NEAT-o-Games: Exertion Interface Interwoven in Daily Life

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Abstract

This paper describes research that aims to encourage physical activity through a novel pervasive gaming paradigm. Data from wearable accelerometers are logged wirelessly to a cell phone and control the animation of an avatar that represents the player in a virtual race game with other players over the cellular network. Winners are declared every day and players with an excess of activity points can spend some to get hints in mental games of the suite, like Sudoku. The racing game runs in the background throughout the day and every little move counts. As the gaming platform is embedded in the daily routine of players, it may act as a strong behavioral modifier and increase everyday physical activity other than volitional sporting exercise. Such physical activity (e.g., taking the stairs), is termed NEAT and was shown to play a major role in obesity prevention and intervention. A pilot experiment demonstrates that players are engaged in NEAT-o-Games and become more physically active while having a good dosage of fun.

Keywords

Pervasive Gaming, Wearable Sensors, Ubiquitous Computing, NEAT, Exertion Interfaces, Obesity Prevention, Obesity Intervention

Figure 1: Users enjoying NEAT-o-Games. Two upper screenshots depict home screens. Lower ones are the two different NEAT-o-Games currently offered. NEAT-o-Race on the left, and NEAT-o-Sudoku on the right.

Figure 2: NEAT-o-Games system

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

The importance of obesity to world health is without question. There are 1 billion people in the world who are overweight and 300 million with obesity. Recent work suggests that this is driven by a reduction in energy expenditure, rather than a rise in energy intake.

Non-Exercise Activity Thermogenesis (NEAT) is the energy expenditure of all physical activities other than volitional sporting-like exercise. NEAT is highly variable among individuals. NEAT in an agricultural job exceeds that for an office job by 1,500 kcal/day. Similarly, an evening of television watching expends 30 kcal whereas an evening of gardening and walking the dog expends 600 kcal. This marked variability in NEAT supports the notion that is fundamental in energy balance. [1]

The ultimate goal of this research is to increase NEAT in the modern lifestyle. The most difficult and important part is how to motivate people to change something as fundamental as their everyday habits. Sedentariness is almost addictive and is reinforced by the specifications of the modern work and leisure environments. Well-designed exertion interface applications may serve as orthotics [2]. The so-called NEAT-o-Games (see Figure 1) are envisioned as a collection of cell phone games where `activity points' may be earned and consumed across the game space. We implemented two games so far, the NEAT-o-Race and NEAT-o-Sudoku game.

Methodology

We use a tri-axial accelerometer, built in our lab, to measure physical activity. The form factor of the sensor is similar to a mobile phone and is typically attached to the waist of the user, since that is closer to the mass center of the human body (see Figure 2). The sensor is driven by a rechargeable Lithium Polymer (Li-Poly) battery that lasts up to 7 hours when the device is active. It communicates with a Palm Treo 700w/wx phone through a Bluetooth connection. Measurements are recorded four times every second and are correlates of the energy expended by the user due to motion at the time. Concurrently, these data are transmitted to an SQL Server database through cellular broadband or Wi-Fi. Thus, the systems of other NEAT-o-Games players can access these data and make competitive real-time racing possible. There are currently two games in the suite – NEAT-o-Race and NEAT-o-Sudoku.

NEAT-o-Race

NEAT-o-Race is indispensable in the NEAT-o-Games system. When the player moves, the corresponding avatar also moves and activity points are accumulated. The player can select his/her opponent from the "buddy list," and compete for activity points. NEAT-o-Race bouts last typically 24 hours, although longer periods can be selected from the user interface. (Figure 1 down-left)

NEAT-o-Sudoku

Sudoku is a logic-based number placement puzzle. The objective is to fill a 9x9 grid so that each column, each row, and each of the nine 3x3 constituent blocks contains the digits from 1 to 9. As many puzzle games, Sudoku may become frustrating at times, In NEAT-o-
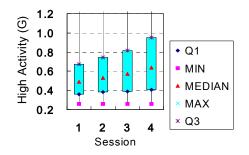
Figure 3: High activity box plots.

Selective verbatim user comments

"Neat-o-Games will help me exercise more! Now when I play Neat-o-Games I take the stairs to go to the 5th floor where my office is, instead of an elevator. I want to beat my opponent!!!!"

"When using Neat-o-Games I want to stand up and keep moving while I work!! This concept is truly innovative!!"

"Neat-o-Games are ok. When the games go on without any software or hardware bugs it is a real pleasure!! Sometimes, though, when bugs occur I just want to throw the system out my window."

Sudoku, a convenient `hint function' is provided that can rescue the player out of this situation as long as he/she has been active enough and has some points 'in the bank' from the racing game. This hint operation requires a certain amount of activity points to be subtracted from the players' activity account. Deposits on this account are being realized through the racing game and can be consumed in the NEAT-o-Sudoku game. (Figure1 down-right)

Evaluation

Eight participants (7 males, 1 female) were recruited from the University of Houston campus. The experiment consisted of 4 sessions. Each session included one weekday and one weekend day. In *session 1 (Baseline)*, the participants were asked to carry around the NEAT-o-Games set (PDA + sensor). The system recorded their usual physical activity levels and the baseline was established. In *session 2 (Emulator)*, the player's avatar was competing with a computer animated avatar in a virtual race. In *session3 (Energy Race)*, the competing avatar was the proxy of an actual player ('buddy') from the player pool that participated in the study. For each duo, a daily winner was proclaimed based on the activity scores logged by the corresponding players. In *session 4 (Sudoku)*, each participant played competitively against his/her buddy as in session 3. This time, however, the player had the option to spend activity points gathered during the daily race to get hints in the PDA Sudoku game.

We termed regular NEAT activity, high activity and inactivity, low activity. A person is considered to be inactive when the output from the Neat-o-Games sensor has a value lower than 0.25 G. Through box-plotting (see Figure 3), it appears that the intensity of

high activity progressively increased as NEAT-o-Games options added in the experiment including human to human race (Session 3) and NEAT-o-Sudoku (Session 4). A similar result was shown for time spent in physical activity. In particular, players not only spent more time walking, but also increased their walking pace as the game options unfolded.

Conclusions

This paper presents a new game paradigm to attack the behavioral aspect of sedentary lifestyle, which is the major culprit for the obesity epidemic. It introduces NEAT-o-Games where characters compete based on energy counts recorded by accelerometer sensors, which players wear along side with their cell phones. Typically, games are diversions of short duration from everyday life. NEAT-o-Games, unlike other games, run for hours, days, or for life. They are meant to become part of people's everyday routines. In a pilot experiment, the games were well received by the users and they appeared to increase both the time and intensity of users' engagement in mild aerobic activities.

More information about the current project, including dynamic content (e.g., videos) can be found at http://www.cpl.uh.edu/Neat-o-Games/.

Citations

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[2] Mueller F. and Agamanolis S., Exertion Interfaces., In Exertion Interfaces Workshop CHI 2007, San Jose, CA, May 2007.