that combines the power of social networking with telehealth systems in empowering patients, especially the elderly, to manage their health independently from home. It addresses the restrictions of traditional telehealth systems, and aims at making telehealth for the elderly more widely available, affordable and extendable. Similar to existing health 2.0 systems, it tries to encourage positive lifestyle change by letting elderlies manage their own healthcare goals.

Healthcare4Life promotes social networks over clinical networks to motivate users, especially the elderly, to take control of their health and to address social isolation. Similar to the social networking applications discussed above, it serves as a medium of interaction between patients. Patients suffering from the same disease are able to share experiences, and most importantly, do exercise together via a video link or in a virtual environment.

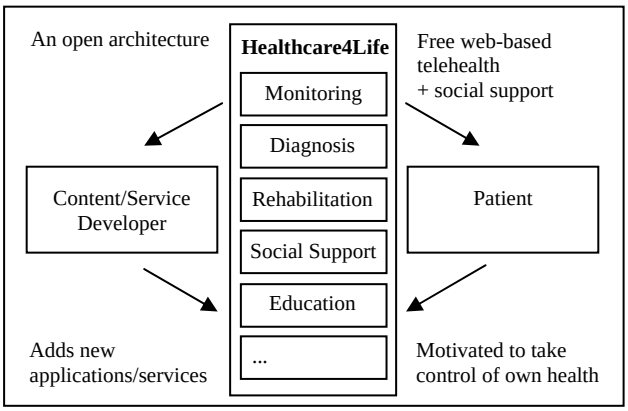

Figure 2: Overview of how Healthcare4Life functions on the surface level

Similar to Facebook, the framework has an open architecture that enables third-party providers to add new content and functionalities (see Figure 2). Applications added into Healthcare4Life fall into the following categories: monitoring, diagnosis, education, rehabilitation and social support. Developers can design applications for these categories in the form of serious games, interactive web pages and expert systems. Unlike existing social networking websites that mainly focus on 'just for fun' or advertisement-based applications, it aims at attracting serious developers to build and share health related applications with patients. Developers get useful feedback from potential users through a ranking system, which displays user satisfaction and the popularity of each service.

To keep overheads low, the framework supports the usage of common consumer level HCI devices such as webcam, keyboard, iPhone, and Wii remote controller with the system. To date, we have developed two iPhone games (discussed in section 5.3) that enable users to perform rehabilitation exercises for the elbow and shoulder joints.

The Healthcare4Life framework can be used in developing extendable ubiquitous patient-centric systems. Currently, the framework is being employed to implement a web-based telehealth system. The system is currently at a prototyping stage. A systematic assessment will be conducted to test the system at elderly community centres using interviews, system usage data, and questionnaires. A summative evaluation will be executed, i.e. evaluation will be done after the system has been developed completely.

Since our system targets the elderlies, usability testing is crucial to ensure that the system meets their expectations (Singh et al, 2010b). The evaluation will mainly focus on two aspects of user experience: performance and satisfaction. User performance is about measuring the ability of the user to successfully accomplish a set of planned tasks (Tullis & Albert, 2008). The user performance will be evaluated by measuring how hard it is for elderly to perform typical tasks in the system, e.g. how long they take to access health information. This is done through session recording, which can be integrated into a web-based system such as ours relatively easily (Weber 2008). User satisfaction refers to how the user feels about the interaction with the system (e.g. if it is easy to use, or confusing).

5.1 Leveraging the Web 2.0

Weitzel et al. (2009) have illustrated the use of Web 2.0 technology in providing extended care networks for chronic disease management and elderly care. Recently, Weitzel et al. (2010) have presented a Web 2.0 model for patient-centred health informatics applications. The suggested model uses open technologies such as OpenSocial, REST, and Open Authentication. OpenSocial is an emerging standard that defines a component model for browsers, called gadgets, as well as APIs for accessing a person's profile, activities, and relationships, such as friends. The model has good potential in creating a standards-based platform to create rich, highly interactive, community-oriented websites that can easily embed third-party applications. This model is used for Healthcare4Life, in order to create a platform that has the ability to integrate with other social networking websites (such as Orkut and MySpace) and enables developers to add content and functionalities into the system.

It is important to realize that it is extremely hard to create an entirely new social network that satisfies the needs of the elderly. However, it is possible to leverage existing networks and adapt them so that they become accessible to the elderly. Recently, Ko et al. (2010) reported about the connect services major social-networking sites have launched, e.g. Facebook platform, Google Friend Connect, and MySpaceID. They enable third-party sites to develop social applications and extend their services without having to host or build their own social network. These extensions allow third-party sites to leverage the social-networking site's features.

Jaffe (2010) describes tools such as Facebook open graph and others, called social plugins for third-party websites, which enable web developers to extend the social experience of visitors on their site. For example, third-party sites can exploit the authentication services provided by Facebook so that users need not create another username and password to access the third-party site. That is, the users can draw on their credentials from Facebook and their established profile.

Two other promising plugins include an Activity Feed, which gives users live updates of their Facebook friends' activities on that site, and a Live Stream, which acts as a Facebook "wall" embedded on the site and allows for users to comment and post discussion pieces during a live event to the website.

Open Graph, according to Axon (2010), will allow Facebook and participating websites to use social information to customize each visiting experience. For example, if the user has stated a preference on Facebook for a certain kind of music or food, another site can use that information to highlight certain content. Hence, by intergrating Facebook's social features Healthcare4Life will enable elderly to connect with their family, especially grandchildren that have Facebook accounts.

Rather than trying to recreate large amounts of existing functionality, the functions of other Web 2.0 applications can be leveraged as well. Such applications are could be useful for elderly if they were adapted to

their user interface and specific content requirements. For example, DailyBurn offers a public API, allowing third-parties to integrate with this website. Rather than tracking burnt calories, this functionality could also be used to track range-of-motion, or other parameters that are more relevant for elderlies. For real-time communication, the Skype API provides a mechanism for 3rd-party scripts and applications to control Skype UI functions, and implement additional or improved features to complement Skype. The API has two layers: The Communication Layer is a set of methods for external applications to establish a connection to a Skype client and communicate with it. The Command Protocol Layer is a text-based "language" that external applications can use to speak to a Skype client, once communication channel is established by Communication Layer. Although APIs that are not entirely web-based are harder to integrate, there are still possibilities to do so, e.g. with the help of browser plug-ins.

5.2 Leveraging Mainstream Consumer Devices

The recent proliferation of motion sensing devices such as iPhone and Wii Remote makes it possible to leverage such devices for healthcare. They can be used to allow patients to perform guided rehabilitation activities to improve their condition, as part of a telehealth system. These devices contain motion sensors such as accelerometers that can measure positions, velocity and direction vectors. This opens up a whole new dimension of human-computer interaction.

For example, the iPhone is ideally suited for developing innovative health monitoring and support tools due to its mobility. This would benefit busy people who are always on the run as well as home-bound patients, such as many elderlies. Besides accelerometers, many mobile devices also support natural input through touch screens. These components allow us to design user interfaces for people that can be operated using their fingers, or rotating and moving the device.

Recently, we have developed and tested two iPhone games to support patients to perform rehabilitation exercises involving the arm's joints and muscles. The game fulfils two purposes at once: therapy and monitoring (Sunwoo et al., 2010). The games use the accelerometer, which allows users to control the game by swinging or flicking their device, similar to those on the Wii.

In one of the games, the player is presented with an environment similar to a real blowing game (see Figure 3). The game rules are based on the real bowling game, so that elderly people can enjoy playing a familiar game. The game is simply played by swinging the phone using the shoulder, just like what people would do in a real bowling game, hence exercising the shoulder joint.

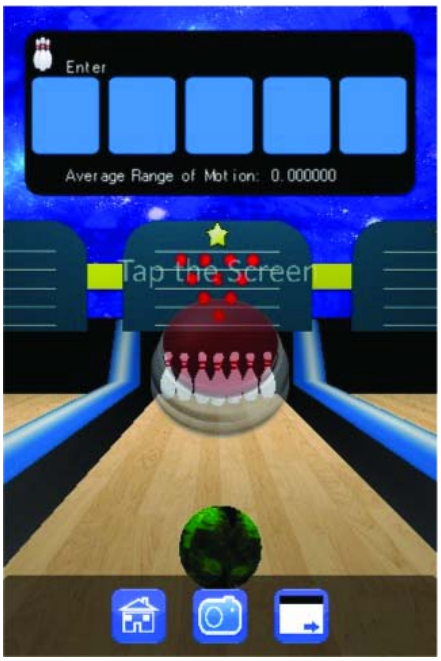

Figure 3: Screenshot of the Bowling game (Sunwoo et al., 2010)

Wii remotes are inexpensive wireless input device. The Wii has a controller which has accelerometers inside and this allows actions to be converted into movement on the screen. Although it is primarily designed as an input device for the Nintendo Wii console, various other systems have used them as an input device. For example, Alankus et al. (2010) demonstrated the use Wii remote to detect arm motions for stroke rehabilitation.

Also standard webcam technology can be leveraged to support patients to perform rehabilitation activities at their homes. A low-cost webcam can be used to capture video data of a user's movement. Burke et al. (2009) reports the use of webcam games for stroke rehabilitation. The games were designed to promote gross arm movements in order to aid upper limb rehabilitation. The main advantage of using the webcam is that the user is not required to have any experience with computers. This is advantageous for elderly as many of them face anxiety when confronted with technology.

6 Conclusion

We have analysed popular Web 2.0 health systems, classified them according to their main functionality and discussed some of their strengths and weakness. Existing patient-focused health systems are mostly based on information sharing, but provide only limited user interaction. They do not yet enable proactive healthcare for elderly users.

We proposed Healthcare4Life, which has a focus on enabling elderlies to manage their own health, by performing and monitoring rehabilitation activities. In this paper, we discussed how existing Web 2.0 resources and consumer devices can be leveraged to achieve this goal. As it turns out, there are technologies that allow us to integrate many of the functionalities of existing Health 2.0 systems. By adapting them to the special requirements of elderly people, Health 2.0 can be made more accessible to this important target group.

7 References

Anderson, P. (2007): What is Web 2.0? Ideas, Technologies and Implications for Education. JISC Technology & Standards Watch. http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf Accessed 27 August 2010

Alankus, G., Lazar, A., May, M., Kelleher, C. (2010): Towards Customizable Games for Stroke Rehabilitation. *Proc of the 28th international conference on Human factors in computing systems*, Atlanta, Georgia, USA, 2113-2122, ACM.

Axon, S. (2010): Facebook's Open Graph Personalizes the Web, Mashable. http://mashable.com/2010/04/21/facebook-open-graph/ Accessed 27 August 2010.

Burke, J., McNeill, M., Charles, D., Morrow, P., Crosbie, J., and McDonough, S. (2009): Serious Games for Upper Limb Rehabilitation Following Stroke. VSGAMES '09, 103-110.

CureTogether: The Collective Wall, CureTogether – CureTogether.com, Inc. http://www.CureTogether.com/. Accessed 27 August 2010.

Carmichael, A. (2009): Crowdsourced Women's Health Books Released by CureTogether. Lifeboat Foundation. http://lifeboat.com/blog/tag/CureTogether Accessed 27 August 2010.

DailyBurn: Burn Fat, Lose Weigth and Gain Mussle – DailyBurn Daily Burn, Inc. https://dailyburn.com/. Accessed 30 August 2010.

DailyStrength: Online Support Groups and Forums at DailyStrength, DailyStrength, Inc. http://www.dailystrength.org/. Accessed 27 August 2010.

Domingo, M.C. (2010): Managing Healthcare through Social Networks. Computer **43**(7): 20-25.

Dishman E. (2004): Inventing wellness systems for aging in place. Computer, **37**(5):34–4.

Disaboom: Connecting the Millions Touched by Disability - Disaboom, Disaboom.com. http://www.disaboom.com/. Accessed 27 August 2010.

Elder Brief (2010): Emota: Bridging the Gap Between Emotion and Technology. Elder Brief. http://elderbrief.wordpress.com/2010/05/02/emota-bridging-the-gap-between-emotion-and-technology/ Accessed 27 August 2010.

Elkin, N. (2008): How America Searches: Health and Wellnes. iCrossing. http://www.icrossing.com/research/how-amer¬ica-searches-health-and-wellness.php.

Fox, S. (2006): Online Health Search 2006. Pew Internet & American Life Project. http://www.pewinternet.org/~/media//Files/Reports/2006/PIP_Online_Health_2006.pdf Accessed 27 August 2010.

Fox, S. (2009): The Social Life of Health Information. Pew Internet & American Life Project. http://www.pewinternet.org/Reports/2009/8-The-Social-Life-of-Health-Information/04-The-Social-Life-of-Health-Information/2-Social-networking-sites-are-used-only-sparingly-for-health-queries.aspx?r=1 Accessed 27 August 2010.

Jaffe, A. (2010): Facebook Social Plugins and Open Graph: What they mean for online newspapers http://www.editorsweblog.org/analysis/2010/04/facebook_social_plugins_and_open_graph_w.php Accessed 27 August 2010.

Jones, S., Fox, S. (2009): Generations Online in 2009. Pew Internet & American Life Project. http://pewresearch.org/pubs/1093/generations-online Accessed 27 August 2010.

Ko, M. N., Cheek, G. P., Shehab, M. And Sandhu, R. (2010): Social-Networks Connect Services. Computer **43**(8): 37-43.

O'Reilly, T. (2005): What Is Web 2.0. Design Patterns and Business Models for the Next Generation of Software. http://oreilly.com/web2/archive/what-is-web-20.html?page=1 Accessed 27 August 2010.

Onor, M. L., Trevisiol, M., Urciuoli, O., Misan, S., Bertossi, F., Tirone, G., Aguglia, E., Pascolo-Fabrici, E. (2008): Effectiveness of Telecare in Elderly Populations – A Comparison of Three Settings, Telemedicine and e-Health, **14**(2): 164-169.

PatientsLikeMe: Patients Helping Patients Live Better Every Day, PatientsLikeMe Inc. http://www.PatientsLikeMe.com/. Accessed 27 August 2010.

Sarasohn-Kahn, J. (2008): The Wisdom of Patients: Healthcare Meets Online Social Media. California Healthcare Foundation. http://www.chcf.org/~/media/Files/PDF/H/HealthCareSocialMedia.pdf Accessed 27 August 2010.

Singh, J., Wünsche, B. C. and Lutteroth, C. (2010a): Framework for Healthcare4Life - A Ubiquitous Patient-Centric Telehealth System. *ACM SIGCHI New Zealand Chapter's International Conference on Computer-Human Interaction*.

Singh, J., Wünsche, B. C. and Lutteroth, C. (2010b): A Taxonomy of Usability Requirements for Home Telehealth Systems. *ACM SIGCHI New Zealand Chapter's International Conference on Computer-Human Interaction*.

Smith, J. (2010): December Data on Facebook's US Growth by Age and Gender: Beyond 100 Million. Inside Facebook. http://www.insidefacebook.com/2010/01/04/december-data-on-facebook's-us-growth-by-age-and-gender-beyond-100-million/ Accessed 27 August 2010.

Smith, J. (2009): Facebook Crosses 60 Million Monthly US Users, But Fewer People Over 55 Coming Back. Inside Facebook. http://www.insidefacebook.com/2009/05/26/facebook-crosses-60-million-monthly-us-users-but-fewer-people-over-55-coming-back/ Accessed 27 August 2010.

Sunwoo, J., Yuen, W., Lutteroth, C. and Wünsche, B. (2010): Mobile Games for Elderly Healthcare. ACM SIGCHI New Zealand Chapter's International Conference on Computer-Human Interaction.

Swan, M. (2009): Emerging Patient-Driven Health Care Models: An Examination of Health Social Networks, Consumer Personalized Medicine and Quantified Self-Tracking, Int. J. Environ. Res. Public Health, **6**: 492-525.

Tullis, T. and Albert, B. (2008): *Measuring the User Experience - Collecting, Analyzing, and Presenting Usability Metrics*. Elsevier, Morgan Kaufmann.

Wauters, R. (2010): IAC Buys Into Fitness Social Network DailyBurn. TechCrunch. http://techcrunch.com/2010/05/20/iac-dailyburn/ Accessed 27 August 2010.

Weber, G. (2008): A Platform-Independent Approach for Auditing Information Systems. Second Australasian Workshop on Health Data and Knowledge Management (HDKM 2008). Wollongong, NSW, Australia. **80**: 65-73.

Weitzel, M., Smith, A., Lee, D., Deugd, S., Yates, R. (2010): A Web 2.0 Model for Patient-Centered Health Informatics Applications. Computer **43**(7): 43-50.

Weitzel, M., Smith, A., Lee, D., Deugd, S., Helal, S. (2009): Participatory Medicine: Leveraging Social Networks in Telehealth Solutions. In: Mokhtari, M., Khalil, I., Bauchet, J., Zhang, D., Nugent, C. (eds.) ICOST 2009. LNCS, **5597**: 40–47. Springer, Heidelberg.