Walking phrases: modeling the walking process with respect to contextual conditions

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Abstract

Designing for everyday life activities has become an important field within mobile HCI. A critical point in mobile interaction design is to understand a person's changing context. Taking into account the conditions that characterize a person's context is a prerequisite to provide interactions that are meaningful to the actual situation and supportive. In this paper, we present our approach of modeling the walking process from a body-centric perspective and with respect to contextual conditions that affect walker's experience. Our walking model is based on a set of walking phrases: sequences of walking movements that are meaningful with regard to walker's context. To make walking phrases empirically discernable, we interrelate biomechanical and contextual data of the walking activity. Towards this goal, we designed a location-based mobile game and conducted a small process-oriented study in which we collected players' walking data.

1   Introduction

Along the so-called third wave of HCI (Bødker 2015; Harrison, Tatar, and Sengers 2007), designing interactions for everyday activities and involved experiences has become a central issue. A critical point in interaction design for activities on the move is to understand and model the activity with regard to contextual conditions within which they take place. Understanding these conditions is an essential challenge to design interactions that are meaningful and supportive to a person in a current situation (de Sá 2011). Equipped with inertial accelerometers, gyroscopes and GPS units, the sensing capabilities of smartphones today allow a wide range of possibilities to collect contextual data, such as location and time. This data is used to interpret a person's context and adapt a system's behavior and information content accordingly in context-aware computing. Major challenges in the design space of mobile interaction are, amongst others, user's attention focus and the physical environment (Marshall and Tennent 2013). Being on the move our attention focus and behavior can be influenced by all kind of changes, traffic, people, signs and noises. Various sets of potential influencing factors have been proposed (de Sá 2011).

However, it should be noted that each situation is unique and that potential factors only become influencing conditions through the actor or as Svanaes defines it: "context is not a

property of the physical world, but rather the horizon within which a user makes sense of the world." (Svanaes 2001). Within one research strand of the project "Flow-Machines: body movement and sound" (2012-2015) (Hajinejad et al. 2013) we sought for a model of the walking activity in everyday life. Drawing on the concept of embodiment that emphasizes the role of bodily interaction with the world in the meaning making process (Hornecker and Buur 2006; Dourish 2001), we analyze walking behavior to understand walker's context. We explore how walkers' body movement can be used as a point of entry to approach inner (attention focus) and outer context (environmental conditions). Towards this goal, we examined the relation between walker's body movement and contextual conditions. In this paper we present our approach of investigating this relationship through a process-oriented study and discuss our results.

2   Walking experience, body movement and context

Walking is a directed everyday activity. Besides its benefits on health, walking is primarily a means of transportation to reach a target destination (Longo et al. 2015): we walk to get to work, to visit friends or to go shopping. A common model of walking is to describe it on a biomechanical level, by the cyclic movement of two consecutive steps, referred to as a gait cycle. Studies have demonstrated that characteristics of the gait cycle reveal information on walkers internal processes, as for example arm swing and stride length change according to walker's emotional state (Montepare, Goldstein, and Clausen 1987). At the same time, it has been shown that walking properties are influenced by external conditions such as sociocultural factors, traffic intensity or vegetation (Franek 2013; Bornstein 1979). Research within mobile HCI has mainly focused on the biomechanical level of walking and analyzed walker's movement characteristics to identify users (Derawi et al. 2010), to monitor physical activity (Yang and Hsu 2010), and to classify types of movement for gaming purposes (Schneider 2012). Simplifying the activity of walking to the gait cycle, there is a risk of isolating a single dimension of an activity that intertwines a subject with a particular environement , and losing sight of what makes walking meaningful in people's everyday life.

In our approach, we consider walking as an activity and the gait cycle as a bodily dimension of the activity process. In this process the walker performs a repertoire of walking movements to attain a goal under changing conditions. Defining this process from a phaenomenological perspective walking in everyday life can be described as "a flow of in-sync actions" of a subject's "intentional body unfolding in the world". Seamon (Seamon 1980) calls these pre-reflective corporal behaviors „body routines - a set of integrated gestures, behaviors, and actions that sustain a particular task or aim, for example, preparing a meal, driving a car, doing home repair, and so forth." Based on the findings above, we understand walking as an *embodied expression of the interplay between a person's inner conditions with the outer conditions* of a specific environment. Following this idea, we assume that strong variations in the walking movement indicate meaningful changes within walker's context and that a sequence of walking in the same manner frames a relatively consistent walking context. In the following we refer to a walking sequence with a consistent walking movement as 'walking phrase'. Accordingly, the course of walking in everyday life,

e.g. when walking from home to the supermarket, can be subdivided into a series of walking phrases. A walking phrase frames an experiential moment of the walking process such as waiting at the traffic light, dodging a dog or pausing and turning around to look at something that just passed. In a concrete case of walking, from the place of departure to the place of destination, the walking process denotes a unique composition of walking phrases in a particular time and space. These walking phrases and their composition constitute the walker's experience of the activity. In order to design meaningful interactions for walking it is reasonable to consider walking phrases as they provide insight into contextual conditions.

3   Segmenting meaningful walking sequences

We aimed for a vocabulary of walking: a list of generalizable body movement routines that allow to describe the process of walking from an origin A to a destination B with regard to walker's context. To identify on an empirical basis the elements of this vocabulary, we designed a location-based mobile game that encourages players to walk through a dynamically generated soundscape. We tested the game with five girls aged 9 to 14, during their course on healthy lifestyle and conducted a small process-oriented study in which we collected biomechanical and contextual data of the player's walking activity.

3.1   Sonic game

The players individually explored the playground, a one-hectare park, divided into four sections. Each player was equipped with a smartphone and headphones. The players were given the task of exploring the park by listening carefully to the soundscape and to identify the location of their personal "sweet spot". This sweet spot is a particular location of five square meters generated dynamically and individually for each player around the GPS position where the player stays for several seconds after some minutes of walking. Every time a player enters the personal sweet spot, a striking sound motive is triggered. The players did not know the conditions that generated a sweet spot and had the task to find it by means of the special sound motive and to mark it by pushing a button. While walking within the park, the player hears a dynamic soundscape composition of three sound layers. The first layer is a sound carpet reflecting the atmosphere of the predefined park section within which the player is currently walking. The second layer interactively resonates with the steps of the player, in the form of percussive sounds. Entering the personal sweet spot triggers the third sound layer. We assessed player's data through an App implemented on the iPhone 4S, using its internal gyroscope, accelerometer, and GPS unit. Each participant was equipped with an iPhone in the trouser pocket.

3.2   Process-oriented analysis

Our goal was to determine meaningful walking movements by interrelating the participant's gait- movement behavior with their individual walking context. Towards this goal, we analyzed player's data using the process-oriented method, as used by (Grüter, Oks, and

Lochwitz 2010). The goal of the process-oriented method is to study change within the process, within which it happens. We repeatedly walked through the synchronized data streams (geoposition, sonic feedback, gait data) of individual players in order to (1) capture the meaning of the whole process; (2) identify events that change the course of the individual activity process or irritate the researcher; (3) identify the state before the event and the state after; (4) analyze both dimensions, the body movement and the changing context; and (5) attempt to explain the change in the process by means of the results gained in steps (3) and (4).

In the following we exemplify the steps of our analysis process with a single case of a female player L.
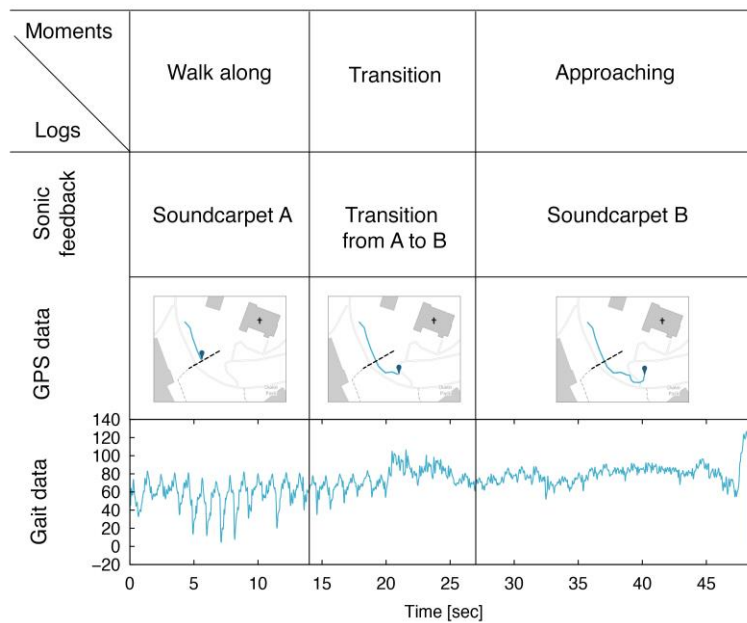

Figure 1:Reconstruction of a sequence in the walking process of player L.

Female player L. walked for about 20 minutes in the park, playing the sonic discovery game. Her walking process can be divided into three phases marked by joining and parting from other players. We now elaborate on one example of change within player L's walking movement. Shorty after starting playing, player L. walks from one play zone into another and experiences the change of sound carpets for the first time. We reconstruct this sequence of 45 seconds (Figure 1) interrelating three processes: sonic feedback (log files), spatial movement (GPS data) and data on player's hip rotation (gait data). We analyze player's walking process with regard to a set of body movements that are directed towards the game task (finding the sweet spot).

- Hip rotation (system): The visualization of the hip rotation time -series data shows a reduction of variation. Indicating that L's walking movement changes from regular big steps to smaller ones.

- GPS (context): The visualization of the GPS data on a map shows that player L is walking alone and stepping from one play zone into another.

- Sonic feedback (context): The system logs show the sonic feedback that L. is hearing. Stepping from one play zone into another, the sound carpet of the zone left is blended out and after 5 seconds of silence the sound carpet of the newly entered zone is blended in.

The change in player L's walking movement from big steps to smaller ones can be explained with the sonic feedback that blends from one sound carpet into another. We interpret the phase before and after the transition with a meshing of two walking phrases, a walking phrase with long target-oriented strides and a walking phrase in an attentive exploring manner.

3.3   Results

We used our single observations for plausible generalizations on four walking phrases: walk-along, approaching, turning, and standing. Walking phrase is a concept to analyze and segment body movement with respect to walker's spatio-temporal context. Each walking phrase frames a meaningful experiential building block of casual walking, is a) discernible on a biomechanical dimension by a particular movement pattern and b) provides indications to approach walker's attention focus and environmental conditions. Incorporating this walking vocabulary as user input, we engaged in interaction design, with the aim to strengthen user's experience of the walking process and its underlying movement routines.

4   Discussion

We took a body-centric perspective to model the process of walking within everyday life. In analogy to the concept of embodiment, we study walker's behavior to understand their context. We aimed for a vocabulary of walking phrases: a set of meaningful walking movement routines that describe the walking process as it unfolds with regard to contextual conditions. From a body-centric view, a person reaches a particular target destination through a sequence of intertwining walking phrases that integrate inner and outer conditions. In order to segment the continuous walking process into walking phrases, we developed a mobile game to frame the walking process, conducted a play test and recorded player's walking activity. We analyzed player's activity data using the process-oriented method and presented a vocabulary of four walking phrases. In a next design step we use walking phrases as a basis to implement detection algorithms to track a walker's activity. Thereby we aim to interpret the walking process with regard to attention focus and environmental conditions in order to design meaningful interactions.

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