NEAT-o-Games: Novel Mobile Gaming Versus Modern Sedentary Lifestyle

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ABSTRACT
The proposed demonstration is based on the work performed as part of the NEAT-o-Games project. NEAT-o-Games is a suite of games that runs on mobile terminals such as cell phones. Unlike other games, NEAT-o-Games' primary goal is to become part of people's everyday routines and attack the behavioral aspect of the sedentary lifestyle. Their main characteristic is that they are not carried out in short bouts, but are being played continuously and are interwoven in the daily routine of the players. Data from wearable accelerometers are logged wirelessly to a cell phone and control the animation of the player in a virtual race game (avatar) with other players over the cellular network. Players can use their excess of activity points earned from the race game to get hints in mental games of the suite, like Sudoku. Initial studies indicate that NEAT-o-Games may bring a positive physical, psychological, and social impact on players.

ACM Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Experimentation, Human Factors, Theory, Verification.

Keywords
Pervasive Gaming, Serious Gaming, Human Computer Interaction, Behavior Modification, Physical Activity, Wearable Sensors, Ubiquitous Computing, NEAT, Obesity Prevention, Obesity Intervention

1. INTRODUCTION
Non-Exercise Activity Thermogenesis (NEAT) is the energy expenditure of all physical activities other than volitional sporting-like exercise. It includes all the activities that render us vibrant, unique, and independent beings such as working, playing, and dancing. Contrary to conventional wisdom, NEAT activities expend a significant amount of energy. 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.

NEAT may be the answer to obesity, an individual clinical condition that is increasingly viewed as a serious and growing public health problem. There are 1 billion people in the world who are overweight and 300 million with obesity [1]. Sedentariness is almost addictive and is reinforced by the specifications of the modern work and leisure environment. Recent work suggests that this condition is driven by a reduction in energy expenditure, rather than a rise in energy intake [2]. NEAT can be a potential solution to the problem. However, NEAT is omnipresent in our life, in contrast to volitional sporting activities, which are bound to specific locations and times. Therefore, strong motivation and ubiquity are two key issues. But how can we increase NEAT in our modern lifestyle, and most importantly, how can we motivate people to change something as fundamental as their everyday habits?

An interesting and fairly new approach to the problem is through computer games that promote physical activity. Computer games have an almost addictive effect that can potentially alter people's behavior. Consolvo et al. [3] have developed a mobile phone

application for encouraging activity by sharing step count with friends. The cultural phenomenon created by the Dance-Dance Revolution (DDR) game has been studied by Hoysniemi [4]. There are also many other novel prototypes [5] [6]. However, the main disadvantages of the aforementioned prototypes are that they are carried out in short bouts and they do not properly address the problem of ubiquity.

We propose the idea of NEAT-o-Games (Figure 1), a collection of cell phone games where "activity points" may be earned and consumed across the game space. NEAT-o-Games are not carried out in small sessions, they are being played continuously and they are interwoven in the daily routine of the players minute by minute. In addition, they address the problem of ubiquity by opting for a game design that does not require the full attention of the user all the time and is implemented using wearable gadgets, that is, accelerometers and cell phones. We have implemented two games so far, NEAT-o-Race and NEAT-o-Sudoku. Initial experiments have indicated that players feel very motivated when using the game suite ([7] [8] [9]).

The proposed demonstration intends on bringing alive the concept of NEAT-o-Games. Users can interact with a novel mobile system that may motivate them to modify their current lifestyle. The next section will provide an overview of the basic NEAT-o-Games methodology, while section 3 will give details of the demonstration setup.

Figure 1. Users enjoying NEAT-o-Games. The two upper screenshots depict home screens. The lower screenshots depict the two games currently offered: NEAT-o-Race on the left and NEAT-o-Sudoku on the right.

2. METHODOLOGY OVERVIEW

2.1 System Architecture
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).

Figure 2. NEAT-o-Games system architecture.

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.

2.2 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 (see Figure 3 top). This real-time feedback appears to "hook" players to the game. During the pilot experiments, there have been many instances where subjects were running around watching the NEAT-o-Race screen. The player can select his/her opponent from the "buddy list" and compete for activity points.

Figure 3. NEAT-o-Race (top) and NEAT-o-Sudoku (bottom) interfaces.

Even when NEAT-o-Games are run in background mode, they use occasional messaging to inform players about major events in the race. For example, they send an alert to the player when the opponent has built too much of a lead in the race. In the contrary situation that finds the player far ahead in the race, a congratulatory message notifies the player to this effect. A message also announces the winner or loser of the NEAT-o-Race session that typically lasts 24 hours from 12:00 AM to 11:59 PM.

The home screen of the NEAT-o-Games suite features along with access buttons to the various functions (i.e., game screens, activity history, and configuration management), information about the current status of the race with a motivational twist (see Figure 1 top). A dial with an up or down arrow communicates winning or losing status of the player respectively, along with a graphical quantification of the lead or lag amount.

One can view the monitoring avatar as a couch figure that is pleased or unpleased based on the user's activity status. Couch avatars are caricatures of well-known athletes, politicians, and actors.

2.3 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. The puzzle setter provides a partially completed grid. As many puzzle games, Sudoku may become frustrating at times, i.e., when the player hits a stumbling block and cannot see a way forward. In NEAT-o-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.

Figure 3 bottom shows the "hint function" of NEAT-o-Sudoku, which fills out one random slot upon tapping the NEAT button. 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. Of course, consumption of activity points lowers the standing of the player in the competitive race. For the player to maintain his/her competitive racing position he/she has to get more active.

3. DEMONSTRATION DESCRIPTION

The proposed demonstration aims on following the basic concept of NEAT-o-Games. That is, NEAT-o-Games are meant to become part of people's everyday routines and attack the behavioral aspect of the sedentary lifestyle. A space of approximately 4 square meters will need to be allocated where a vertical workstation and one plasma screen will be provided (see Figure 4). The vertical workstation is comprised of a treadmill and a stand where a laptop can be positioned. Two players at a time can play NEAT-o-Games. One can be on the workstation and the other on the conference premises. At the same time there will be another player who will be situated in our lab headquarters in Houston, USA. Each of the Mobile HCI attendees can play against each other or against the "Houston buddy". Any player can check his/her status against his/her buddy in real time. The plasma screen will show each player's PDA screen, so that the global interactive element comes alive.

The recommended minimum time to spend at the demo is about 5 minutes. During this period a player can taste the system's multi-faceted functionality and realize its appeal. Select visitors will also have the opportunity to check out a NEAT-o-Games set (up to 2 sets will be provided) for a few hours, so that they can experience the system at length. The demonstration design aims to bring to the fore the ubiquitous nature of NEAT-o-Games; they can be played not only when one exercises in the gym, but also while he/she does office work (vertical workstation), or during a coffee break in a lab or conference anywhere in the world.
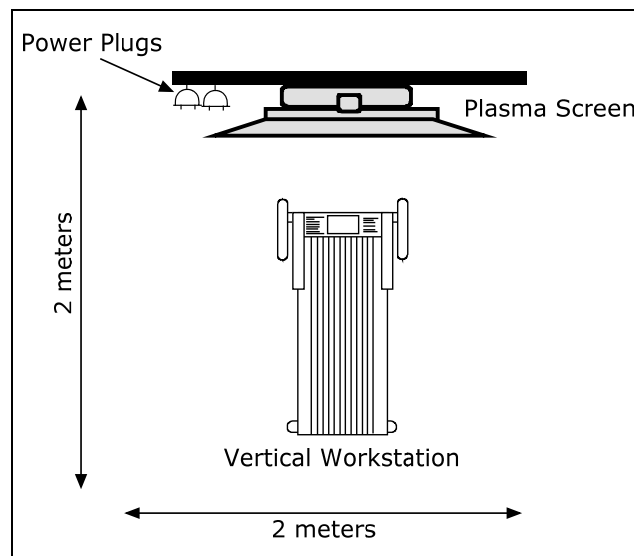

Figure 4. NEAT-o-Games proposed demonstration

4. ACKNOWLEDGEMENTS

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