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The Mechanics of Dance: Using Parametric Equations as Inspiration for Dance Choreography

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ABSTRACT

Lissajous figures are parametric equations that deconstruct into equations of simple harmonic motion. They were a source of inspiration by artists and mathematicians alike, well before the digital age, due to their esthetic forms and simple equations that could be easily deconstructed. Here for the first time in literature, we present Lissajous pattern analysis in the context of modern dance movement, thereby expanding the physical understanding of dance and redefining the creative choreographic process. Through the implementation of wearable sensors, specifically wireless accelerometers, we have collected movement data from professional dancers to serve as an additional lens to visualize dance in a novel way and to analyze dance mechanics. The resulting Lissajous figures from the movement phrases were used to both inform and inspire creativity in the choreographic process of the Artistic Director of the Bowen McCauley Dance Company to create a new piece of work entitled *Lissajous*.

ARTICLE HISTORY

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Mathematics in art

The fascination with producing art inspired by mathematical concepts traces back to a history centuries old with one of the first few documented cases found in 4th century BC: the Greek sculptor Polykleitos prescribing proportions of $1:\sqrt{2}$ for the ideal nude male (Tobin, 1975). This connection between the art of the human form and mathematics makes an appearance several times through the course of history, such as Leonardo da Vinci's golden ratio and graphic artist M. C. Escher's use of hyperbolic geometry, which was actually produced with the help of mathematician H. S. M. Coxeter (Emmer, 2006). In 1807, Fourier had presented the premise that a superposition of very simple trigonometric sine and cosine functions with varying frequencies and amplitudes could be used to create interesting, seemingly arbitrary shape patterns (McKenna, 2011). In 1815, Nathaniel Bowditch applied a similar concept studying the movement of suspended pendulums (Bowditch, 1815), resulting in what was known as "Bowditch Curves." Later on in the mid-nineteenth century, Jules Antoine Lissajous studied these curves in more detail and like many other physicists of his time, desired visual manifestations of vibration, or movement. He was the first to obtain Lissajous patterns through the superposition of tuning fork vibrations (Lissajous, 1857), giving way to what is now more commonly known as "Lissajous Figures."

Applications of Lissajous figures

Prior to the digital age when computer programmers first began creating mathematical art, the most creatively inspiring method to capture imagination was to play with oscillatory systems, not too different from what Bowditch and Lissajous researched in the nineteenth century. In 1969, Laposky employed the use of electronics to produce art created by oscillating waves, which he called "Oscillons" (Laposky, 1969). Oscillons were electronic abstractions that used unique images in light composed of waveforms as they appeared on the screen of a cathode ray oscilloscope. Laposky himself described them as "visual manifestations of some of the basic invisible aspects of nature, such as the movement of electrons and energy fields" (Laposky, 1969, p. 353), giving way to a new method of employing modern technology and mathematics in the creation of art.

The extent Lissajous figures have made their appearance in many applications is far beyond the scope of the current work, expanding into optics, imaging, antenna scanning, machining, music and even robotics, to name a few. However, there are a few specific Lissajous studies that should be mentioned here due to their unique application to movement. Most recently, Borkar utilized Lissajous figures to study aerial surveillance using multiple quadrotors moving in concert. He determined that the movement path of autonomous agents can meet multiple surveillance objectives of repeated collision-

free patrolling, target capture, and complete area coverage in a finite time by leveraging some novel properties of Lissajous figures (Borkar, Sinha, Vachhani, & Arya, 2020). This method was chosen due to a variety of reasons: the curves can be described by using only two parameters, making it simple and time-effective to run through several path simulations. Lissajous figures have smooth, closed curves, which facilitate the smooth and graceful movement of each robotic agent and ensure that they end up in the same position that they began. Lastly, the points at which the curve intersects itself are well defined, making potential collisions highly predictable and thus avoidable. More applied methods of utilizing Lissajous figures include work done by Tesio and Rota, who found that representing the motion of the body center of mass (CoM) during walking projected in 2D and 3D result in what look like Lissajous figures and can reveal motor impairments not detectable by clinical observation (Tesio & Rota, 2019). Similar work on movement was performed by Takiyama, who observed these figure-eight Lissajous-type figures evident in both walking and running (Takiyama, Yokoyama, Kaneko, & Nakazawa, 2020). He claimed that the use of such a method could detect signs of walking/running gait impairments and help develop a path to recovery. It is clear that the entanglement between Lissajous figures and organic movement reveals itself if one chooses to take a closer look.

Technology in dance choreography

The use of technology to study and inspire dance movement has evolved dramatically over the decades (Dixon, 2015). Since the 1980s, researchers, choreographers, and teachers begin using video as a crucial method of documenting their dances and/or studying existing choreography (Sanders, 2021). In the mid 1990s, workshops were emerging that introduced choreography composition that was combined with instruments including cameras, video projectors, sensors, and computer software (Birringer, 2002). It was during this time that the definition of dance organically evolved, and choreography could include aspects like film edits, video projection, and use of other technology and media (Birringer, 2002). By the mid 2000s, digital technology such as virtual reality and augmented reality, combined with the advent of portable internet began to impact many aspects of society, and numerous university dance departments integrated technology (most often in the form of computer-assisted efforts) into their traditional course work (Sanders, 2021), including choreography composition. In recent years, the development of the smartphone has

become one of the most powerful digital devices used by dancers and choreographers to create and document movement (Sanders, 2021). Smartphones provide dancers with a quick and easy way to experiment with their own movement and watch the product from the viewpoint of an audience member or outside eye. One noted unique means of incorporating videography in dance includes a study on the relationship between choreography and surveillance equipment, where inspiration for dance was drawn from the today's surveillance tracking of movement in regular day-to-day life (Skybetter, 2019). Product designer Lesia Trubat took the incorporation of technology in dance one step further: by designing ballet pointe shoes that could track the pressure and movement of a dancer and render them into a visible form (Hosmer, 2014).

However, what separates these aforementioned endeavors of combining technology and dance choreography and this approach is the fact that the choreographic inspiration used here is a deconstruction of the movement via a unique visualization based on a comparison of its fundamental physical waveforms. Most technological methods, while similar in their use of sensors to take the data, typically visualize the full form of a human or some part of it in a position-tracking sense (in physical space). Thus, it is still a direct, relatively qualitative representation of the movement; whereas here we leverage a very old mathematical visualization technique (Lissajous) with newer technology (Bluetooth wireless sensors and handwritten mathematical code) to deconvolve dance movements to fluid images of their accelerations, and use them as a tool for choreography composition. That said, all of the cited endeavors including the present study could fall under a broader description of "digitally-inspired dance choreography," where technology is used to aid in creativity during the choreographic process.

In this case, mathematical and physical analysis of a Lissajous figure is leveraged in the artistic branch of dance, which to the author's knowledge has never been done before. Limited studies of dance through a purely physics lens have been conducted, notably Laws and colleagues performed the foundational work exploring the underlying fundamental physics of various dance steps, including balances, turns, standard jumps, and aerial jumps (Laws & Sugano, 2008). However, the focus of their work is from a postmortem analytical understanding of the movement and appreciation for a dancers ability to perform it, and not as a choreographic visualization tool as used here. Consequently, we present Lissajous patterns in modern dance movement expanding on a physical manifestation

of dance, and by applying these findings, in turn utilizing these manifestations to produce dance choreography from a new source of inspiration.

Equations of a Lissajous figure

Lissajous figures are a unique set of parametric equations that have a generalized form listed in Equations 1 and 2, as:

$$x = C\sin(at + \delta) \quad (1)$$

$$y = D\sin(bt) \quad (2)$$

Here each of these are wave equations, and C and D represent the amplitudes of each respective wave, while a and b represent their frequencies. The delta

term (δ) refers to the phase shift between two different waves, while t is the independent variable. These concepts are explained in detail below.

Taking a set of t -values, ranging from -2π to 2π , and plotting their cosine and sine functions in increments of $\pi/2$ results in Figure 1a. The amplitude can be described as the height of the wave, or the distance between its peak and zero. Frequency is the number of occurrences a wave repeats within a certain amount of time. Using the plot from Figure 1, increasing the amplitude of the cosine wave results in Figure 2, while the result of increasing its frequency can be seen in Figure 3. The effect of changing the phase-shift between the two waves is represented in Figure 4.

Depending on the ratio between the frequencies of the waves and the phase-shift between them, various patterns are formed when the parametric is plotted; some of these figures can be seen in Figure 5.

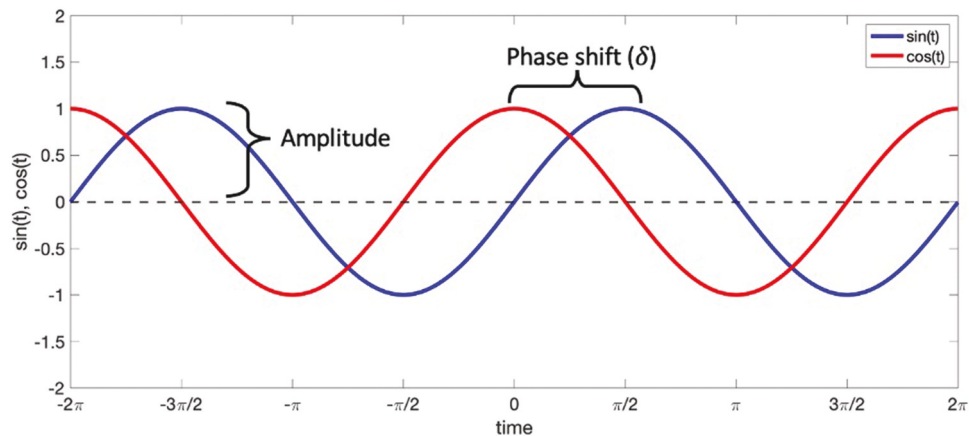


Figure 1. A sine and cosine wave (example parametric equations), both with an amplitude of 1, and a phase-shift of $\pi/2$ between the two waves.

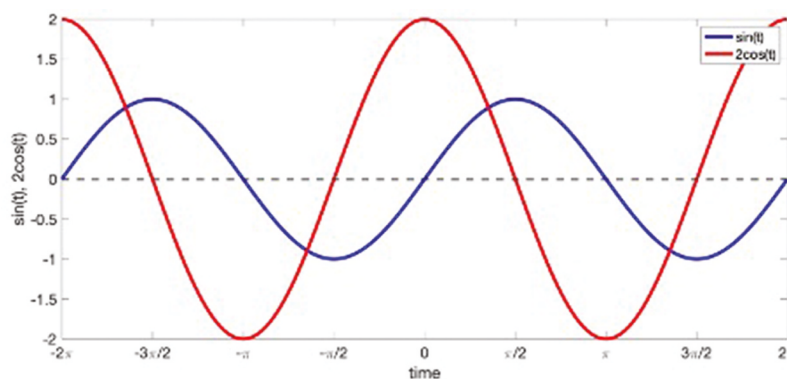


Figure 2. The amplitude of the cosine wave has been multiplied by 2 while the frequency was kept at 1. The sine wave remains unchanged.

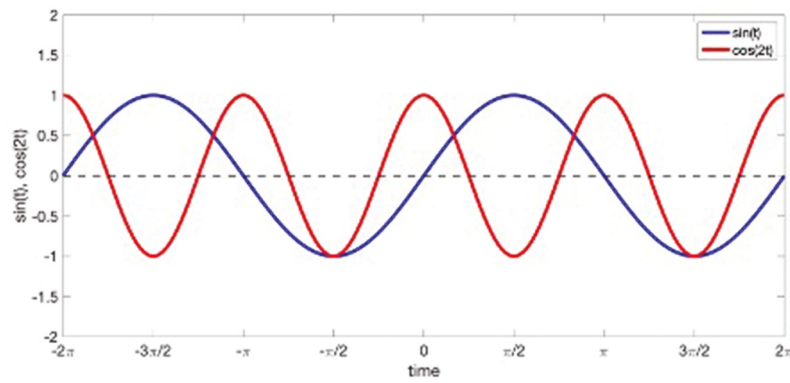


Figure 3. The frequency of the cosine wave has been multiplied by 2 while the amplitude was kept at 1. The sine wave remains unchanged.

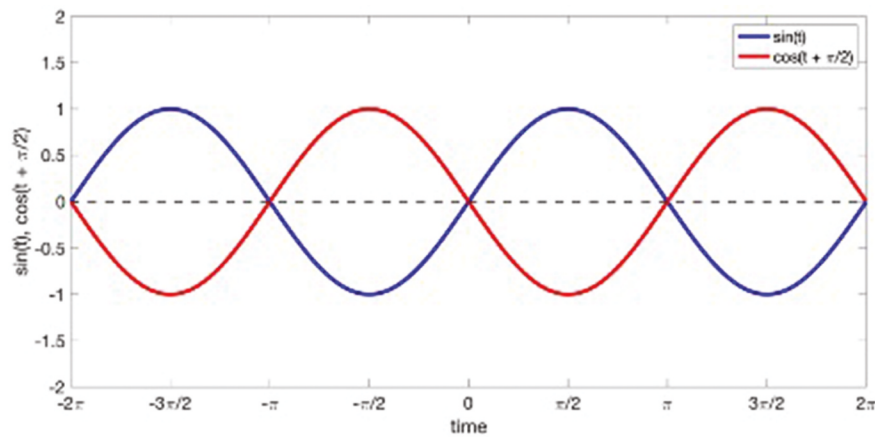


Figure 4. The cosine wave from Figure 1 has been shifted by $\pi/2$ while the sine wave remained unchanged.

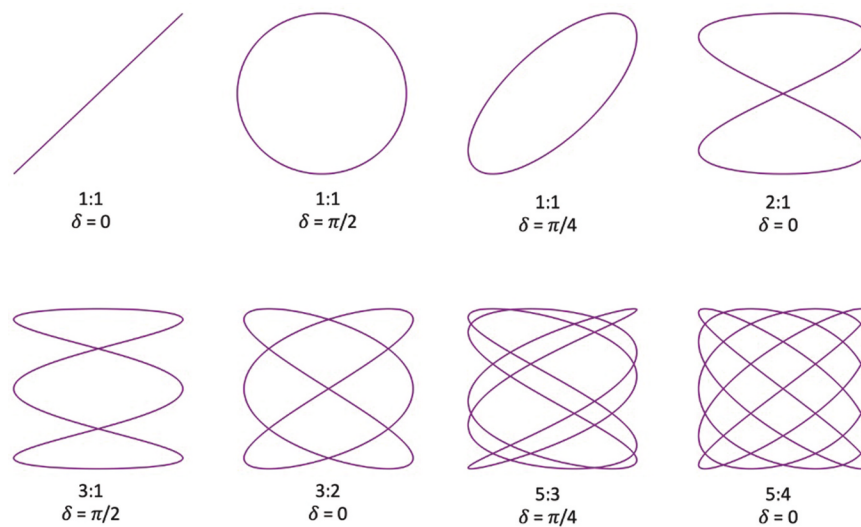


Figure 5. Examples of Lissajous figures, with varying frequency ratios and phase-shift values.

Method

Participants and materials

In this project, we have collaborated with a nonprofit professional modern dance company based in Washington D.C. metro area, the Bowen-McCauley Dance Co., led by chief choreographer and artistic director, Lucy Bowen McCauley. Accelerometers from MBientLab called “MetaWear” sensors were affixed to the dancers at different locations, such as the ankle, wrist, waist, and forehead with athletic tape, as shown in the schematic of Figure 6. These accelerometers measured acceleration (or the rate of change in velocity) of motion at the location affixed in three axes.



Figure 6. A schematic of wireless accelerometer placement on dancers involved in this study. The wireless accelerometers used to collect essentially real-time data via Bluetooth technology using the product smart phone application.

Proof of concept

As a proof of concept, we first collected acceleration data on a subject with the wrist accelerometer attachment. These data were collected as the subject moved their arm vertically up and down in a repetitive motion; initially at a “slow” rate, followed by a “quick” rate (referred to as slow and quick movement, respectively). The data was collected wirelessly via Bluetooth technology on the smart phone application for MBientLab MetaWear. The data were transferred, processed, and visualized with custom MATLAB (mathematical coding software) programs written by the authors in near real-time. Figure 7 represents the Cartesian coordinate system for the accelerometer used, and Figure 8 displays the

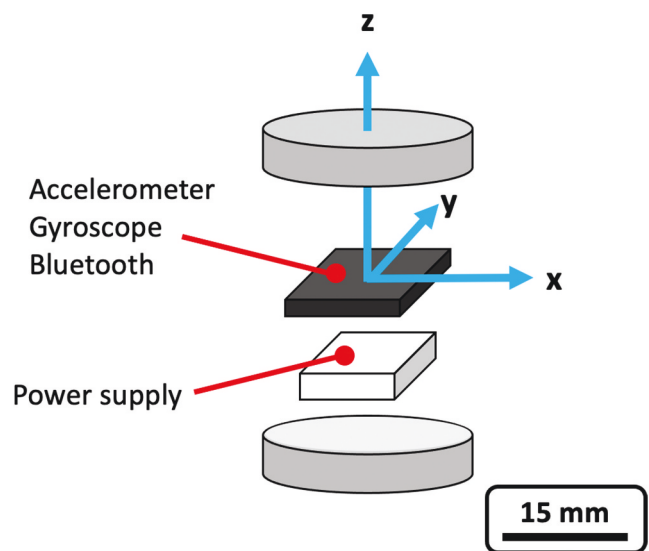


Figure 7. Schematic of the accelerometer (exploded view) and coordinate system used in the analysis: the x-, y- and z-directions are denoted by the axes presented, sourced from MMR, MBient Lab.

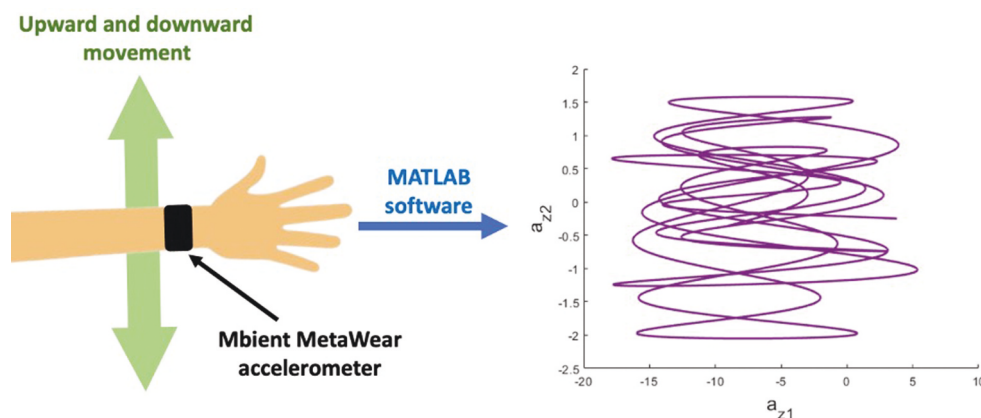


Figure 8. A Lissajous pattern composed from proof of concept “slow” and “quick” repetitive arm movements in the z-direction.

acceleration in the z -direction (or up-down axis), denoted a_z , of the “slow” movement plotted against the acceleration in the z -direction of the “quick” movement. When these two graphs are plotted together, a parametric curve is created, forming a Lissajous pattern.

Application to dance choreography

The majority of raw accelerometer data were collected during the first rehearsal of the new season with eight professional dancers (four men and four women) and the artistic director (referred to as the choreographer). Prior to this first rehearsal, the choreographer had conversations with the authors in order to have a general understanding of the dancer’s acceleration measurements, as well as the fundamental concept of visualizing movements through Lissajous plots based on the measurements, in order to inform and inspire the dance choreography process. As such, she used these prior discussions to create two initial phrases of movement as a theme to start from, which she dubbed the “Pod” and the “Grand Circle.” These movement phrases were approximately 60 seconds in total length, but the data-taking portion leveraged for Lissajous analysis was varied between 20 and the full 60 seconds in length. It should be noted that these phrases were performed to an audible beat (in time) so that the dancers stayed in synchronization and the phrases were repeatable from a data perspective. These phrases were then taught to and performed by the dancers (often in repeated fashion) wearing the accelerometers at the first rehearsal, and a feedback loop between the modifications of the initial phrases of choreography and development of new choreography via Lissajous visualization was created between the authors and the artists. The time between taking the raw acceleration data from movement and creating various Lissajous plots to visualize it was on the order of minutes thanks to nearly immediate wireless transmission of the data from the sensors and the efficient mathematic codes to process and visualize it. Thus, the response time between artists and authors, while not instantaneous as is usual dance choreography creation (in that the choreographer typically uses the mirror in the dance studio to be inspired and create their phrases in real time), remained relatively immediate. That said, both dancers and the choreographer tended to watch the animation of the produced Lissajous figure resulting from their efforts on the computer screen multiple times for inspiration, so this added time for absorption of the new creative medium that was not usually part of the choreographic process.

During the “Pod,” the dancers were positioned at center stage in a condensed formation. In synchrony, the dancers slowly undulated their upper bodies with slight variation in bending of their knees; this movement was repeated as a base step with various dancers, and one by one they elaborated on this movement, e.g., the female dancers were lifted by a male partner during an undulation. The “Pod” is demonstrated in Video 1 found in the supplementary material. The acceleration data was collected in three Cartesian directions (a_x, a_y, a_z , with respect to the coordinates shown previously in Figure 7) for two different dancers. The first dancer’s accelerometer (Dancer A) was attached roughly to their center of gravity (around their waist), while the second dancer’s accelerometer (Dancer B) was attached to their right ankle.

A second phrase, the “Grand Circle,” was analyzed similarly to the “Pod.” Within the “Grand Circle,” the dancers performed a short combination of steps while moving in a large circle pattern, rotating clockwise. All eight dancers revolved along the outside of the circle while they performed a sequence of individual rotational steps during their translation, such as full body turn with both legs straight together (classically referred to as a *soutenu* turn) followed by a roll onto the floor. The “Grand Circle” movement phrase can be found in Video 2 of the provided supplementary material. The first dancer’s accelerometer (Dancer C) was attached just above their right knee, while the second dancer’s accelerometer (Dancer D) was attached to their abdominal area, or essentially very close to their center of gravity.

This method and these two movement phrases provided a seemingly unbounded amount of data combinations that could be used to generate Lissajous figures to inspire the choreography. This was due to the fact that there were multiple parameters of data available to utilize including different dancers, sensor locations, axis of acceleration chosen and duration of movement for the two different phrases. Here, we focus on two different combinations of dancers with sensors in two different locations for each of the two movement phrases. This allows us to demonstrate the differences and similarities of the resulting Lissajous figures when examining different axes of acceleration and different durations for the same dancers, sensor locations, and movement phrase.

Results

Figure 9a,b illustrate the as-collected, or raw data for each dancer in acceleration space for the “Pod,” which appear to have no relation. However, when these two waves were plotted against each other, this formed

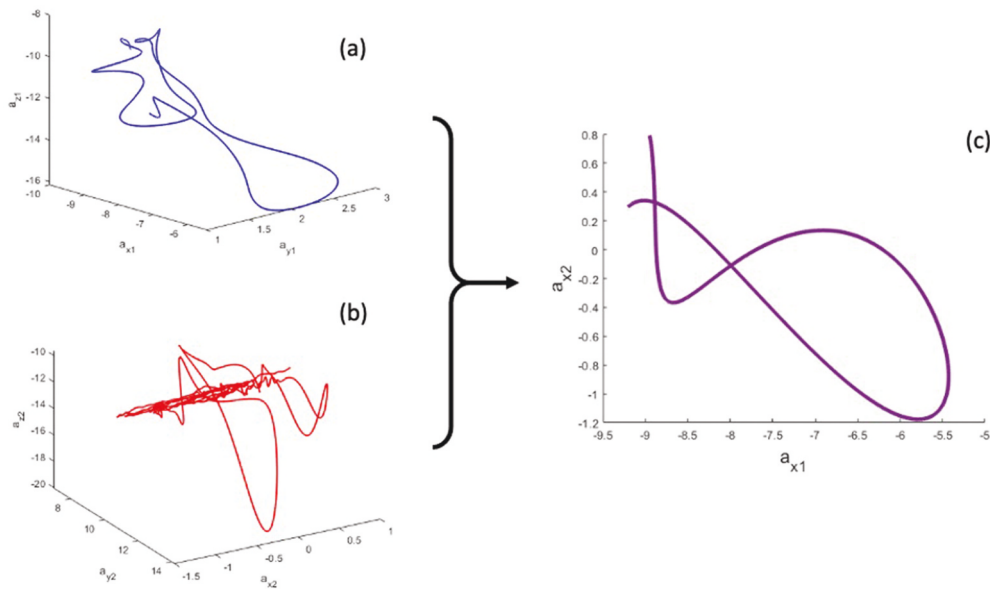


Figure 9. (a) and (b) are as collected data from the “Pod” phrase for each dancer in 3D space for the entire movement phrase. (c) “Pod” acceleration in x-direction for both dancers plotted against each other for 20 seconds of the movement phrase, resulting in a clear Lissajous figure.

a parametric composed of the a_x of Dancer A and the a_x of Dancer B, and a clear Lissajous pattern is formed, as shown in Figure 9c. This Lissajous pattern may result due to the repetitive nature of the undulated motion in each dancer’s body, giving the choreographer a pattern to work from when developing further movement. Figure 9a–c demonstrate about a 20 second duration of the “Pod” movement phrase, which exhibits a clear infinity-like shape in the Lissajous plot.

Figure 10 illustrates the same “Pod” phrase for the same dancers with the same sensor locations, but now shows the full duration of the phrase (approximately 60 seconds) and examines the y-direction accelerations, instead of the x-direction accelerations (as shown in Figure 9c). Here you see an entirely different shape emerge due to the different acceleration data chosen, and there are many more loops associated with the Lissajous figure due to the longer duration of the movement phrase examined.

Figure 11a,b show the raw data for each dancer in acceleration space for the dance phrase “Grand Circle,” while Figure 11c is the parametric data composed of the a_y of Dancer C and the a_y of Dancer D. Again, a Lissajous figure that resembles an infinity symbol is formed, much like that in the “Pod” shown in Figure 9c. This was used by the choreographer to further manipulate and visualize movement in the Lissajous space as inspiration for process, while creating dance in real space and time, as shown by the more complex Lissajous figure variant in Figure 12c.

Figure 12 illustrates the same “Grand Circle” phrase for the same dancers with the same sensor locations, but now shows the full duration of the phrase (approximately 60 seconds) and examines the x-direction accelerations, instead of the y-direction in Figure 11c. This shape is more stretched than that of the “Pod” equivalent and illustrates multiple loops due to the longer duration of data examined. This Lissajous figure has a more calligraphic, less busy appearance than Figure 10.

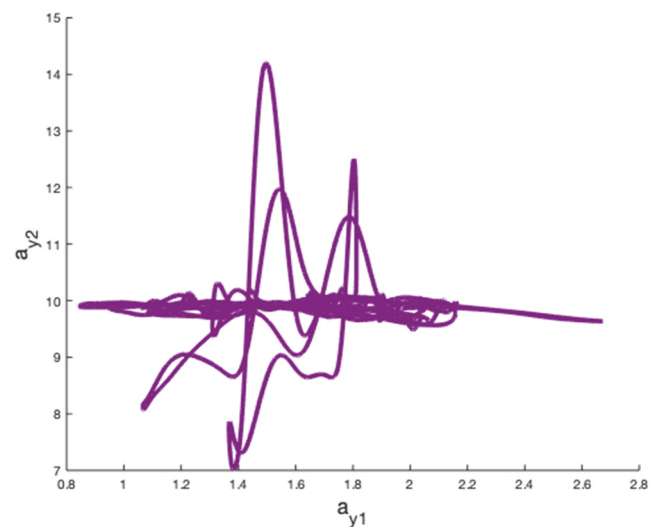


Figure 10. “Pod” acceleration in y-direction for both dancers plotted against each other for the entire movement phrase (whose 3D raw data is shown in Figure 9a,b), resulting in an intricate Lissajous figure.

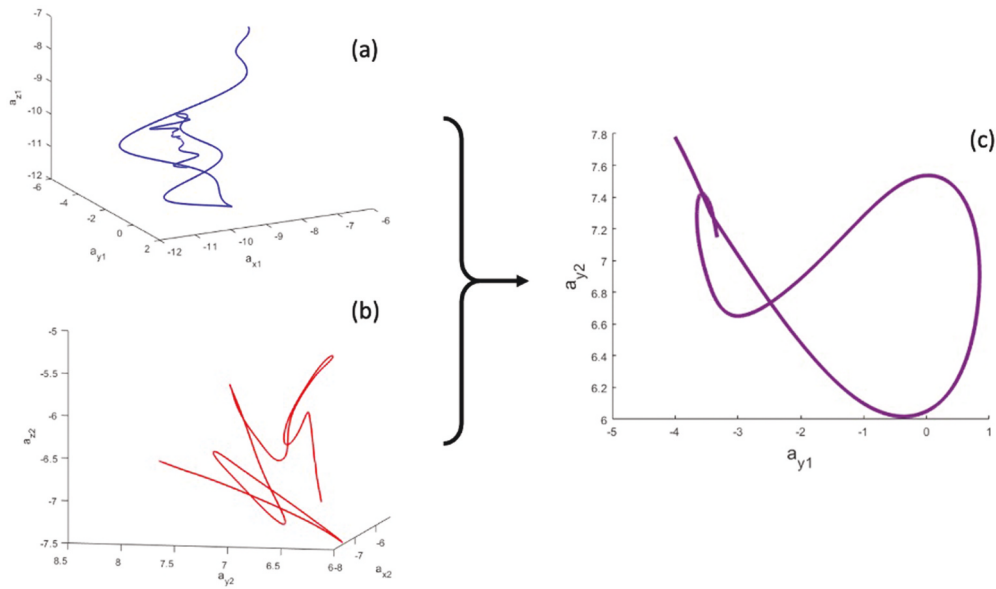


Figure 11. (a) and (b) are as collected data from the “Grand Circle” in 3-D space for the entire duration of the movement phrase. (c) “Grand Circle” acceleration in y-direction for both dancers plotted against each other for 20 seconds of the entire movement phrase, resulting in a clear Lissajous figure.

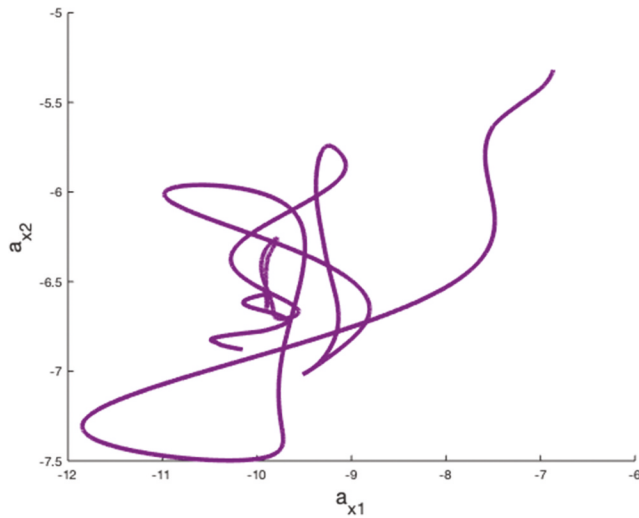


Figure 12. “Grand Circle” acceleration in x-direction for both dancers plotted against each other for the entire movement phrase (whose 3D raw data is shown in Figure 11a,b), resulting in an intricate Lissajous figure.

Discussion

We have successfully discovered distinct Lissajous patterns in accelerations in different Cartesian directions between different dancers, as well as locations on the dancers’ bodies in multiple choreographic phrases. Much like the works of those previously mentioned in the introduction section (Takiyama et al., 2020; Tesio & Rota, 2019), we were able to take the essence of movement and deconstruct it into essential components. The resulting Lissajous plots were then successfully utilized

by the choreographer to explore the dance space of two baseline phrases, and through the cycle of multiple rehearsals and interactions with Lissajous analysis, develop an entirely new ten-minute dance piece from an entirely new creative space never utilized in dance before. Instead of using the typical techniques for digitally inspired dance such as camera or smartphone recordings (Birringer, 2002; Sanders, 2021), a novel method for creating dance choreography was developed. This piece was debuted to sold-out shows with positive audience response, illustrating the potential of utilizing a unique and creative means to inform and inspire the dance creation process and demonstrating a successful intersection of arts and science.

It is possible that the Lissajous patterns present in the modern dance phrases studied here are a direct result of the specific construction of the choreographed phrases used as a baseline. The nature of the initial phrases measured are repetitive, which allowed the dancers to experience variations of harmonic motion in movement. Regardless, the phrases and analysis still allowed the choreographer a means to play with the common dance choreography concepts of theme and variation.

As mentioned previously, the insight provided by the accelerometer data on the multitude of harmonic motion in modern dance phrases provided the choreographer inspiration to create the remaining phrases of the piece. It is well known that the creative process behind any new dance choreography is complex and difficult to quantify; traditionally dance choreography can come from a variety of sources including the musical

score, a poem, the dancers themselves, a basic idea abstract concept, or even just a feeling or emotion, to name a few. Consequently, this creative choreographic process deviates from traditional choreography pedagogy approaches, which often leverage improvisation (or on-the-spot movement ideas) where choreographic elements are often born out of placing theoretical dance materials into the soma-psyche or body-spirit (Blom & Chaplin, 1982). That said, leveraging Lissajous figures for dance development still follows a well-accepted idea in choreography composition of movement creation requiring motivation and intention, it just provides a different and unique source; although it still plays with a common choreographic theme of symmetry and asymmetry (Humphrey, 1959).

To that end, in one of many interviews with the resident choreographer of the Bowen McCauley Dance Company, Lucy Bowen McCauley, she revealed that the method presented in this paper differed greatly from her traditional process and challenged her creativity and choreographic process. She often selects the music that she feels lends itself to the dance or choreography first and as her inspiration, and then creates movements that suits both the music as well as the dancers in intricate ways from there. Her goal is always to create a piece that is pleasing to the eye and the audience. However, for the piece created in this study, she stated that she deviated from this traditional method and that she was not as focused on the final product; allowing her to put aside her instinct to prioritize esthetics and letting the mathematics and sensor data and resulting Lissajous visualizations drive her inspiration instead. This unique creative approach provided an additional perspective for the choreographer to view the movement and reflect on its development in a different way. Typically, the sole lens for a choreographer to compose a piece is their direct vision of the body performing the movement, thus this methodology provides an additional outlet for feedback which can help drive the creative process in modern dance in new ways. In this case, the final dance piece was entitled *Lissajous*, and debuted in Washington D.C. at Dance Place (December 2018), then continued in the company's repertoire at the Kennedy Center for the Performing Arts in the May 2019 playbill. A photograph featuring the dancers during the piece is shown in Figure 13. It should be noted that the Lissajous visualization analysis of the dance movement also inspired the dance costumes, theater backdrop and music, for a cohesive audience experience.



Figure 13. Promo photo for the piece *Lissajous*, performed by dancers of the Bowen-McCauley Dance Company at the Dance Place in Washington DC (shown here) in December 2018, and again at the Kennedy Center of Performing Arts in Washington, DC May 2019. Photo Credit: Jeff Malet.

Limitations of current work

While advancing the literature on the application of mathematics in art in a new, unique way, some limitations must be considered. First, most of the measurements were taken in a single rehearsal period and software analysis of the movements needed to be done as quickly as possible due to time constraints of the company and their needs of the rehearsal space and time. Equipping the dancers with the sensors, acquiring data from the baseline dance phrases, analyzing the data using MATLAB software, relaying these results to the choreographer, and developing new dance phrases and choreography to be taught to the dancers did take up more time than traditional methods, even with the fast data analysis program and visualization code created by the authors. Additionally, the data was collected using modest Bluetooth-enabled accelerometers and technology, which had a noticeable lag between data collection and data uploading, as well as periods of dropped data, adding to the overall time constraint. Perhaps more robust equipment and technology could have made the process more effective, allowing for a more rapid process of producing Lissajous figures, and additional new choreography to be developed in a faster time period. Finally, it is not entirely clear if Lissajous patterns would be as apparent in classical ballet choreography, or other styles or types of dance, so further study in these areas would be worthwhile.

Future direction

As Lauren Babel, a dance-maker and human-computer interaction designer stated in a 2020 Dance Magazine article, “interacting with digital information in 3D space contains similar elements to

choreography” (Skybetter, 2020). In this way, any digital information taken from dance leveraging technology, such as the accelerations used in the Lissajous construction, constitutes a useful element in the choreographic process. Regardless, it is apparent that the exact definition of choreographic elements or building blocks continues to evolve and grow in dance. Further, the traditional conceptual boundaries in dance choreography composition, i.e. using a mirror and perhaps a smartphone, are being challenged and there is a general belief among the communities that bringing artistic intelligence to engineering can provide a more equitable and creative world (CRCL, 2021). As Birringer put stated in *Dance and Media Technologies*, “the question is not whether human bodies are obsolete, but how they can be redesigned, and how such incorporations of technologies change the stories we tell about dance and ‘being human’ in the twenty-first century.” This appears to include a process of artists and engineers, and combining disciplines. Likely in the future, more dance works will be originated from non-traditional sources and collaborations and dance may become more an exploration of the alternatives.

More specifically, a piece like *Lissajous* is particularly impactful because it brings science, technology, engineering, and mathematics (STEM) to the public using the arts (STEAM). It takes well-defined (yet over one-hundred-year old) concept in math and science, Lissajous plots, and when combined with modern technology and data capture, is able to directly apply it as a means for creative inspiration for dance choreography. After the success of this collaboration, the piece *Lissajous* will be performed in K-12 public schools in the greater area of Washington D.C. this upcoming season with an accompanying free educational curriculum to inspire the next generation of scientists, engineers, and artists. For example, the curriculum, “Lissajous: The Influence of Pi” includes one student lesson that explores the math behind circles and irrational numbers such as Pi (also known as 3.1415 ...) with corresponding circular movement dance demonstrations, and includes a supporting teachers’ guide set to Virginia’s Standards of Learning (SOLs). The curriculum was specifically designed for grades 6–8, but the teacher’s guide provides suggestions for adapting the lesson components for grade bands K-5 and 9–12 grade levels. Introducing K-12 students to STEM through the arts, thereby creating STEAM opportunities, can help challenge gender stereotypes by potentially encouraging the interest of young females to pursue degrees in STEM disciplines, which are historically male-dominated (Baird, 2018;

Segarra, Natalizio, Falkenberg, Pulford, & Holmes, 2018). Overall, this work opens new pathways to explore modern dance movement through the use of wearable sensors, and to view dance and the creative process for dance choreographers in new and more mathematical ways.

Toward that broader goal, technology in dance as a means of inspiring the choreographic process has a few emerging avenues of exploration. Some of these include the use of artificial intelligence (or AI), already being explored between world-renown choreographer Wayne McGregor in collaboration with Google Arts & Culture, for example (McGregor, 2021). Additionally, full motion capture suits, that allow for countless data points from all locations on a dancer, instead of a single sensor data from a single point on the dancer (as was used here) may provide a means to augment the choreographic process with additional and nearly unlimited visualization opportunities in movement development. Moreover, newer like-minded technology/engineering enthusiastic and artists exist such as the International Conference on Movement and Computing or the Conference for Research on Choreographic Interfaces where such advancements in wearable technology and intersections of the performing arts and technology developed (CRCL, 2021; MOCO, 2021). All of these serve as important intersections between art and science, and challenge current movement knowledge and inherent artistic expression with engineering and technological approaches.

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