

Persuasive Mobile Health Applications

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Abstract. With many industrialized societies bearing the cost of an increasingly sedentary lifestyle on the health of their populations there is a need to find new ways of encouraging physical activity to promote better health and well being. With the increasing power of mobile phones and the recent emergence of personal heart rate monitors, aimed at dedicated amateur runners, there is now a possibility to develop “Persuasive Mobile Health Applications” to promote well being through the use of real-time physiological data and persuade users to adopt a healthier lifestyle. In this paper we present a novel general health monitoring software for mobile phones called Heart Angel. This software is aimed at helping users monitor, record, as well as improve their fitness level through built-in cardio-respiratory tests, a location tracking application for analyzing heart rate exertion over time and location, and a fun mobile-exergame called Health Defender.

Keywords: eHealth¹, Persuasive, Exercise, Mobile.

1 Introduction

It is well accepted that the increasing sedentary lifestyle of many industrialized societies is helping fuel the dramatic rises in type 2 diabetes, chronic heart disease and obesity. In the UK it has been reported across the various News media that recent estimates suggest that over 60% of males and 50% of females will be clinically obese by 2050, and that 40% of school age children are overweight or obese. In addition to this, depression and mental ill health is set to be one of the fastest growing conditions in UK with 1 in 6 of the population suffering from a neurotic disorder [7]. Whilst the overall reasons for this are may seem complex there is one simple thing we can all do to improve this situation, exercise.

Exercise not only makes the body stronger, fitter and more flexible. It also helps to reduce the risk of illnesses such as heart disease and stroke, the latter being the greatest single cause for severe disability in the UK [9]. It is widely recommended by experts that everybody should undergo at least 30 minutes of mild exercise 5 times a week, but with our ever increasing busy life styles we try to find new ways in which to persuasively encourage people to undertake such physical exercise.

In the early years of this decade health clubs were at the peak of their popularity with around 8.7 million members in Britain, though numbers have been falling

¹ eHealth 2008, September 8th and 9th, 2008, City University, London EC1.

rapidly in recent years. Surveys show that 6 months after joining there is a dropout rate of around 60%, and that near 20% of members only attend once a month [10]. With attendance to health clubs dropping, new technologies are arising to try to promote individual personal exercising.

Nike and Apple joined forces to release Nike+ iPod Sports Kit which calculates distance and pace for a walk or run while storing and relaying back the data to the user as they listen to music. The data can later be uploaded to Nike's website for analysis, as well as sharing and comparing it to other members of the community. Similarly Adidas and Samsung released miCoach, which consists of a specific Samsung mobile phone connected to a heart rate monitor and external stride sensor with very similar functionalities to the Nike+. Both approaches are great at monitoring physical exercise though limiting as they are principally targeting users already involved in physical activities, required to purchase specific gadgets that can only be used together. With the increasing power of mobile phones and the ability to connect them between emerging health monitoring devices, as well as their adaptability to the mobile health sector [5], is making it possible to develop and deploy mobile health promoting applications at low prices to an ever growing mobile community.

Persuasive technologies [2] can be described as those that attempt to change user attitudes and behavior in some way or another. In this paper we present a novel persuasive mobile health application called Heart Angel intended to encourage users to assess, monitor and improve their fitness level.

2 Heart Angel

Heart Angel is a structured exercise and health monitoring application written in J2ME developed to help people measure, monitor, record, and improve their personal health whether starting or already indulged in physical activities. This is achieved through in-built cardio-respiratory tests, a HR and position tracking application, or a mini-game inspired by the old arcade classic Space Invaders called Health Defender. The application makes use of a Bluetooth enabled mobile phone connected to a Heart Rate Monitor (HRM), as well as an inbuilt Global Positioning System (GPS) receiver to collect data on users HR, as well as location trail.

Heart Angel incorporates a series of tests developed to measure and improve health. Users can choose between a 3 minute Step-Test, or the recognized Rockport Test, to measure and monitor their current fitness level. Results can be saved to a text file for future analysis and interpretation through the application itself, or downloaded to a personal computer.

Users requiring a detailed analysis of performance can use the phones inbuilt GPS receiver together with the HRM. This allows data on HR at a given time for a given location to be recorded at 2 second intervals and then saved as a text file on the device for download. Exertion Maps can then be drawn for analysis seeing when, where, and why, exertion was highest during workouts. Multiple workouts for the same circuit can then be analyzed over time to observe improvements in performance.

In the following paragraphs we present the different cardio-respiratory workouts incorporated in the application, as well as how Heart Angel tries to persuasively encourage users to exercise on a regular basis through real-time physiological data and results feedback. Further development to the application will also be discussed.

2.1 Connectivity

To make use of the Heart Angel application users are required to enable Bluetooth connectivity on their mobile phones, as well as strapping up to the Alive Technologies HRM Chest Strap, as shown in Fig. 1. Initial testing showed that the HRM was prone to errors due to the nature of the connection between the Chest Straps and a user's skin, as well as friction generated between these when users where in motion. Dampening the area of contact minimized the frequency and range of the errors, but a five value filtered average for HR was implemented for HR feedback.



Fig. 1. Alive Technologies HRM Chest-Strap connected to phone via Bluetooth

2.2 Cardio-Respiratory Workouts

Heart Angel provides a selection of workouts from which users can calculate, monitor, and improve their physical fitness. Following is a description on each focusing on their functionality.

2.2.1 Tecumseh Step-Test

This is the simplest cardio-respiratory workout available for calculating user fitness level. Users are required to enter details on gender and age, and have the option to save their results for future interpretation through the application it self, or download to a personal computer.

When ready, users perform a 3min step-test performing a four-step cycle (R-foot UP, L-foot UP, R-foot DOWN, L-foot DOWN) ideally completing an average of 24 cycles in one minute on an 8inch (20cm) bench/step. An inbuilt pace keeper can be enabled by users to help them keep to this pace. Once completed user HR is captured, and their subsequent results calculated and displayed on the phones screen. During the cardio-respiratory test the last 115 HR values for a user are displayed via a line graph at the top of the screen, allowing users to visualize HR exertion over time.

2.2.2 Rockport Test

Users can also perform the internationally recognised cardio-respiratory test, The Rockport Test in which they are required to walk a distance of one mile as fast as possible. As in the Tecumseh Step-Test, users are required to enter data on gender, age as well as weight, and choose whether to save their results for future comparisons.

When completed the walk, users stop the workout and a measure of their current fitness level as well as their VO_2MAX^2 is displayed, see Fig. 2 leftmost screenshot. Again the last 115 HR values for a user are displayed via a line graph at the top of the screen, allowing users to visualize HR exertion over time.

To try to ensure that results are as accurate as possible, the application makes use of a running filter which collects user HR every 15 seconds as well as at workout completion. Such filter tries to minimise errors due to users increasing their pace near completion, giving a higher than normal final HR.

2.2.3 Free-Jog

For users more concerned in analysing and comparing past and future workouts whether it be walking, jogging or cycling, Heart Angel includes its “Free-Jog” application which allows use of a GPS receiver. Users are required to enter details on age and resting HR, entered manually or automatically collected via the HRM, as well as being able to enter a description on their location which will be saved along with the results.

By knowing a user’s resting HR and age it is possible to calculate their maximum HR and consequently their different HR Training Zones. This information is then relayed back in real-time to the user through a pie chart displayed on the mobile phone’s screen showing at what Training Zone intensity they are currently working at as well as the linked health benefit it carries. The last 115 HR values for a user are again displayed via a line graph at the top of the screen, allowing users to visualize HR exertion over time, see Fig. 2 rightmost screenshot.

Through the use of the inbuilt GPS receiver, data on user position can be collected together with current HR and time. This data is saved at 2 second intervals to a text

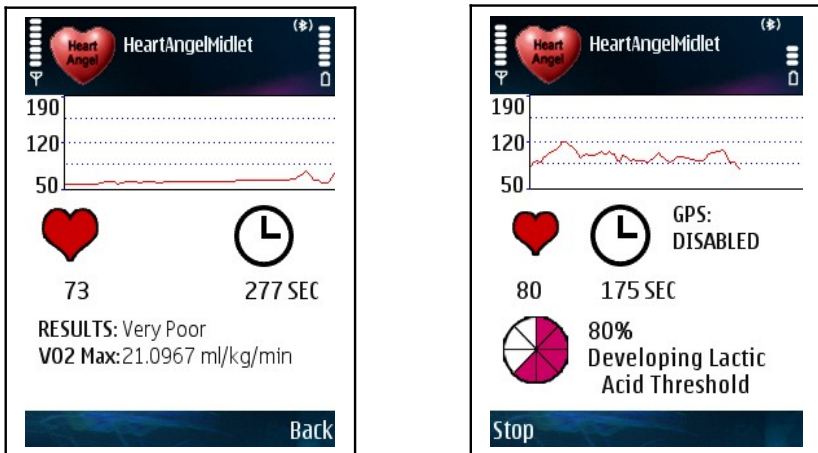


Fig. 2. Rockport-Test (left) & Free-Jog (right) display and result layouts

² The volume of oxygen that can be consumed while exercising at maximum capacity, or the maximum amount of oxygen in millilitres that can be consumed in one minute per kilogram of body weight.

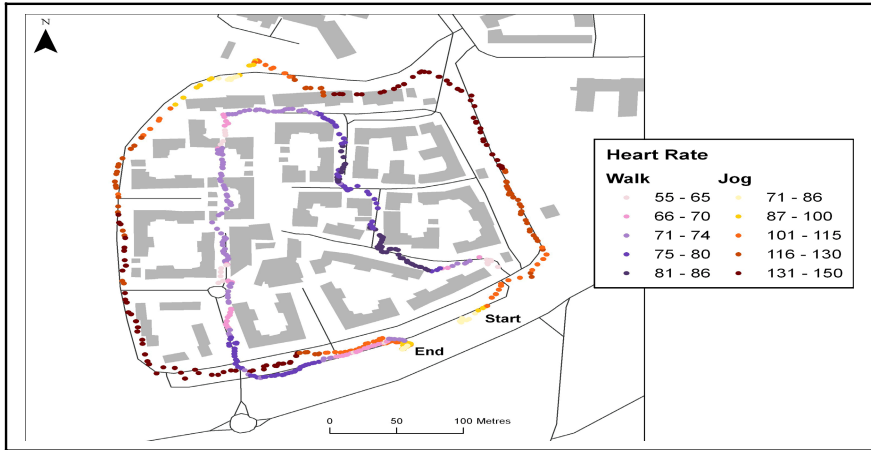


Fig. 3. Exertion Map showing two routes for Lancaster University's SW Campus³

file on the mobile phone's memory for download. From such file it is then possible to draw Exertion Maps for individual or multiple workouts and have a much improved visual representation of HR exertion over time and location. Though Heart Angel does not provide the means to plot such graphs, Fig. 3 represents an exertion map showing two different routes for Lancaster University's South-West Campus in which HR exertion can be analysed with knowledge of the terrain.

2.2.4 Health Defender Exergame

Health Defender is an Exergame inspired in the old classic Space Invaders which makes use of a HRM to collect and relay real-time HR data back to a player. Such data is used to inform users on their current HR exertion during game play, and trigger Bonus events. It is through these bonuses that Health Defender tries to encourage users to physically exercise by raising their HR to obtain such bonus. The objective of the application is to encourage players to exercise during game play to both improve gaming experience, as well as personal health [3].

2.3 Persuasive Physical Exercise through User Feedback

Heart Angel tries to persuade users to keep using the application, and therefore continue exercising, by providing real-time feedback on user current HR exertion and relative HR Training Zone. Users have a real-time visual representation of the intensity at which they are exercising at together with a report on the health benefit that exercising at such intensity is providing them. By reporting such information to users while actively involved in the physical workout, these are encouraged to either maintain or further increase their physical exertion as they are reassured that a physical benefit is being achieved.

Allowing users to keep track of past workout results is also important to allow for observations in any physical fitness improvement. Before initializing any of the

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inbuilt cardio-respiratory test users may choose to save their results for future interpretation and analysis through the application itself, or downloaded to a computer. This allows users to conduct weekly or monthly tests, compare their results and observe any improvements in fitness, which in turn encourages users to carry on exercising due to improvements being observed.

3 Further Work

Through interpretation of the HRM inbuilt Accelerometers it would be possible to calculate user pace, and encourage users to increase it by matching beat of a music track to their own foot fall. It would also be possible to count the number of strides a user takes and with knowledge of their average stride length estimate the distance covered for a workout. The average number of calories burned could then also be calculated and relayed back to the users while exercising. By relaying back this additional information Section 2.3 is further developed by encouraging users to further indulge into physical exercise. The use of the accelerometer data would also make it possible to further accessorise user workouts by introducing specific exercises such as crunches or push-ups verified by the application.

The discussed version of Heart Angel has been designed as a personal assistant to help in the assessment and improvement of personal fitness. But just as data is saved to a mobile phone, it would be easily possible to allow for network data transmission of such data back to GP's. Through the use of 2.5 and 3G technologies it is possible to safely transmit user real-time physiological data after or during workouts over the wireless network for their interpretation and monitoring of GP's [4, 8]. This would help minimise on site patient health monitoring visits and allow users to perform their assessments in whatever location was most convenient for them while relaying progress and results back to GPs.

Finding the time to be able to perform structured exercise, where HR is elevated for long periods of time, is less probable every day that goes by. Our ever increasing busy life styles prevent us from taking much time off, and less people are using such time for exercising. By introducing opportunistic physical activity feedback, incorporation of physical activities into everyday lifestyle to increase the overall level of activity, it would be possible to further encourage users to exercise while going about their everyday lives. By informing users on the total number of steps taken and calories burned in a normal day, it would be possible to encouraged users to further increase their calories burned by, for example, taking the stairs as oppose to an elevators. Natural human competitiveness could then be used to further encourage exercise by allowing comparison of results between users in nearby areas, though data shared should be limited to purely performance data, such as steps taken or calories burned, and not personal such as weight or age [1].

4 Conclusion

With people no longer turning to health clubs as a means of getting and keeping fit but rather choosing to perform their own workouts whenever convenient for them, it

is necessary to come up with genuine ways in which to assess, monitor, encourage and promote well being through physical exercise, structured or opportunistic. With mobile phone technology ever improving, and the number of applications we find on these growing, mobiles have become the ultimate gadget for work as well as entertainment. With the development of external health monitoring devices and the increasing connectivity of mobiles it is now possible to pair up such devices to promote personal health.

Heart Angel effectively allows users to convert their already acquired and daily used mobile phone into a mobile personal trainer with the only extra cost of acquiring a HRM. Users can decide to firstly assess their current fitness level against recognised cardio-respiratory tests, and then monitor any improvements to their fitness level at their own convenience carrying no extra gadgets other than their own mobile phone and a HRM. The ability to assess user fitness level through the application allows users to obtain a standardised measure of their current fitness level, as oppose to judging how fit they may be based on their relative performances during workouts, and therefore observe and measure improvements. Heart Angel allows using mobile phone functionalities without any limitations or restrictions so users can listen to their favourite music using their phones inbuilt mp3 player while running the application, as well as making and receiving phone calls.

Monitoring and promoting personal health through the use of technology should not be limited to an economically segmented minority required to purchase the latest specialised equipment. Rather it should be widely available to all that posses a mobile phone that meets a set of basic requirements. The discussed version of Heart Angel does necessitate the use of an inbuilt GPS receiver to obtain location coordinates, but this is not a basic requirement to operate the software and so users can still obtain the maximum health benefit from the application. Not only is the cost of monitoring physical exercise drastically reduced by limiting the number of specialised exercising gadgets users are required to purchase, but users can go round their everyday lives carrying a personal trainer at the touch of a button while using their already purchased, daily used mobile phone.

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References

1. Consolvo, S., Everitt, K., Smith, I., Landay James, A.: Design Requirements for Technologies that Encourage Physical Activity. In: Proceedings of the SIGCHI conference on Human Factors in computing systems, Montréal, Québec, Canada, April 22-27, 2006, pp. 457–466 (2006)
2. Fogg, B.J.: Persuasive computers: perspectives and research directions. In: Proceedings of the SIGCHI conference on Human factors in computing systems, Los Angeles, California, United States, April 18-23, 1998, pp. 225–232 (1998)

3. Garcia Wylie, C., Coulton, P.: Mobile Exergaming. In: ACE 2008, Yokohama, Japan, December 3–5 (2008)
4. Konstantas, D., Jones, V., Bults, R., Herzog, R.: MobiHealth - Innovative 2.5 / 3G mobile services and applications for healthcare, 11th IST Mobile and Wireless Telecommunications Summit 2002, Thessaloniki, Greece, June 16-19 (2002)
5. Laca Jose, C.: Cell Phones and Tele-Medicine. In: Proceedings of Healthcom 2003, the Fifth International Workshop on Enterprise Networking and Computing in Healthcare Industry; Santa Monica, California (June 2003)
6. Marti, R., Delgado, J.: Security in a Wireless Mobile Health Care System, Universitat Pompeu Fabra – white paper (2003)
7. Rashid, O., Coulton, P., Bird, W.: Using NFC to Support and Encourage Green Exercise. In: Proceedings of the 2nd International Conference on Pervasive Computing Technologies for Healthcare 2008, Tampere, Finland, 30 January - 1 February (2008)
8. Varshney, U.: Using wireless technologies in healthcare. *International Journal of Mobile Communications* 4(3), 354–368 (2006)
9. BBC Health, <http://www.bbc.co.uk/health/conditions/stroke/>
10. Times Online, Britons are leaving the gym, March 4 (2008), http://www.timesonline.co.uk/tol/life_and_style/health/features/article3476487.ece