Implicit Interaction: A Modality for Ambient Exercise Monitoring

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Abstract. Ambient Exercise refers to the implicit exercise that people undertake in the course of their everyday duties - a simple example being climbing stairs. Increasing awareness of the potential health benefits of such activities may well contribute to an increase in a person's well-being. Initially, it is necessary to monitor and quantify such exercise so that personalized fitness plans may be constructed. In this paper, the implicit interaction modality is harnessed to enable the capturing of ambient exercise activity thereby facilitating its subsequent quantification and interpretation. The novelty of the solution proposed lies in its ubiquity and transparency.

Keywords: Ambient exercise, Implicit interaction, Pervasive health

1 Introduction

A major challenge for heath professionals is how to motivate people to incorporate more physical activity into their daily routine. Increased incidences of obesity and cardio-vascular disease are just two common health problems that could be reduced if people engaged in more physical activity. Though multiple factors contribute to the prevalence of each, the sedentary lifestyle that is common in many societies at present is suspected to be a key contributing factor. Addressing this can be difficult as it is frequently not a life style choice but a side-effect of one's profession. Thus there is a need to reconcile normal daily activities with health and fitness requirements.

Ambient Exercise refers to the implicit exercise undertaken in the course of everyday activities. Examples include, walking to a local convenience store, climbing stairs and so on. Though not formal exercise per se, nevertheless, the cumulative effect of such physical activity could be significant. Increasing awareness of such exercise, and motivating individuals to incorporate more of it into their everyday lives, is a desirable objective. A prerequisite to the successful fulfilment of this objective is the capture, analysis and interpretation of ambient exercise activities such that they can be quantified and incorporated into fitness regimes. However, fundamental to the integration of such exercises into an individual's daily routine is the autonomous and transparent monitoring of such activities. The implicit interaction modality offers one potential model by which this can be achieved.

1.2 The Implicit Interaction Modality

Implicit interaction [1] occurs when users interact with an arbitrary system in a determinable but subconscious manner. It has been harnessed in a number of domains, for example, in electronic tourist guides. Such interaction may be captured as discrete events or as a result of continuously monitoring a stream of data – a pertinent case in this discussion being the continuous monitoring of physiological signals. Harnessing such an interaction modality minimizes the need for explicitly requiring user attention, thereby ensuring that users focus uninterrupted on their tasks.

1.3 Related Research

A number of applications have been described in the broad pervasive health domain that enables monitoring of various activities. (PmEB) [2], hosted on a mobile device, monitors caloric consumption and expenditure; however, details must be manually entered to enable the calculation of an updated caloric balance. SHAKRA [3] detects patterns in GSM signal strength fluctuation to infer the physical activities of the carrier. HealthGear [4] harnesses a suite of body sensor technologies to detect incidences of Sleep Apnea. Similarly, MOPET [5] hosts a suite of wearable sensors to monitor physical fitness activities in an outdoor scenario. Ermes et al [6] explore activity identification in supervised and unsupervised settings. In the next section a prototype is introduced that is distinct in its focus on implicit interaction and harnessing of the intelligent agent paradigm.

2 Engineering an Ambient Exercise Monitor (AEM)

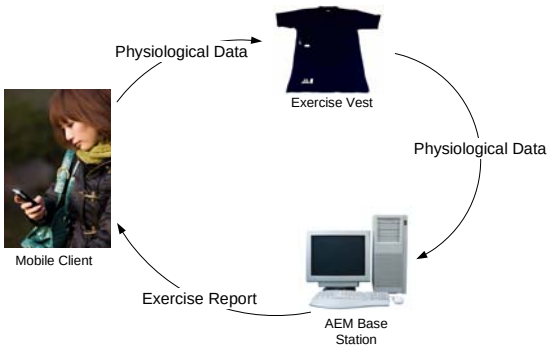


Fig 1: Architecture of AEM

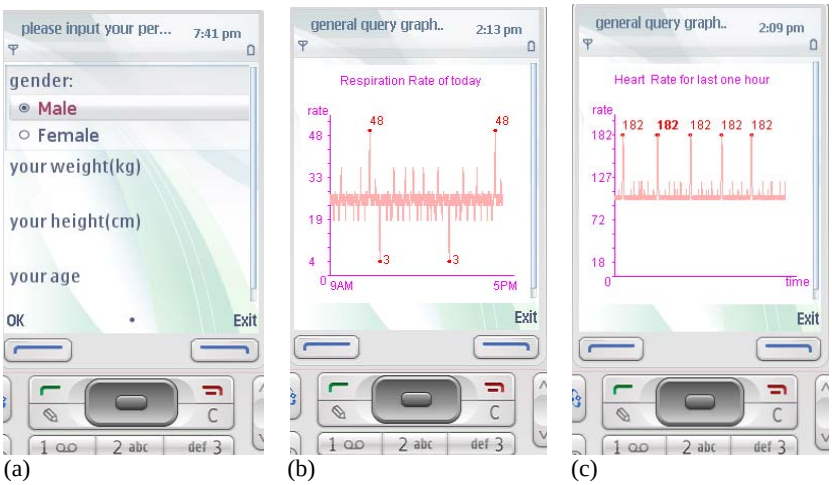
The architecture of AEM is outlined in Figure 1. Key components include:

– Exercise vest: A vest incorporating a number of integrated physiological sensors, including heart rate, respiration rate, activity level and skin temperature, is worn by the user. Data from these sensors is continuously collected in a transparent manner

and stored on the vest thus enabling activity monitoring in both indoor and outdoor environments. It should be noted that location-sensitive data is not collected, thus significantly reducing privacy concerns.

– AEM Base Station: When in the vicinity of the base station, sensor data is seamlessly uploaded and stored in the data base. A Web interfaces defines the protocols required for database access.
– Mobile Client: The mobile client incorporates two embedded agents to deliver key AEM functionality. A User Agent manipulates the interface, communicates with the user, and manages their queries. The Analysis Agent interprets queries, and interfaces with the AEM database.

The AEM client has been implemented in J2ME and deployed on a Nokia N95. The server has been implemented in Java and MySQL. A sports vest, augmented with appropriate sensors has been harnessed to deliver the necessary physiological data.



(a) (b) (c)

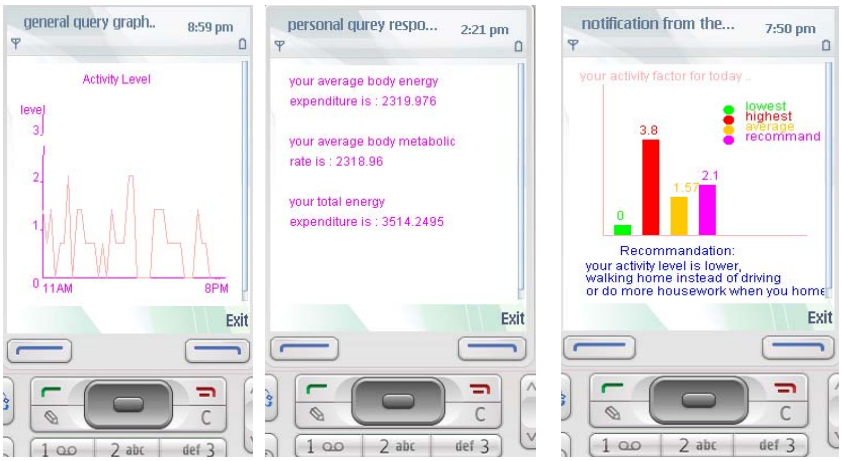
Fig 2: User profile construction (a); daily respiration history (b); hourly heart rate record (c).

An initial profile must be constructed to seed the AEM functionality (Fig. 2a). Heart beat and respiratory rate records can be constructed for arbitrary time intervals (Fig. 2b and Fig. 2c). A summary of the activity level is illustrated in Fig 3a while Fig 3b demonstrates the average daily energy expenditure. This can be compared with various norms, resulting in appropriate actions being recommended (Fig. 3c).

3 Future Work

A number of avenues for augmenting the AEM are being explored. The model currently used for calculating energy expenditure is generic so an adaptable model that can be personalised for individual users is being considered. Secondly, it is intended to realise an Intelligent User Interface (IUI) that will provide feedback to

users so as to encourage them to partake in further exercise activities, as circumstances dictate. Agents have proved successful when developing IUIs for mobile devices [7] so incorporating this technology should not prove problematic. Finally, it is intended to validate the approach using an initial series of user evolutions that will, it is hoped, lead to further refinement of the AEM.



(a) (b) (c)

Fig 3: Acquiring the user profile (a); energy expenditure (b); and activity recommendation (c).

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