Towards an Interactive Tango Milonga

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ABSTRACT

Social partner dances, particularly Argentine tango with its close embrace, present challenges to interactive dance system development. First, the system must address the motion capture problem of multiple closely interacting bodies. Secondly, the system deployment should not disrupt the social dance conventions and expectations. Thirdly, the system must capture movement features relevant to the dance style. This paper presents and reflects upon the process of building such a system for interactive Argentine tango dance, in which dancers' movements drive a real-time composition system, illuminating solutions to these limitations.

1. INTRODUCTION

When dancers are granted agency over music, as in interactive dance systems, it is often for staged performances with an audience. However, Argentine tango social dance is most concerned with participants' internal experience and their relationship to the broader tango community. In this paper, I present the development of a system intended to explore creative approaches to amplify the sense of connection, that is, the experience of one-ness with a partner and complete immersion in music, in the context of social dance. I examine 1) related work exploring interactive Argentine tango and interactive dance in social contexts 2) system design in an Argentine tango and social dance context 3) implementation of the motion capture system, initial motion analysis and preliminary prototype 4) conclusions and further work.

Argentine tango has a history rich in experimentation, arising as a mix of several traditions, including the habanera, the Andalusian tango, and the candombe, an Uruguayan African slave dance[1]. It began as a form of vernacular music and dance of the lower classes in the Río de la Plata, and by the 1920's it had become a worldwide cultural phenomenon[2]. Dancing Argentine tango involves non-verbal communication with one's partner, as well as moving creatively to the music that is played[3,4,5]. *Interactive Tango Milonga* seeks to increase this experience of feeling at one and immersed in these elements of the dance through the creation of an interactive dance system. The aim is to enhance musicality through contributing to a deeper understanding of the tango notion of connection via direct and explicit cohesion between dance and music. Musicality in this context refers to the manner and ability with which dancers move and engage with music.

Figure 1. Couple dancing in *Interactive Tango Milonga.* Sensors are on the back, and behind both ankles.

The system allows dancers to drive compositional and sound parameters via individual and group movement in the context of a milonga, an Argentine tango social dance event. Different aspects of music, such as accompanying rhythm, texture, melodic line, timbres, and tempo are modified in real-time by the system. The music is in Argentine tango style, electronically generated without live musicians. This is not unusual in terms of social context, as a tango music genre, called electrotango, is influenced by electronic dance music. Eventually, this system will accommodate multiple couples on the same floor.

1. RELATED WORK

1.1. Previous Interactive Tango and Social Dance

Music and dance have been interconnected disciplines since antiquity, but only recently has motion capture technology enabled the sonification of typically unsounding dancer movement. Of such interactive dance systems, very few directly engage with the social dance context, and its fluid space between dancers – experts and novices, alike, and observers. A fascinating example of such a system is Proyecto Biopus' audio-video installation, *Tango Virus* (2005), in which dancer movements are translated into viruses infecting the music playing, gradually distorting the sound via a biologically-based simulation[6]. This installation allows

any dancers from the general public to take part, using optical motion capture to sense general movement trajectories[6]. In contrast, the aim of *Interactive Tango Milonga*, is to foster a sense of individual agency over the music, allowing a measure of musical intentionally to each dancer. Another interactive tango dance system is Laura Sinnott's *Augmented Tango Shoes* (2008), allowing one dancer to create and affect music via tango-like movements, showing how agency over music can be implemented in an Argentine tango context[7]. *Interactive Tango Milonga* expands these ideas by including the social dance context, revealing relations between partners and the rest of the dancers on the floor.

This project is also preceded by work on interactive electronic dance music, such as MIT's Interactive Dance Club[8]. In this installation, club dancers could interact in relatively specific ways with different exhibits meant to enhance a club dance atmosphere[8]. The *Experio* project expands this idea, by detecting dancers' feet movement through laser tracking. The signals get sent to Ableton Live, and then a DJ can then change how these moves affect the music in real time[9]. *Interactive Tango Milonga* grows this engagement with social dance into a context of skilled amateurs with tango's specific musical and movement practice.

2. DESIGNING INTERACTIVE TANGO

1.1. Introduction

Interactive Tango Milonga intervenes within an existing social, movement, and musical tradition. The system primarily aims to create an internal experience deepening dancers' understanding of Argentine tango. Thus, the system must afford interactions that are idiomatic and comfortable inside multifaceted Argentine tango practice. For example, tango dancers generally do not use their arms expressively since they are almost always in the embrace. Meanwhile, foot movement is varied and animated. It follows that the system sonifies foot gestures, rather than hand gestures. Additionally, this project was designed using an iterative design process.

1.2. Designing for Argentine Tango Movement

As the old saying goes: "It takes two to tango." Indeed, partnering is a crucial dynamic in tango. In every moment, movement is a complex negotiation between leader and follower. Unlike other Western social dances, Argentine tango has no basic step set to a particular rhythm. Instead, the leader invites the follower into each step, imparting information about the speed and movement character. The follower then accepts and interprets the invitation via her movements. Thus, kinetic connection, the means by which tango partners communicate with one another, is essential to this improvised dance [3].

Where is this kinetic connection? It is largely in the embrace, specifically in the upper chest. Torso movement plays a very important communicative role that translates into leg and foot movement. The variations of torso motion trajectory between two partners yields valuable information about their connection to each other. Thus, the system must robustly capture this movement without encumbering these movements. Not only are the torsos close together in both close and open embrace, but legs are also frequently intertwining. For example, leg wraps and ganchos, kicks that hook around a partner's leg, are extremely common. Motion capture devices must not encumber the dancer from these intertwining movements. Moreover, occlusion, i.e., one object obscuring another from a camera or signal receiver, becomes a problem. Each couple in the space adds to the difficulty.

1.3. Designing for Argentine Tango Social Spaces

Milongas occur not on stage, but in dance halls, bars, and social clubs. Generally, the attire is relatively formal. Potential dance partners trade significant glances, called cabaceos, with each other before anyone is asked to dance. The interactive tango system, thus, must be portable and durable in order to enter tango spaces, and discrete so as not to interfere with the atmosphere.

Argentine tango is also danced in tandas, sets of three to five songs, with break music in between, called the cortina, literally, curtain, during which dancers often switch partners. This structure creates natural breaks in dance to also switch sensors, and if needed, reset system parameters. Novices and experts share the floor and partner with one another, walking counterclockwise, and great pains are often, although not always, taken not to collide with one another.

This system allows dancers an avenue to connect with all dancers on the floor via sound, not only their partner. Thus, the compositional problem of movement-sound orchestration must be addressed. How does the system allow users to distinguish if they are or their partners are creating which sound? For this phase, we scope the problem by limiting dancers to four couples, with a initial goal of one couple.

3. IMPLEMENTATION

1.1. Motion Capture Implementation

Markerless optical motion capture was an attractive option due to lack of movement constraints. A preliminary prototype with the goal of discovering group movement in tango used a single overhead camera to track dancer couples. See Figure 2. The downside of this approach is that it cannot track individual bodies, allowing agency for each dancer.

Thus, the next prototype focused on the problem of individual body part tracking. Using 6-8 Kinect I's covering a reasonable-sized dance floor, the system could also be both affordable and portable. However, even under favorable

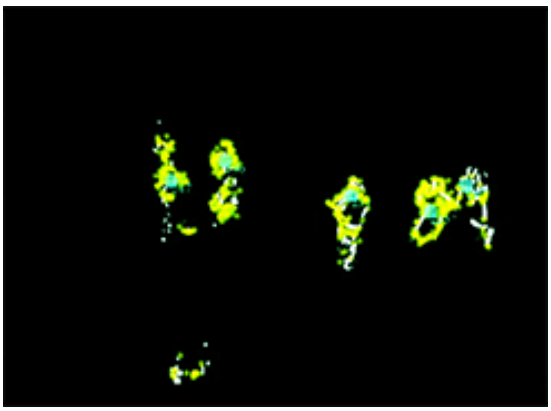

Figure 2. Tracking of dancers at a tango milonga. The image is background subtracted. Yellow shows the tracking of optical flow of the foreground. Light blue shows the blobs, recognizing each couple.

conditions, the skeletal tracking failed to recognize a couple as two dancers. Hence, computer vision techniques were applied to the video stream using the Cinder C++ framework, OpenCV, and OpenNI. Using face and skin tracking was promising, but the failure rate was too high for the robustness needed. See Figure 3, showing an optimal performance of this tracking. In this example, the face tracking is largely successful, with some false positives. Most instances of the tracking lost the faces and head easily, for too long, i.e., seconds. Adding markers likewise did not prove fruitful, as resolution of the Kinect cameras were not high enough at the distances required.

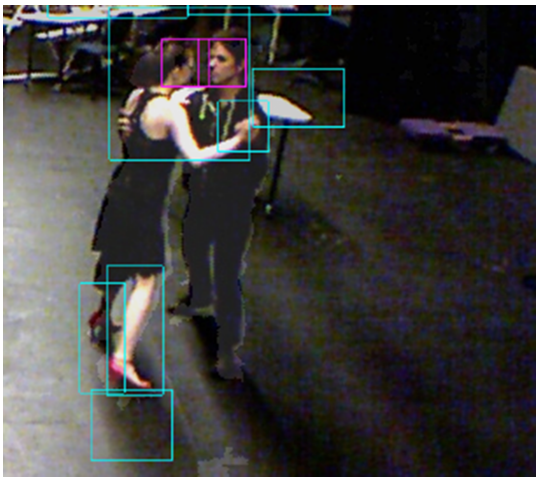

Figure 3. Showing face and skin tracking results. The blue rectangles indicate skin, and the pink rectangles indicate faces.

In light of the complexity of the optical motion capture solutions, we moved to wearable inertial sensors. While wearable sensors added impediments for dancers entering the floor, it solved the open problem of distinguishing interlaced dancers' limbs. Further, the position of each body was far less important than the motion trajectory. Shimmer3 sensors were chosen because they were a small and affordable out-of-the-box solution[11]. They use Bluetooth Class 2 technology to send sensor information wirelessly, and could be put on quickly, perhaps between tandas. Originally, two were placed on each outside calf, and one the torso, specifically the back. Thus, the sensors did not interfere with the embrace or interleaving foot movement.

However, the sensors had trouble maintaining connectivity, even for one couple dancing in open embrace in a small space. Interlocking body parts were also problematic, since human bodies absorb the Bluetooth radio frequencies. Connectivity was lost early and often during the dancing, that is, within the first thirty seconds. A solution used Android 4.3 phones. The Android is placed on the dancer's back, replacing a Shimmer sensor. The leg sensors then send information via Bluetooth to the Android. The Android then forwards this information via OSC (Open Sound Control) and Wi-Fi to the computer. Meanwhile, on a separate thread, the Android sends its own sensor information via Wi-Fi. While Androids are larger than Shimmer sensors, they are in a place where their size does not interfere with the dance. This solution has so far been successful; however, UDP transmissions, like OSC, can fail when the Wi-Fi radio band is saturated, as can be common in large crowds using smart phones. Thus, in the future, this project will move to XBee for both the Shimmer and Android data, which uses different radio band for wireless transmission.

1.2. Sonification Implementation

The majority of Argentine tango music is in song form using verse-chorus structures, even instrumental works. Thus, music was composed with Ableton Live, which had the benefit of allowing fast prototyping and further complexity via Max4Live. A motion analysis application, written in C++ and Cinder, receives the OSC from the Android phones, sending the motion data to another computer running Ableton Live (and Max4Live), also via ethernet and OSC. Two computers were used for performance reasons.

1.3. Prototype I

The first prototype sonified acceleration curves of the leg sensors. Leg movement controlled volumes, onsets, filter envelopers and frequencies of different melodic tracks. For instance, the acceleration values of one dancer's leg were mapped to both the volume and band-pass frequency filter center frequency of a bandoneon track. The music also contained repeating drum loops and bass patterns which consisted of the milonga rhythm[1] and variations. Dancers could change filters but not onsets of these tracks. While this approach had obvious weaknesses, using only very simple mappings, it yielded valuable information about the next directions. First, it was extremely exciting to affect the music. In fact, more control was desired. Secondly, leg sensor

[1] The same syncopation as the habanera rhythm. In this instance, 'milonga' refers to a style of tango, not the tango social dance event.

placement was found to be better on the back of the ankle because it captured more relevant tango motion. Thirdly, we found having information about the walk, in particular, was important. The step frames the action of each foot, e.g., length, in terms of distance and time, and sometimes onset force. This prototype also missed significant action in the dance when the actions were slow and gradually crescendoing. Often, one had to move forcefully in order to have a feeling of agency.

1.4. Motion Analysis

As gait is crucial to tango experience, step detection for each foot was implemented. Each onset is detected via thresh-holding the jerk (first derivative of acceleration) of each ankle sensor, in all the rotational axes (x, y, z). As this process yields too many false positives, the system only accepts footsteps that fall on a multiple of a beat. This serves as a temporary solution; ideally, dancers will have the ability to step off beat to give a greater sense of agency. Further, false positives are more desirable than false negatives in this case. False positives give the impression that something unknown may be happening, whereas false negatives call into question an embodied sense of agency. Additionally, as a physical measure of connection, the cross-covariance is found between corresponding sensors in each partner. Cross-covariance between two sensors can be used as a measure of spatial and temporal similarity and had been used previously in Aylward's work with dancers[10] For example, the cross-covariance is found between the left ankle sensor of the leader, and the right ankle of the follower. Therefore, the relation between the two dancers will also be used to drive the musical processes, explicitly sonifying an aspect of kinetic connection. Moreover, the windowed overall movement for each dancer will be used to orchestrate and affect music. Further, the derivative of this measure is a valuable measurement of the suddenness of movement, as it is related to the jerk. In future work, we intend to implement machine learning strategies, recognizing common tango moves such as the gancho, mentioned earlier.

4. CONCLUSIONS AND FUTURE WORK

This paper has discussed strategies for designing and implementing work for interactive social dance through presentation of the *Interactive Tango Milonga*. We presented challenges involved, such as the motion capture of interlocked bodies, and discussed various solutions, as well as discussing preliminary prototypes. We have shown methods of accommodating and designing interactive systems in specific social contexts and traditions.

Looking forward, we are continuing the process of system development, designing for internal experiences such as the amplification of the sense of connection to self and partner. This involves a multilayer approach in which sound-movement relationships are considered at different temporal, dancer (individual, couple, entire dance floor), and orchestral levels. Additionally, this work shows promise in teaching tango dancers different ways listening and responding to music, changing their dance even in a more traditional context. We further aim for the social dance floor to become a sounding ensemble, creating of new tango dances, music, styles, and experiences.

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