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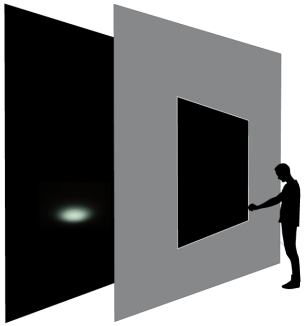
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From Dance to Touch: Movement Qualities for Interaction Design



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Abstract
In this paper we address the question of extending user experience in large scale tactile displays. Our contribution is a non task-oriented interaction technique based on modern dance for the creation of aesthetically pleasant large scale tactile interfaces. This approach is based on dance movement qualities applied to touch interaction allowing for natural gestures in large touch displays. We used specific movements from a choreographic glossary and developed a robust movement quality recognition process. To illustrate our approach, we propose a media installation called A light touch, where touch is used to control a light spot reacting to movement qualities.

Keywords
Movement qualities, tactile interface, natural user interaction, user experience, interaction aesthetics.

ACM Classification Keywords
H5.2. [User Interfaces]: Input devices and strategies, Interaction styles.

General Terms
Algorithms, Design, Experimentation.

Introduction

While large scale multi-touch displays are becoming increasingly popular, the actual approach for designing their interfaces is mainly driven by HCI: touch is taken as a pointing input (mouse metaphor) and research focuses on new interaction techniques in terms of performance and usability for a given task. Moreover, while some works try to extend conventional mouse metaphors in large displays [6] [20], they usually try to adapt human gestures to the interface (technology-driven design) instead the opposite.

Those approaches are not suitable for the creation of pleasurable, non task-oriented interfaces. According to Gaver et al [5], ludic activities are motivated by curiosity, exploration, and reflection rather than externally defined tasks. Indeed, we cannot engineer enchantment [19]. Moreover, as underlined by Petersen [18], there is a need for alternative frames of reference in interactive systems design. The author suggests aesthetics of interactive systems is an additional perspective on user-centered design. For instance, Moen [11] connects dance with interaction design, from an aesthetic point of view. Actually in his paper, modern dance methods and theories are used as a starting point for interaction design of wearable movement-based systems [11]. As underlined by the author, "modern dance is an area that has a strong and deep knowledge of bodily expressiveness and human movement as a communicative device".

Dance practice and theory provide us with important insights for the understanding of complex dance movements. A central aspect is "movement quality", meaning the distinctly observable attributes or characteristics produced by dynamics independently of movement trajectory or shape. We believe that this additional dimension of movement enriches interaction aesthetics and interaction gesture design.

In this paper, we propose to use the notion of movement quality in dance to extend the interaction experience in large-scale tactile displays. The novelty in our approach is that we extract related dance movement qualities in user's touch. This allows to enhance user experience in aesthetically pleasant interfaces through the use of natural movements. We first introduce a background concerning aesthetics and interaction design. Then we describe how we translated dance-based movement qualities into touch properties. Finally, we describe the implementation of the touch tracking and recognition system and the tests performed using an illustrative example, an interactive installation called *A light touch*, where spectator controls a light spot reacting to movement qualities.

Background on designing aesthetic experiences

Aesthetics and interaction design

In their paper "Aesthetic Interaction - A pragmatist's Aesthetics of Interactive Systems", Petersen et al. [18] develop a framework for aesthetics, as the fifth element of interaction design (other four elements are System, Tool, Dialogue Partner and Media). They also make a difference between analytical and pragmatic aesthetics. In analytical aesthetics, interaction is designed independently of social, cultural or user context. In pragmatic aesthetics, experience emerges from interplay between user, context and culture. In our work, we focus on pragmatic aesthetics. Peter Wright et al. [19] analyze pragmatic aesthetics use in interaction design. According to the authors, pragmatic aesthetics



Figure 1: Breathing



Figure 2: Jumping

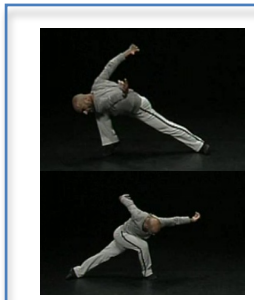


Figure 3: Expanding.

starts with the attention to the relationship between user and interactive artifact. It does not concern only the cognitive, but also the emotional threads of experience. And it does not only concern the way we evaluate interaction, but also the approach to design. Our work presents a new application of the principles of pragmatic aesthetics design based on linking modern dance movements with tactile interaction.

Dance and HCI

Some previous works have already used modern dance methods and theory in order to create new interactive techniques or systems [3] even though nobody has used it before on large-scale tactile interfaces. Kjolberg [7] used dance to design full body movement interfaces. The author used Laban's theory to create an empirical study introducing modern dance to HCI practitioners in order to observe how it would affect their design work. However, the empirical study did not conduct to any prototype development. Jin Moen [11] explored human full-body movement as interaction modality. He created BodyBug, a wearable task-free interaction concept where the user is free to move and express as in modern dance. However movement qualities analysis remains qualitative. A contribution of our work is to introduce dance movement qualities recognition for large-scale tactile interface.

Dance-based movement qualities

In this section we first define movement qualities and present the ones considered from Emio Greco | PC (EG|PC) dance company's vocabulary. Then, we see how they can be transcribed from dance context to touch interface and how they can be recognized.

Dance movement qualities

In modern dance, the notion of movement qualities is considered as a key aspect of movement. To understand this notion, it is important to consider it as the manner in which the movement is performed independently of its trajectory. Rudolf Laban [8] refers to it as "effort", the fourth dimension of movement besides of the body, the space and the shape dimensions.

In HCI, the body, the space and the shape dimensions of Laban's Effort Theory have been already exploited to constitute gesture vocabularies. For tactile interfaces, the body dimension is usually the fingers or hand involved in the movement. The space dimension is the touch surface. The shape dimension represents either the static postures or the trajectories of the touch gesture. The last "effort" dimension has been barely explored in HCI for the design of movement-based interaction [11]. In our work, we choose to transcribe three movements or "components" from EG|PC dance company's vocabulary into our touch movement vocabulary [2]: "breathing", "jumping" and "expanding". Our motivation is the existing glossary of these movements 0 that describe their inherent qualities to be used in the interaction.

Dance metaphor for touch

The "breathing" is a two-parts movement: breathing in and out (see figure 1). The first part is a progressive and vertical expansion where the dancer reaches the maximum length of the body and sustains. The second part is a slow release from the maximal expansion to the initial position. We translated this movement into the touch interface as an oriented increase of hand's velocity and a release of the hand with a slow velocity.

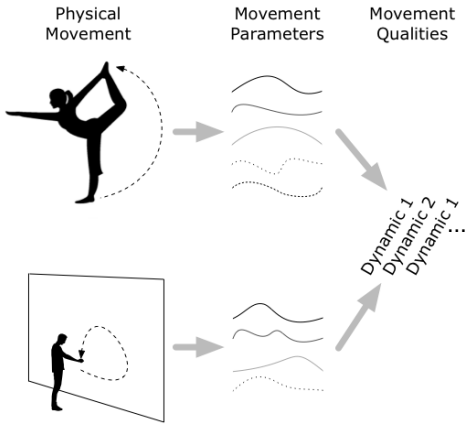


Figure 4: From dance movement quality to touch movement quality.

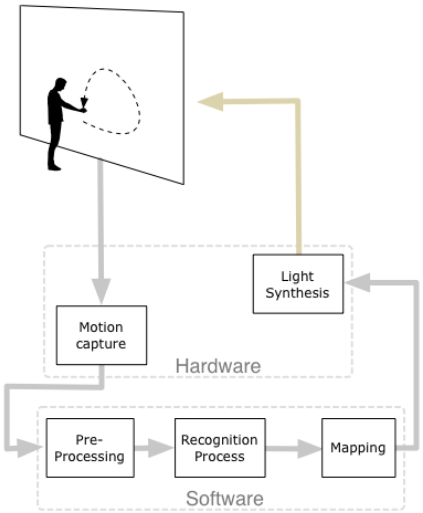


Figure 5: General architecture of the system

During the "jumping", the dancer drops the weight of the body into the feet letting it rebound for a long time creating a repetitive movement (see figure 2). The touch translation is a periodic caress on the surface where the hand sweeps periodically from top to down at different position on the interface.

Finally, the "expanding" is an extension of the whole body in various directions where the body travels through the space by opening the legs, and creates a shifting of weight through the feet (see figure 3). We translated this movement as a multi-directional travel of the hand on the surface.

These three movements are articulated sequences of dynamics (see figure 4). In this paper, we preferably use dynamics instead of movement qualities when considering the gesture recognition process. Dynamics refer to how kinematic parameters that describe the movement are related. These dynamics are independent from the particular gesture's geometry. Hence, the challenging task is to be able to recognize a whole movement not as a specific trajectory on the screen but as a sequence of given dynamics.

Recognition approach

One approach to gesture recognition is to choose relevant gesture parameters and to compute the similarity between their temporal evolution [4]. Another approach consists in fitting a dynamic model on gesture measurements. This paper proposes a method that belongs to the latter case. Most of natural systems are a combination of dynamics and one approach to this problem is to consider the whole non-linear movement as a succession of smaller linear dynamical profiles. Following this idea, recognizing a movement consists in identifying it as a switch between the defined profiles or a linear combination of them [12]. Referring to our aim, we choose to use the Switching Linear Dynamic System (LDS) already applied to describe dynamical phenomena as human motion [17] or dance of honey bees [13]. This model fulfils the following requirements needed by the proposed concept. First it can retrieve dynamics composing a given movement. Then it can be implemented in real time. Finally, it is easily interpretable in terms of movement analysis and, as a matter of fact, gives important clues for interaction design.

Implementation

Illustration: A light touch

In order to illustrate our approach, we present an aesthetic large-scale interactive installation called *A light touch* (see figure 5). In this installation, spectators can interact with a transparent surface letting them control a light spot projected in a rear surface. Light spot coordinates are defined according to touch coordinates. Light spot characteristics (or behavior), such as light intensity, spot size, blur or shape, are controlled by parameters issued of the dynamic of the spectators' touch gestures.

The experience engaged by this installation is based on the initial interpretation of the visual feedback ("I move my hand, the light moves") and its contrast with the secondary behavior of light, more subtle to understand by the spectator ("why the light is blurring?"). When spectator understands the relation between his movement qualities and the spot behavior, he becomes fully aware of his gestures and starts exploring the limits of his movements in relation with the interface. This installation engages the spectator in an intrigue,

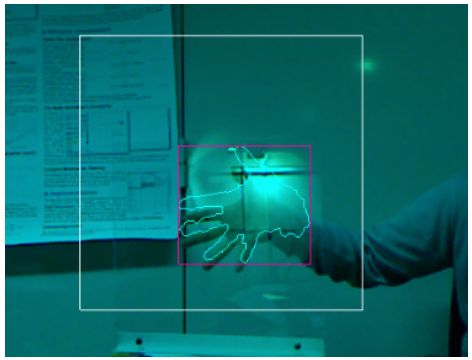


Figure 6: Tracking of the hand using Kinect.

improvisation and play, the three aspects defined by [18] as being part of the aesthetics of interaction.

Proof of concept

The tangible interface is a vertical square of plexiglas used to define a plane where the movements are active (see figure 6). A Microsoft's kinect [10] placed in front of the screen allows to capture the 3D scene. Kinect streams the data to an OpenFrameworks application [15] that isolates gestures in the interface area using OpenCV [14] to extract blobs. Then it sends the blob's centroid coordinates surrounding the hand in contact with the interface. Coordinates are streamed via the OpenSoundControl protocol [16] to the real time programming environment Max/MSP [10] that stores the data. In this work-in-progress, gesture recognition is processed and tested offline and a short-term perspective is to embed the online algorithm in Max/MSP.

Recognition evaluation

A preliminary study has been settled and five candidates were asked to perform five times each one of the three movements "breathing", "jumping" and "expanding". These movements were previously annotated meaning that we have segmented them into constitutive dynamic profiles. Hence, one periodic dynamic is learnt from "breathing" (indexed by 1), one from "jumping" (indexed by 2) and two from "expanding" (indexed by 3 and 4). In this section we propose to inspect the result given by the recognition process. Figure 7 reports the result given from a performance of expanding. It shows that the system reports switches between dynamics included in the global movement that correspond to the annotated segmentations. Also, we see that switches can be delayed compared to the perceived change in dynamics in the performed movement. Finally, dynamics of a candidate's movement (e.g. expanding) can differ from those learnt from the same movement and can be closer to another movement dynamic (e.g. breathing).

Conclusion

In this paper, we addressed the question of extending user experience in large scale tactile displays. We proposed to use dance movement qualities for the creation of aesthetically pleasant large scale tactile interfaces. The novelty in our approach is that we extract related dance movement qualities in user's touch. The notion of movement quality in dance is defined as the manner in which the movement is executed. We use movement qualities or dynamics

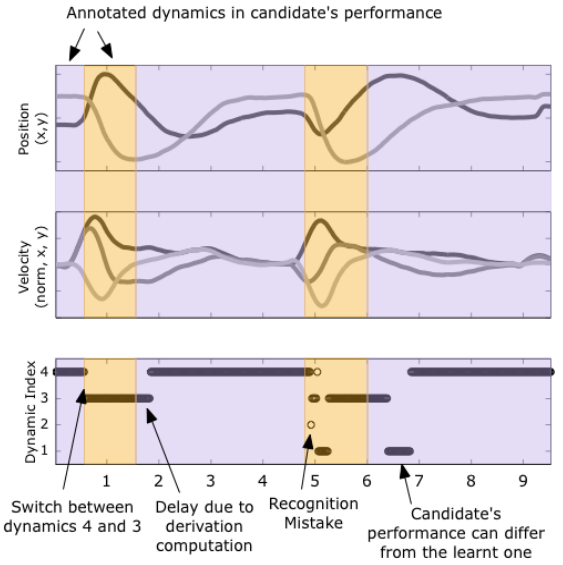


Figure 7: Recognition result. Switches are coherent with manual annotations of dynamic changes

from three movements, named "breathing", "jumping" and "expanding" that we apply to touch gesture. A proof of concept was presented and we implemented a dynamics-based recognition algorithm that has been evaluated on real data and used in an interactive installation called *A light touch*. The next step of this work in progress is to evaluate the experience of *A light touch* by testing it with a variety of users in order to see how the reflective aspect of the interface and the interaction are perceived.

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