Andante: Walking Figures on the Piano Keyboard to Visualize Musical Motion

Xiao Xiao, Basheer Tome and Hiroshi Ishii
MIT Media Lab
75 Amherst St.
Cambridge, MA 02142
[x_x, basheer, ishii]@media.mit.edu

ABSTRACT

We present Andante, a representation of music as animated characters walking along the piano keyboard that appear to play the physical keys with each step. Based on a view of music pedagogy that emphasizes expressive, full-body communication early in the learning process, Andante promotes an understanding of music rooted in the body, taking advantage of walking as one of the most fundamental human rhythms. We describe three example visualizations on a preliminary prototype as well as applications extending our examples for practice feedback, improvisation and composition. Through our project, we reflect on some high level considerations for the NIME community.

Keywords

Piano, Augmented Reality, Yamaha Disklavier, Visualization, Learning, Embodiment

1. INTRODUCTION

"Music is sound in motion."
— John de Lancie, oboist and pedagogue

To many musicians, a profound sense of motion lies at the heart of every masterful performance. The performer must first understand how the music flows and then translate that understanding into bodily movements that render sound in the physical world [9].

Piano pedagogue Abby Whiteside describes the concept of "basic rhythm" which coordinates both the flow of music and the whole body engagement of a performance [18]. Rhythm is not meant in the sense of metrics, or the regular succession of beats and accents but rather as the long line that holds together a musical statement, a sentiment echoed by composer Edgard Varèse [16].

People naturally attune to basic rhythm while listening to music—swaying their bodies, tapping their feet [6]. But when learning to play music, the sense of basic rhythm too often goes by the wayside [18]. Eager to avoid mistakes, the student focuses on producing correct sequences of notes, losing sight of lines holding the notes together. Rather than channeling long, expressive lines with the whole body, attention narrows on mechanisms to sound individual notes.

We introduce Andante, a graphical representation of music as animated figures projected on the fallboard of a player piano. Stepping along the keyboard, the virtual figures appear to "play" the physical keys. As walking is one of the most fundamental human rhythms, we use it to promote an understanding of line, rhythm and characterization rooted in the body.

Figure 1: Visualization of a canon with one figure as each voice (top); A duet with virtual accompaniment (bottom)

This paper articulates two views of music learning while situating our work among prior projects. We then explain our design rationale and frame a space of applications using a series of prototyped examples.

2. BACKGROUND

2.1 Music Tutorial Systems

The vast majority of music learning systems have been designed with an understanding of the learning process where the primary focus is training the student to play correctly. Typical systems for piano learning use lights and colored shapes to point out the correct sequence and timing of notes, usually derived from a written score [15]. Examples range from electronic keyboards with light up keys to visualizations similar to the Guitar Hero model where blocks representing notes descend onto virtual or physical keyboards augmented with projection [4, 1, 2, 24]. Some systems auto-

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mate feedback on a variety of criteria to notify and penalize students of mistakes [12].

Consideration for the physicality of playing is generally limited to technical problems. In the case of piano, several systems have been designed to convey proper fingering, both haptically and visually. Haptic systems involve tactile feedback units attached to fingers [5]. Visual representations range from abstract to literal, such as elaborations of block graphics colored to represent fingering, virtual hand models for demonstration, and video of full-scaled physical hands shown in situ at the keyboard [17, 8, 21].

Many learning systems claim to support the beginner and discount developing natural expression as beyond the target scope. When considered, expression is approached intellectually—decomposed into elements such as timing, articulation and dynamics, each analyzed and scored for correctness along with notes.

While the conventional view among designers of pedagogical tools isolates the intellectual, physical and emotional aspects of music, the three are seen as inextricably linked for many who perform and teach at the highest levels of musicianship.

2.2 Alternate View of Learning

Bassist Victor Wooten offers the analogy of an infant babbling when beginning to speak, learning words and muscular control at once while all the time constantly expressing [20]. It seems absurd to impose correct pronunciation and rules of grammar onto the infant at the outset, even more so to inflict penalties for every mistake in the process.

Bassoonist David McGill extends the analogy between language and music, arguing that both written language with its associated grammatical rules and musical notation are artificial, external systems designed to permanently capture aural traditions that previously vanished in time [9].

While an infant learning to speak desires communication over correctness, the two are often reversed for the fledgling musician, who learns to play and read at once in the beginning—memorizing vocabulary without learning to speak with ease and expression.

Ease and expression in playing are often seen either as elusive things to be coaxed out from years of rigorous, unavoidably unpleasant discipline or as the gift of a talented few that cannot be taught [18]. However, notable pedagogues argue that expressive playing can and must be systematically but enjoyably taught from the beginning, and it must not be isolated from learning notes [14, 18, 9]. Our work explores the role technology can play in this view of music pedagogy.

2.3 Artistic Inspirations

For inspiration, we look to more artistic works that give form to musical gestures and motion through elegant blends of the digital and physical.

Messa di Voce transforms the speech and songs of two virtuoso vocalists into highly nuanced and expressive graphics projected onto the space behind them [7]. Rouages augments electronic music performances using a mixed-reality 3D visualization of gears whose movement responds to the performer's gestures [3]. Our own earlier work MirrorFugue plays back recorded performances on a player piano augmented with projected video, making visible subtleties in the performer's musical embodiment such as breathing and posture [22].

Across disparate genres of music, these pieces visualize the intricate link between gesture of the body and of sound. While none were explicitly designed to tutor music, enhancing sense of motion within the sound and tying that sense with the body has vast potential for teaching the expression and physicality of music.

3. DESIGN

Rather than initially focusing on correctness of notes and mechanism, we aim to establish a "basic rhythm" in the body right from the start. The design goal is then about how to convey this sense, not just an intellectual understanding but a visceral one [13]. Instead carefully counting time while playing; we want to feel the flow of time.

Fortunately, most people already have a basic rhythm engrained in the body—from walking around everyday. Moreover, we already have a keen understanding of expression in a walk. We can intuit from afar details of people's identity and mood just from their gait [19]. The art of animation takes advantage of this understanding, crafting vivid characters in our imagination through the movement of lines and shapes.

We envision a visualization system for the piano, Andante, where animated figures walk along the keyboard play the music, appearing to physically press a key with each step. The figures give visual form to musical phrases, encouraging thinking beyond individual key strikes by connecting notes in lines of motion. As walks inherently communicate affect, the figures convey at once both the notes and the expression of a musical line through where and how they step.

We built our prototype on a Yamaha Disklavier grand piano with a replacement fallboard to enable projection [23]. A short throw projector is mounted 7.5ft overhead the piano bench based on [22]'s setup. A custom Java program runs the animations and drives the MIDI input and output from the player piano. Animation frames, which show various characters in silhouette, were made using traditional hand-drawn techniques and Adobe Photoshop.

4. INTERACTION EXAMPLES

Andante is not meant to be a stand-alone self-teaching system, neither in its current iteration nor as a concept. We intend it to be one way to present and to interact with music that could supplement the learning process. To demonstrate potential usage, we describe three example applications, generalizing interactions from each. For generalizability of the type of music walking figures can effectively visualize, please see the Appendix.

4.1 Scaling the Keys

A single walking figure can visualize the motion of one musical line. We built a set of examples where characters traverse the keyboard playing scales to explore visualization of linear motion. An essential component of the musical vocabulary, scales are used to construct melodies and are often included as daily practice for students of all levels, though often treated as a mindless exercises devoid of musicality.

We prototyped the C major, pentatonic and chromatic scales, ascending and descending with adjustable tempo. To show variations in scalar exercises, we made animations with multiple figures playing the C major scale in contrary motion and harmonized in thirds.

We also experimented with changing the characters' appearance and gait, animating a fat man, a tip-toe sneak, and an ostrich for the basic C major scale. Initial observations from viewers seem to suggest differences in how figures look and move noticeably altered the way a scale is perceived, even with MIDI playback lacking in dynamics of our current prototype.

Andante could encourage students to play scales with

Figure 2: Changing the look of characters—fat man (left), tip-toe sneak (middle), ostrich (right)

more shape and expression, imitating the movement of various characters. Particular characters could also be assigned to scales as a way of helping students remember by association.

By adding user input, we can provide feedback on expressive playing. A pianist can play a phrase, which is then repeated by a procedurally generated virtual character, with nuances in timing, dynamics and articulation reflected in its movement to visually reinforce expressive dimensions of the phrase [11]. We can also render the same phrase with different characters, adjusting emotional parameters such as "sadness" or "excitement" to experiment with different ways of phrasing. This way, a relative beginner can explore the expressive dimensions of a melody and then learn to play by imitating the character.

4.2 Walking Bass

Walking figures can also establish steady rhythm, especially useful in bass accompaniments. In fact, the "walking bass line" is a common pattern in both Baroque and Jazz style, which evokes the rhythm of alternating steps. We prototyped a boogie woogie vamp, an iconic example of walking bass in blues piano.

Though our prototype uses a fairly neutral figure, the distinctive character of various rhythmic styles, such as samba and swing, can be accentuated with characters with corresponding appearance and movement. Playing along with these characters could teach the feeling of rhythms that are difficult to convey only as abstract concepts.

A student can also play against a character, focusing on melodic improvisation while offloading the accompaniment. The animation acts as the rhythm section of an ensemble, helping the player get into a groove.

4.3 Canon Perpetuus

Multiple figures can break down more complex compositions into separate voices. We prototyped a visualization for Canon BWV 1073[1] by J.S. Bach, a perpetual canon that can be infinitely looped as its ending wraps back to the opening. Our visualization assigns a differently colored figure to each of the canon's four voices and allows the user to turn each character on and off.

A student can learn a piece with more attention on compositional structure, inspecting the shape of each voice, interaction between pairs of voices, and how all voices fit together. Isolating subsets of voices can reveal compositional techniques such as imitation, echo, and inversion through the characters' motion. The student can learn the piece one voice at a time from each figure and practice while accompanied by the rest of the characters for a global perspective early in the learning process

[1] `http://imslp.org/wiki/Canon_in_A_minor,_BWV_1073_(Bach,_Johann_Sebastian)`

We can also use Andante as a composition tool, building pieces through layers represented by figures. A composer can record one layer at a time, keeping track of layers and their interactions through the visualization. Representing voices as characters can also help the composer create a narrative throughout the piece.

5. CONCLUSION AND FUTURE WORK

Through a series of early prototypes, we have introduced an idea for representing music using animated figures walking on piano keys, situated our approach within a pedagogical perspective, and illustrated a space of applications. We are currently planning the next iteration of software, which will procedurally generate character animations in real time, thereby allowing us to more quickly build new visualizations. With the new software, we plan to build a new set of examples, which we will evaluate for effectiveness in promoting expressive playing.

6. CODA

We offer some final reflections, facets of larger ideas reflected by our individual project for the community to consider.

6.1 Visualizing Information

Despite many very evocative visualizations of music, the convention in visually presenting musical *information* tends toward the symbolic to be perceived purely intellectually. Expression is either abstracted into more symbols (e.g. sheet music) or abstracted away entirely (e.g. the Guitar Hero model). Andante proposes an approach for visualizing musical information that retains a visceral sense of expression at its core with symbolic representational information layered on top. For example, both the conventional abstract blocks and our characters can be colored to represent harmonies. In the conventional case, the entire representation of colored blocks is abstract and symbolic. Andante combines a symbolic representation with an inherently expressive one.

Though a piece of music contains vast amounts of information, we experience it more as expressive statement than intellectualized information. We posit that our approach is more consistent with how people perceive music.

6.2 Expressive Experience

Our current prototype is very limited, especially in expression. With the exception of the canon, all notes are programmed to be played exactly the same way by the Disklavier, with no variation whatsoever in dynamics, articulation and timing. Even the animation is made from canned sequences with no nuanced reactions to phrasing. Nonetheless, people still perceive "expression" when confronted by Andante in action. This raises the question of what makes people perceive a musical experience as *expressive*.

From observing our examples, we hypothesize two key

conditions: feeling the music through the body and feeling a sense of direction within the music, which harken back to Whiteside's ideas of "basic rhythm" and full body engagement. Though we cannot generalize from anecdotal observation, these points merit further investigation.

6.3 Sensory Dimensions

That we are able to perceive expression within Andante even with the most mechanistically reproduced notes suggests that the experience of music goes beyond the hearing of sound alone [10]. The contemporary Western musical tradition holds dear the notion of "purity" of musical ideas within the sonic realm, but before the invention of the audio recording (and even today in certain societies), music had always been enjoyed through many senses. We conclude with a call to action for the community: to design for deeper experiences of music, multi-sensory and multidimensional.

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APPENDIX

We address some elements of piano music that may seem problematic to visualize on Andante. Though there is no doubt a limit on the space of visualizable music, we hope to demonstrate significant variety within the space beyond our limited examples.

1. **Rests:** All our examples feature continuous streams of notes with no rests. For voices with breaks during or between phrases, figures can fade in and out or decrease in brightness to maintain presence based on the structure of the line.
2. **Large Leaps** In pianistic music, large leaps within a melodic line are relatively rare. Animated figures can actually enhance the perception of leaps as it visually reinforces effort to make the jump as demonstrated in our canon example. More frequent leaps are often better understood when heard as two distinct voices which we would visualize as two distinct figures.
3. **Harmonies** While we often think of harmonies vertically, a crucial aspect of harmony is the horizontal movement of component parts [9]. The Canon example highlights horizontal motion as each figure is assigned a different color. Alternatively, figures in the same same example can be colored according to underlying chord changes to show harmonic progression (e.g. red for tonic, yellow for dominant)