Interactive Tango Milonga: Designing DMIs for the Social Dance Context

Courtney Brown
Center for Creative Computation
Southern Methodist University, Dallas, TX
browncd@smu.edu

ABSTRACT

Musical participation has brought individuals together in on-going communities throughout human history, aiding in the kinds of social integration essential for wellbeing. The design of Digital Musical Instruments (DMIs), however, has generally been driven by idiosyncratic artistic concerns, Western art music and dance traditions of expert performance, and short-lived interactive art installations engaging a broader public of musical novices. These DMIs rarely engage with the problems of on-going use in musical communities with existing performance idioms, repertoire, and social codes with participants representing the full learning curve of musical skill, such as social dance. The project, *Interactive Tango Milonga*, an interactive Argentine tango dance system for social dance addresses these challenges in order to innovate connection, the feeling of intense relation between dance partners, music, and the larger tango community.

Author Keywords

NIME, interactive dance, Argentine tango, participatory music

CCS Concepts

• **Applied computing → Sound and music computing**; Performing arts;

1. INTRODUCTION

Our system, *Interactive Tango Milonga*, gives dancers agency over music in the Argentine tango social dance community. Motion sensors are attached to dancer limbs, the data is sent to a computer, and then algorithms then transform movement to sound. By creating a new relationship via sound, I seek to enrich connection as well as innovate new tango practices. In Argentine tango dance, connection describes feeling at one with dance partner, music, the rest of the dancers on the floor, and the larger tango community. Our broader long-term motivation is fostering more intimate social engagement in broader society via musical interaction.

How does one design DMIs for extended use in an entrenched participatory musical tradition to actualize these aims? Few DMIs engage existing participatory musical communities outside academic and DIY projects. Novelty and experimentalism are fundamental to many of these DMIs, yet musical innovation and technical advances for their own sake do not always appeal to the general public [9, 11]. There is a lack of NIME research in the exploring the related problems of developing for musical traditions outside of European and North American contemporary classical and experimental music [2] and musical collaboration by users with mixed skill levels [3]. This work should be useful for others addressing these challenges.

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Figure 1. Couple dancing in *Interactive Tango Milonga*. Android is on the back and sensors are on both ankles of each dancer.

2. APPROACH

Argentine tango dance is grounded in the relation between two moving bodies, leader and follower. Lacking a basic step set to a specified rhythm, dancers determine rhythmic phrasing freely via non-verbal conversation between a leader and a follower. Musical creation in real-time via *Interactive Tango Milonga* allows dancers an additional avenue for communication and improvisation: sound. While the interactive tango system may be seen as replacing live musicians, this is generally not the case. Currently, the vast majority of milongas (tango social events) are danced to fixed, recorded music.

As dancers learn to purposefully drive music via their movement, they also learn to hear music in new, more detailed ways. As they associate movements with sounding outcomes, dancers can perceive the movements of other dancers via sound, allowing insight into other dancers' actions and increasing intimacy between dancers. The sound thus opens a window into others' movement that dancers cannot see or perceive via touch.

2.1 Theoretical Framework

How can sound act as a conduit between dancers? As part of musical listening, humans empathically experience the movement used to produce the sound via a motor system simulation process [10]. Then, if the information of physical gesture is embedded within sound in perceivable ways, it suggests that musical creation can facilitate connection. Recent research supports this view, implying that humans can perceive the affective and physical state of other music-producing agents such that they feel their presence [12].

3. CONTEXT

Music and dance have long been interconnected practices, but only recently has motion capture technology enabled the sonification of typically unsounding dancer movement. Such interactive dance systems include DIEM's Dance System [14], and newer systems such as *Raja* [1]. Most interactive dance systems, such as the above, are created for the stage, meant for expert dancers, and rarely take social context into account nor are they designed to facilitate social connection. Often these systems are designed for use by only a few performers or developed for only one work. Very few interactive dance systems engage with the social dance context. By the social dance context, I refer to events held within a community of mostly amateur dancers with a common movement vocabulary. Observers, novices, and experts alike may take part. As in art installations, the roles of performer and audience in social dance are fluid, but participants have a context for activity and by moving, they are taking part in an ongoing tradition.

Most of the work done for a social dance context has been done in the genre of Electronic Dance Music (EDM). An early example of such a system is MIT's Interactive Dance Club [16]. The creators' aim was managing the 'chaos' of many musical contributions so that the outcome was coherent and pleasing. Their solution was to have an Experience Jockey (EJ) whose job it was to mix the results and choose which contributions to include in the resulting sound. The participants had uncertain musical agency, as their contributions may or may not be pivotal to the end result. This lack of consistency also impairs participant's sense of social relation via participation in the system, as they need to identify both their own contribution and others to feel a mutual engagement [5].

Additionally, the Interactive Dance Club did not engage with the movement vocabulary of EDM dance, as the event consisted of a series of interactive zones in which participants with specific interfaces, such as drum-like pads. Other systems for social EDM dance, such as Talbot3 [7] engage more deeply with the EDM tradition. For instance, Talbot3 developed glow sticks for users to form crowd interaction. However, individual participant musical contribution was not extensive, as generally average group movement rather than individual action influences musical changes [7]. Talbot3 also exploits the freeform nature of EDM dance rather than engaging with a specific movement vocabulary, and does not have a pathway for expert use of the system.

Few musical interactive systems engage with dance traditions outside of EDM, modern dance, and experimental practices, and generally, systems engaging with social dance practice are rare. One example of such a system is Proyecto Biopus' audio-video installation, *Tango Virus* (2005), in which movements are translated into a biologically-based simulation of infection corresponding to the gradual distortion of playing music [6]. This installation allows any dancers from the general public to take part, but it is a one-time event staged in a gallery rather than for social events, and only one couple can dance at a time.

Augmented Tango Shoes (2008) is another tango dance system allowing a dancer to drive musical outcomes [15]. However, the system is developed for stage performance rather than for a fluid social dance context and has been implemented only single dancer use. For instance, the system uses wearable sensors attached to the shoes, and they cannot be easily exchanged or worn by many other dancers. Additionally, available performances and demos[1] appear tango-influenced rather than within any social Argentine tango dance or music tradition. For instance, the performers dance unpartnered choreography for the majority of the performance.

Additionally, DMIs for musical traditions outside of contemporary classical and DIY culture are few but include Ajay Kapur's work on Indian Classical instruments and similar work on other traditional Asian instruments [8] and Barbosa's work on creating DMIs for popular instruments [2]. In all these cases, the DMIs were designed for performance by expert musicians or as, less commonly, as pedagogical tools for novices rather than for use by musical communities of participants with mixed skill levels all creating musical (or movement) outcomes together.

4. DESIGN PROCESS

Tango experience was investigated from the individual outward to partner, to other dancers on the floor, to tango community using an iterative design process. The inspiration for this work came from the author's experience as an Argentine tango social dancer, and thus, first person embodied knowledge was drawn upon, as well as the tango literature. Iterative prototypes were then developed, which were evaluated by playing, performance, user studies[2], and informal presentations at local practicas and tango classes.

4.1 Designing for Connection

In our research, tango dancers cited connection as the main motivation for their participation, and enriching this aspect is a central aim of our system. To achieve this goal and enable two-way communication via sound as well as movement, dancers should have individual musical agency and be able to perceive the musical consequences of their movement and other's movements: a problem of orchestrating interactivity.

The interactive system thus assigns separate roles to individual dancers to aid dancers in the task of distinguishing individual musical response. For instance, followers drive melodic lines via their movement while leaders drive accompaniment patterns. Experiments revealed that followers felt very little musical agency when the melody/accompaniment roles were reversed. However, as leaders direct the follower at every moment, they report musical agency even when they, themselves, are not wearing sensors. Leaders also have less cognitive resources to drive musical outcomes as they are also navigating and deciding on the next steps. In user studies, many more leaders than followers reported having trouble paying attention to musical outcomes due to involvement in making dancing decisions.

Another issue is how to orchestrate individual musical agency for a large number of participants as tango songs are generally sparsely orchestrated. Our solution is to have a smaller number of active dancers driving system musical outcomes at a time. The rest of the dancers on the floor move to the music that the system creates in response to ensembles of one to four active couples. Dancers can then exchange sensors during breaks in dancing, at the same time that they switch partners.

The system also allows for extreme musical response to extreme movement, which may be the result of either unintentional movements ('mistakes') or unorthodox experimentation, in order to facilitate a high degree of agency. However, such extreme musical responses may be disruptive in a tango social situation, particularly to dancers accustomed to traditional tango music. This problem was addressed in two ways. First, relevant parameters of musical response, such as rhythmic quantization, may be adjusted on-the-fly for different types of social events and dancer skill level. For instance, at first melodic onsets were quantized to the 32nd note, but it was found that more pleasing musical results with no loss of reported musical agency could be obtained via using a 16th note quantization. Second, the interactive system is presented at venues open to experimentation, such as practicas (informal events), so that the dancers are more likely to be open to newer, unexpected sounds.

4.2 Tango Movement and Music

Dancing Argentine tango, even when not using an interactive system, is generally a musical action, similar to playing an

[1] https://vimeo.com/94626008

[2] See Section 6 for description of user studies.

instrument. Tango dancers often acknowledge musical síncopa and other rhythms by mimicking or articulating them with foot movement and in our research, dancers confirmed primarily associating rhythmic arrival with foot onset. Dancers also reported following specific instrumental lines with their movements. Thus, melodic note onset and phrasing corresponds with dancer foot onset and movement in the system. Sensors are placed on the ankles to capture the details of these movements. Further, as the nonverbal communication flows from upper torso, a third sensor placed on the back captures this movement.

Tango moves can be articulated in many ways. For instance, a fast boleo (whipping kick) recalls a sharp, loud staccato attack. However, the same move may also be performed as a slow, smooth movement. Thus, the character of the movement is more important than which tango step it is in terms of correspondence to a perceived sound result. Therefore, the system generally responds to dancer movement quality rather than to specific tango steps in the resulting design. For instance, movement density is suggestive of musical parallels, as generally, one makes more gestures to create denser textures in both movement and music, and the interactive system responds thusly. A unified model of movement-music perception was developed to guide these transforms of movement qualities into sound qualities.[3]

A critical design problem is finding a suitable response curve for the dynamic variation of each perceived movement quality. For instance, how much movement requires a typical dancer to perceive herself as creating a dense texture? Reasonable values were arrived at during user studies. However, using a single response curve for all dancers resulted in dancers with impaired movement being unable to create musical changes since they could not create the required range of dynamic movement variation. Thus, the response curve was altered to allow on-the-fly adjustment for each dancer, improving accessibility. As tango communities include many older dancers, it is vital to create a system to that allows their full participation.

As Argentine tango music and dance are tightly coupled, the interactive system produces music in the tango style, reflective of what is played at social events. Currently, the majority of milongas play Golden Age (1920s-40s) music, and system musical output is close to that style. The interactive system produces highly structured music via a database-driven system because tango dancers expect musical structures such as phrases and specific rhythmic patterns to follow tango musical conventions. The system uses a "choose your adventure" approach, selecting melodic fragments of 1-5 notes depending on dancer movement density. Phrasing and harmonic structures are determined a priori by song arrangement, and different accompaniment patterns and orchestration is chosen based on dancer movement qualities. For instance, sharper more staccato movement leads to the system choosing a more percussive instrument such as a piano, and smoother movement leads to more continuous instruments, such as a violin.

4.3 Social Context and Motion Capture

Milongas are often crowded events place in restaurants, bars, and dance halls. The interactive tango motion system must then accommodate many intertwined dancer couples and its motion capture system should be portable. Thus, the system uses wearable inertial sensors [4]. During the early design process, I discovered the tango embrace of a single tango couple could disrupt the Bluetooth class2 sensor signals. The solution was an Android placed on the torso, forwarding signals from the smaller inertial sensors via WiFi [4]. The sensors are limited to three (including the Android) per dancer to facilitate fast exchange between dancers during dancing breaks. This system has proven to be robust in social dance situations with multiple intertwined couples, each taking turns wearing the sensors.

5. IMPLEMENTATION

5.1.1 Tango Movement-Music Perceptual Space

Tango movement-music perceptual space is modeled as a three-dimensional continuum representing distinct categories of perceived energy. Tango dancer effort is required to produce and sustain these energies, always subject to decay. The perceptual space stretches across varying time granularities from the gestural/continuous to the event/trigger. The types of energies currently implemented in the interactive tango system are: movement density (sparse/busy), articulation/textural (legato/staccato), and spatial (closed/open). These perceptual categories also are fairly low-level descriptors, and so some perceptual categories could be arrived at by combination or also, arise emergently.

Movement density can be seen as a 1st or 2nd order energy (i.e. 1st or 2nd derivative of a positional signal), in which states of low energy are 'sparse' and states of higher energy are 'busy'. The articulation/textural energy may be seen as a higher order energy, (i.e. third or fourth derivative), in which low energy states are 'legato' or smooth/rounded and higher energy states are 'staccato' or rough/pointed. The spatial category is energy of relation, rather than an individual movement state. Tango dancers may be moving more or less spatially similar and tightly synchronized. More synchronized is judged as more 'closed', whereas further apart and distinctive movement pushes energy to more 'open' state. Both an energy lack and having equal amounts of closed and open energy would measure at the center of the open/closed continuum.

5.1.2 System Overview

The interactive tango system consists of three modules: 1) the motion capture system consisting of a Shimmer3[4] inertial sensor on each dancer ankle, and an Android phone on the upper back, 2) custom C++/Cinder[5] software for motion analysis and making musical decisions, and 3) sound production using Ableton Live/Max4Live . The Shimmer3 sensors send data via Bluetooth class2 to the Android phone, which forwards those sensor signals as well as its own data (thus also acting as the torso sensor) to the C++ software via WiFi.

The custom C++ software then analyzes the movement and uses the results to drive real-time dynamic music generation and arrangement. The C++ software then sends control signals to Ableton/Max4Live[6], choosing which musical fragments to play and changing sound parameters. Open Sound Control[7] (OSC) is used to transmit data from each part of the system to the other, making the data chain modular and highly adaptable.

To obtain perceptual measures corresponding to the unified tango music-movement continuum, the system 1) removes noise and other variables, such as gravity effects from the sensor signal via low and high-pass filtering, 2) extracts low-level features (e.g., windowed variance), 3) normalizes the values of those features to a specific range (e.g. 0-1), 4) combines weighted values to form the perceptual measure over a specified time window. Extracted lower level features include windowed variance and its derivative, step detection, and the cross-covariance between the signals from sensors on corresponding, mirrored tango partner limbs. After perceptual measures are

[3]See Section 5.5.1 for further description of movement perceptual qualities.

[4] http://shimmersensing.org
[5] http://libcinder.org
[6] http://www.ableton.com/en/live/max-for-live/
[7] http://www.opensoundcontrol.org

determined, they drive musical outcomes, such as the choice of melodic fragments and accompaniment patterns.

Gestural data from the torso sensors drive instrument timbre and dynamics. More rotational energy produces more vibrato, brighter timbres, and relatively louder sounds. The system also recognizes boleos, or fast whipping kicks, via wekinator. [8] As this is generally an ornamental move in tango, the system responds with an algorithmically-generated melodic ornament.

6. ASSESSMENT

6.1 User Studies

There were three user studies for the system versions were for use by a single tango couple (see Table 1). Tango dancers were videotaped dancing for 15–25 minutes using the interactive tango system. They participated in video-cued recall (VCR) [13] after dancing, in which they were asked their embodied experience as they watched the video of their dancing session. After VCR, they took part in a semi-structured interview. All subjects danced the role associated with their gender. In Study 1 and 2, each couple participated in separate sessions. In Study 3, all subjects danced together in one session. Transcripts were analyzed via corpus analysis software and interpretative phenomenological analysis (IPA). Due to sample size, results should be seen as exploratory.

Table 1. Study Demographics and Information

	Study 1	Study 2	Study 3
Dates	Sep-Oct 2015	Dec. 2016	Jan. 2017
Subjects	7 m./6 f.	5 m./5 f.	3 m./3 f.
Ages (years)	18-68	20-60	20-38
Years Dancing	0.3-14	0.5-9	0.8-9
ITM Experience[9]	0-1	1-5	2-6
Workshop before?	No	Yes	Yes
Social Context?	No	No	Yes

6.1.1 Results Summary

Overall, the trajectory of dancer experience from Study 1 to Study 3 supports the notion that sound can be a conduit for connection. More ITM experiences were correlated with reports of higher musical agency, which in turn correlated with reports of being connected to other dancers via sound in Study 3.

A divergence between system outcomes of dancers who identified as amateur musicians[10] and those who did not emerged beginning in Study 1, with musicians able to drive musical outcomes with more intention and purpose. One dancer remarked, *I don't know anything about music theory, so it was confusing for me. But then, each time it's got more and more easy to use and clearer*. As they gained more experience with the system, most non-musicians were able to close this gap. For instance, dancers reported trouble consistently distinguishing melody vs. accompaniment, and thus, they had to develop this skill to distinguish their musical contributions from others.

Dancers who developed these musical skills reported receiving information about other dancers via sound in the social session. One dancer in Study 3 reported, *I was just listening just to how it [the music other couples made] is different, what -- because in your head you kind of imagine what they are doing.* Some dancers, hearing examples of different dancers using the system helped them understand system potentials. One couple mentioned that it was strange dancing after their turn, as they still had the feeling that they were affecting the music in their body, but the music was not responding to them, which caused dissonance.

7. FUTURE WORK

Outcomes of this work imply that interactive dance systems can facilitate novel connection experiences and open up new ways of listening for social dancers. While our outcomes test single couple use, the system also allows two-couple (i.e. four dancer) use, and user studies are forthcoming.

One critical discovery of this work is the importance of accessibility for DMIs in the participatory music space. A system for social connection should not exclude differently abled participants who may be a part of these communities. In the future, we are interested in pursuing how our DMI may be used to allow entry for individuals who may have mobility constraints that would otherwise limit involvement in tango and other participatory music communities.

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[10] There were no professional musicians in the study.