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Computer Music and Haptic Mechanisms for Live Performance**

Hurban, Hedy

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*DERVISH SOUND DRESS; AN INVESTIGATION OF WEARABLE TECHNOLOGY USING
COMPUTER MUSIC AND HAPTIC MECHANISMS FOR LIVE PERFORMANCE.*

by

HEDY HURBAN

A thesis submitted to the University of Plymouth
in partial fulfillment for the degree of

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School of Humanities and Performing Arts

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Author's Declaration

At no time during the registration for the degree of Research Masters has the author been registered for any other University award without the prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at Plymouth University has not formed part of any other degree at Plymouth University or any other establishment.

I, Hedy Hurban, confirm that, except where other sources are acknowledged, the work contained herein is my own.

Word count of main body of Thesis: 17,760

Signed.....Date.....

Abstract

Dervish Sound Dress

Hedy Hurban

The realm of this thesis combines the areas of computer music, fashion design, digital art, smart clothing, biometrics, cultural traditions and performance. *Dervish Sound Dress* is a wearable piece of technology; a garment that is inspired by the sacred ‘turning’ experience of the Whirling Dervishes or the Mevlevi Sufi order in Turkey known as the *sema*. It utilizes the fundamental aspects of the *sema* such as music, performance and body movement through spiritual elation by creating a unique and interactive experience.

Wearable technology is a burgeoning field of research. Fashion designers who are using smart textiles or integrating fashion and technology in some way require collaboration with electrical engineers and programming professionals. The garment functions as a body instrument and can be manipulated by the wearer. The cultural traditions of the Mevlevi Sufis and their metaphysical experience during the turning ritual of the *sema* performance is the inspiration behind the creation of a garment that emulates sounds by using body movement. *Dervish Sound Dress* is outfitted with sensors that trigger musical sounds when the wearer touches the bodice interface or changes gesture or movement. The wearer is alerted to the sounds through the use of haptics that are sensed on the body. The sensation is similar to when a musician plays an instrument that reverberates resulting in an immersive relationship that goes further than the auditory. The aim is to develop garments that will inspire the creation of musical sounds that can be controlled by an intuitive interface in clothing. It is a study that uses technology and performance by taking a sacred experience and creating artistic expression.

Dervish Sound Dress seeks to examine how technology can be integrated into a garment as an expressive body instrument to augment contemporary sonic performance.

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Chapter 1

Introduction

The research in this thesis is concerned with using wearable technology as an intuitive interface for exploring new artistic and sonic performance practices. This chapter outlines the overall research aims and objectives and the structure of the main chapters, as well as the background story and motivations for pursuing the research project which has culminated in the creation of a wearable technology garment.

1.1 Background Story

How can gestures be used to create musical sounds in a garment embedded with sensors? Can musical compositions be made by using gestures and body movements? How can a sacred tradition that uses expressive body movement inspire the creation of a garment that can be used in new performance practices? What are the technical and conceptual challenges that need to be addressed? These are some of the questions that have emerged from this research project.

The language in which we communicate with music is ever-changing. Engaging in new ways of creating sonic experiences is a process that has limitless possibilities. The progression of this research and these concepts have been an assemblage of life experiences over several decades. More specifically, coalescing several areas of interest including music, fashion design and performance in a way that can be exceptional has presented numerous critical and practical challenges. Traveling to various cities and countries and living amongst different cultures have also impacted the design process and direction of this research.

Experiencing the music, fashion and cultural traditions when traveling in Turkey in 1998 ignited an opportunity to explore the possibilities of fusing costume and fashion design with music and performance. It was during this time that an encounter with a *semahane* or a place where the Mevlevi Dervishes practice the sacred turning ritual of the '*sema*'¹ in Istanbul opened an avenue of discovery and investigation of traditional performance practices that

¹ The *sema* is described in detail in Chapter 2; for more information refer to www.semazen.net

use body movement, music and costume design. Often referred to as the 'Whirling Dervishes' in the West, the *sema* is the traditional ritual dance or performance of the Mevlevi Dervishes of Turkey. It involves a sacred prayer and Qur'anic recitation at the beginning of the performance followed by several musical instruments leading the Dervishes through their journey as they spin in a circular movement; a spiraling portal that guides them closer to the Divine. Using music, body movement and contemplative prayer, the performance is ignited by musicians who expel melodies that drive the performers into a state of constant turning in perfect circles around a room resulting in an enthralling spectacle. These moments in time were catalysts for the conceptual design process of *Dervish Sound Dress*.

To design a unique garment that can function as an autonomous body instrument based on the music used in a traditional Turkish *sema* defines what *Dervish Sound Dress* implements. Other factors that contributed to these explorations have been engaging with reverberations that are felt physically when an instrument such as a guitar or keyboard is plucked or struck. The vibration is an essential feature that allows the player to become more physically and emotionally immersed. The design of *Dervish Sound Dress* addresses this by using sensors that emulate the experience of feeling a musical instrument by having it worn on the body.

This project gathers many threads, bringing the mystical traditions of the *sema* together with music, fashion or costume design by adding another element: wearable technology. *Dervish Sound Dress* engages with the past, the present and the future of a rich Turkish tradition by examining the captivation of the *sema* and providing an opportunity for the performer and potential audiences - to be immersed in a new sonic art experiment.

1.2 Research Questions and Aims

The methodological framework that encompasses the thesis is led through practice-based research as well as documenting the process of conceptualizing the construction of *Dervish Sound Dress*. The approach is multi-disciplinary; to develop a way to capture various gestures and body movement, to create musical compositions using samples of traditional Turkish instruments and shaping the sounds in computer music software, to utilize technology in an intuitive way that is controlled by the wearer and to choreograph movements based on Mevlevi Dervishes. The garment is an experience for anyone to encounter yet, the goal is to determine whether this can also be used by a Dervish in Turkey and implemented as a way

to augment their existing practice. This could lead to devising a contemporary performance using wearable technology and computer music compositions based on the traditional *sema* that can be presented in a setting outside of the Turkish *semahane*.

The majority of existing work on wearable technology has been in the field of sportswear and commercial applications. Although there have been considerable developments in harnessing this knowledge, the application of wearable technology in sonic art performance practices and creating costumes or garments for this purpose, is still evolving. The aims of this research are to implement new performance practices using wearable technology, with a focus on how the *sema* performance of the Mevlevi Dervishes of Turkey can inspire new musical compositions using gestural recognition and body movement. The intention is to create a relationship between a garment that is equipped with a user interface that can interact with the performer to create musical compositions and body movements that are based on the *sema*. This research should be conducted to better explore how the body can be capable of creating music by using gestures and movement.

Therefore, the main aims of this research are:

- To create an intuitive piece of wearable technology for the purpose of new performance practices which uses sound, costume design and haptic² feedback.
- To emphasize the intersection between digital art, culture and technology, music and performance, and fashion/costume design.

The direction in which these research aims are leading can be defined by answering these two questions:

- How can technology be integrated into a garment as an expressive body instrument to augment new performance practices?
- How can a sacred tradition such as the *sema* be used to create a unique contemporary sonic art experience using body movement, sound, gestural recognition and haptic feedback?

² The term 'haptic' is derived from the Greek word meaning 'touch', from Greek *haptikos* "able to come into contact with,"

1.3 Thesis Overview

The thesis is composed of three parts: The text, the sound samples and a short film of the garment with an explanatory video of the operation of the practical counterpart, *Dervish Sound Dress*. The sound samples are documented on the accompanying CD and the performance/short film is documented on the accompanying DVD. The thesis is divided into four chapters each of which relate to the preceding chapter in familiarity.

The second chapter describes the practice of the Mevlevi Dervish and how it informs the design of *Dervish Sound Dress*. It also discusses the changing context of the dervishes in performance practices. The garment of the dervish is described and how the design of *Dervish Sound Dress* is influenced by the traditional silhouette. Contemporary interpretations of the *sema* practice are also discussed as well as an introduction to traditional Turkish instruments followed by a preface to *Dervish Sound Dress*.

Chapter 3 is a survey of wearable and fashionable technology and how *Dervish Sound Dress* is positioned within this developing genre. Outlined are current examples of wearables and artists or musicians using wearable technology in their practice. Concluding this chapter is a section on gesture recognition and its use in the context of creating music with wearable devices or clothing.

The final chapter discusses the conception of *Dervish Sound Dress*; the design process, technical challenges and solutions to creating a useable interface, including test performances of the prototype and the final garment. The musical composition is also described in terms of how the sound elements were created and how and why they were mapped to sensors on the dress.

The concluding chapter summarizes the thesis and outlines outcomes of the research project as well as future work and concepts.

Chapter 2

The Contemporary Dervish

This chapter establishes the theoretical framework for appropriating the traditions of the Mevlevi Dervishes in the design of the *Dervish Sound Dress*. The discussion gives a background history and explanation of the practice of the *sema*, followed by contemporary visions of the practice and how *Dervish Sound Dress* attempts to draw from the sacred traditions to create a new and unique sonic art experience in different contexts.

2.1 The Mevlevi Practice of the *Sema*

The story of the Turkish *sema* is the ritual ‘turning’ practice of the Mevlevi Dervishes which dates back to 13th century Rum or the Turko-Persian Seljuk state, now known as modern day Anatolia (Lewis, 1963 p.14). Its capital Konya was the center of Islamic learning and a strategic point in the Seljuk Empire; this was also where Jalaluddin Rumi came to live by way of modern-day Afghanistan. It is from this region that Rumi’s name is derived and is most associated with the development of the Sufi traditions of the *sema* practice. The term ‘Mevlana’ translates to ‘master’ in Turkish and is the more appropriate name given to Rumi in Turkey. The name ‘Rumi’ in the West is associated with a ‘spiritual master’ known for his mystical aphorisms now made abundantly popular on social media and in ‘new age’ spiritual practices. However, Mevlana’s art and poetry and the development of the *sema* as an Islamic practice is often discounted by Western ‘spiritual seekers’.

The foundations of the Mevlevi Order were laid by Mevlana (Rumi), and were established by Husam al-Din Celebi and Rumi's son Sultan Valad (Can, 2005). The practice originated as a supplement to regular obligatory Islamic prayers to create a direct connection to the divine. Mevlana’s inclinations towards a more heightened spiritual experience using poetry and prayer became intensified upon meeting Shams-I Tabrizi, whose visions of combining music and mediation with dance spawned the beginnings of the *sema*³. This dance or movement while reciting prayer has its origins several centuries before him in Baghdad and was a

³ For more information on the traditions of the *sema*: www.semazen.net

meaningful way to experience listening to the voice of God⁴. Essentially, the practice was a way to guide people to a heightened form of enlightenment and connection with the divine through music and body movement. The heart of the *sema* is the music itself, which is driven by the whirling motion of the *semazen* or dervish, and the repetition of sacred text as well as Mevlana's poetry. It was his poetry that fueled the gatherings during his time and was carried forward after his passing.

"One should know that "sema" is a kind of worship expressing submission to the eternity of Allah by revolving clockwise around the heart" (Sargut, 2005).

The ceremony or performance of the *sema* involves the creation of patterns that relate to the movements of the planets and the stars. According to Köse (2005), "moving and revolving are the fundamental conditions of existence. The universe and the atom exist by revolving systematically." It is these celestial patterns that are created by revolving, turning or whirling that in a sense, enhance the dervish's likelihood of entering a pure state of focus whereby the movement and music allows a sort of 'spiritual ecstasy' by those who are believers.

The word 'sema' or 'säma' has various meanings, but all are along a similar thread including 'spiritual concert' or 'audition' (Lewis, 2000, pp. 309). The sense of loss of control during a *sema* is something that dervishes may experience so they must be reminded by the *semazenbaşı* or leader of the performance, gently tapping their cloaks to not get carried away in a complete euphoria. It is said that Rumi's poetry intensified while performing the *sema* repeatedly, and that the practice transformed him from a scholar and thinker into a true Sufi mystic among the ranks of other Sufi saints.

The *sema* ideally involves the use of poems and music to focus the listener's concentration on God, and perhaps even induce a trance-like state of contemplative ecstasy (Lewis, 2000). During a *sema* performance, the dervish begins their turning very slowly; almost as though they are undetected. The hands start to spread out as one faces the heavens, the other points down to the earth, and the turning begins as though their skirts reflect the orbital patterns of the planets. The choreographic elements of how *Dervish Sound Dress* can be performed is informed by the way dervishes turn. The movement is interpretative however, the goal is to achieve the sense that the dress is evolving from a static position to when the garment is

⁴ <http://www.dar-al-masnavi.org/mevlevi-glossary.html>

'turned' exposing how the dress changes. As the sound evolves, so does the dress; much like the climactic pinnacle of a *sema* when the *tennure*⁵ are in full turning position, the music and recitation is at its loudest, and the momentum is at its highest.

2.1.1 The Turkish Ban on Classical Turkish Music, the *Tekke* and *Sema*

After evolving for centuries where the practice became the norm among scholars and regular folk in Turkey especially in Konya, the practice of the *sema* met with inevitable backlash and ultimately, near annihilation. This significant marker in Turkish history is the period after 1925 in which the 'father' of modern-day Turkey Mustafa Kemal, otherwise known as Atatürk, in a move to reform Turkish culture, effectively banned and closed the dervish lodges or *tekke* including any religious practices and dervishes were forced to practice the *sema* underground. Music in the traditional Ottoman style used in the *sema* was also taken off the airwaves for a period of twenty months or so, where mostly polyphonic jazz, classical music and western pop were broadcast (Tekelioğlu, 1996).

According to Yalman (1968), although the ban was a fundamental way to oppress the Islamic culture and traditions of Turkey over the centuries, Atatürk believed that western civilization was far superior. The absurd overnight change in the alphabet from Arabic script to Roman lettering to become more 'westernized' resulted in an inevitable national friction⁶. This clash between the political and sacred is what has formed the identity and the identity crisis that Turks have endured for decades. It was not until after 1954 that the Mevlevi could practice the *sema* again in a religious context (Wheeler, 2002).

The traditional *sema* in contemporary society has changed dramatically. It has become a de-authenticated version of the original traditions in terms of the length and brevity of the performance, to appease the tourist industry and demands in Turkey. Authentic *tekke* and dervish performances still exist and have been revived in folkloric curriculums in schools. A variety of performances have flourished in untraditional settings where citizens can hire dervishes to perform for special events throughout Turkey, including wedding ceremonies and other functions at hotels and entertainment venues. There is some concern in the communities of traditionally practicing *semazen* (dervish in Turkish, or one who performs the

⁵ *Tennure* refers to the dress or skirt portion of the garment worn by Mevlevi Dervishes.

⁶ The history of Turkish reforms after 1925 is described in many texts, both secular and those not in support of Atatürk's drastic measures to westernize Turkey.

sema) of taking the dervish outside the context of the tekke. Interest in the *sema* although positive in reviving elements of the ritual, brings with it a fear of devaluing the spiritual integrity. When in the context of a wedding hall or public gathering, the *sema* becomes reduced to background noise and entertainment for onlookers rather than a journey that connects the performers and the audience. Therefore, appropriating this tradition is interesting to some contemporary dervish practitioners and of no interest to those who prefer to perform the ritual as it was centuries ago in the time of Mevlana.

2.2 Sufism and Dervish Philosophy

Sufism or mysticism have become synonymous in the West as being a branch of an 'Eastern' enigmatic religious practice. It is incorrect to imply that Sufism is independent of Islam (Lings, 1973 pp.16). *Dervish Sound Dress* draws upon the sacred turning ritual of the *sema*, which means 'to hear' or 'to listen' to music. It means moving with a frenzy which is fueled by the music to enter into exhilaration. It symbolically expresses the formation of the universe and man's transference of love and respect to the Creator.⁷ Kühl (2008 pp. 129) explains that feeling is evoked by the listening of music and that music 'resonates in the body', effectively allowing one to delve into a deeper state of consciousness. This is the premise upon which a trained dervish follows their path, by combining the elements of body movement and music to form an expressive musical experience. Islamic dogma emphasizes the purity of the practice in religion, which is one of the definitions of Sufism (Rahman, 1966). During a *sema*, the possibility of achieving an enhanced metaphysical state is dependent upon the dervish themselves and the pureness of their belief.

Dervishes or Sufis were called such because their clothing was of simple unrefined cloth wool or 'suf' in its raw form, unadorned without colors or accessories (Schimmel, 1975 pp.14). The aesthetic carried forward through the centuries and continued to be an important aspect of the garb donned by dervishes, especially during a *sema*. *Dervish Sound Dress* is a contrast to the austere vestment of the traditional dervish; the silhouette of the garment is similar in shape yet the textiles used are bolder in color and texture.

A dervish or Sufi is someone who has renounced material possessions and devotes and focuses their life and spiritual purity to God. Persian scholars have taken the 'der' to mean 'door' whereas 'vish' means 'to beg; essentially, the accepted meaning is that of a poor man

⁷ <http://www.semazen.net>

who goes from door to door requiring help. This is also a common word in India, Turkey, Egypt, Syria and other Arabian countries where the dervish is referred to as 'fahkir' or beggar (Brown, 1868). The meaning behind the word 'dervish' has also changed to mean 'spiritual seeker' or 'devotee of God' but in many other circles has meant 'poor man'.

The entire performance of the *sema* from beginning to end is about creating patterns through the shape of the rotating and expanding dress or *tennure* (Kilınç, 2011), the movement of the body in circular rotations around the performance space, the positioning of the hands, arms and head, as well as the music which propels the movement in repetitive formations.

2.3 Dervish Body Movement and Costume

Traditionally, the process of becoming a Dervish or a *semazen* includes going through lengthy and rigorous training to cope with the physical demands of turning for a long period of time during a *sema*. This involves having the *semazen* practice turning their foot on a chalk-filled wooden board with a nail or dowel in the center of it. Hours are spent obtaining the correct positioning of the foot by using a combination of endurance and balance in a single place - sometimes for hours at a time. It is said that the head must be tilted to contend with the effects of gravity and spinning for a long time to avoid dizziness. Dervishes spend 1001⁸ days and nights training for the moment that they may participate in a full *sema* (Schimmel, 1975 pp.234).

The training process involves adjusting the body to be able to perform the act of turning for an extended period. The turning movement has specific parameters: the left foot must be kept on the ground while the right spins the body in a full rotation either of which barely touch the floor at the same time. Although the dervishes' body seems to be in a static position, the level of difficulty in keeping the arms aligned with the head while turning takes significant practice and perseverance. It is said that the right hand must point upwards towards the heavens to receive the love from God while the left points downwards to inject that love into the earth. All the while that the dervish turns, they are conscious of the cloth that moves in sync with them; adhering to the design and shape of the garment when at the pinnacle of a turn is of great importance to a positive *sema*.

⁸ In Rumi or Mevlana's time, in order to become a fully trained dervish, one had to go to an intensive retreat of learning which included meditation, prayer practice, ethics, poetry and dance. Most dervishes who completed their training would go about their daily lives but remain within the order to practice the *sema*.

Garments worn by Mevlevi Dervishes are simple yet mesmerizing when they become fully turned during a *sema*. The dress has been compared to the conical shape made by the force that governs hurricanes (Güven et al, 2013). It is this shape that distinguishes the garment from any other performance garment and is associated with the Mevlevi practice. It is the one element in the entire *sema* that makes it intriguing and striking. Without it, the overall performance would be lacking in a strong visual accompaniment to the music. There is a technical aspect to the progression of the dress as it evolves and continues to move in spheres. This is an integral component to how the overall design of *Dervish Sound Dress* has been informed; experimenting with the relationship of the movement and shape of the dress as well as the movements of the arms and legs and the positioning of the head. The way in which sound is emitted from the garment evolves from a relationship with how the wearer moves in it.

The garment that is traditionally worn by the dervish consists of many layers; each with their own way of being tied or fastened to the body and many parts of which are symbolic. The garments are not ordinary and often indicated rank and status in the past (Lifchez, 1992). Köse's (2005) description of the costume of the Mevlevi Dervishes is as follows:

The *sikke* (cap) on the head of the dervish whose ego is dead is his tombstone.

The *tennure* (which is the white and long dress) he wears is his shroud.

And the cloak is his grave.

The *samahane* (the place where *sama* is performed) is the universe; the right side of it represents the materialistic world, and the left side represents the spiritual world.

Over the centuries, the Mevlevi Dervish costume used in *sema* evolved to a more specific form of garment that is synonymous with the dervish costume most familiar today. Variations of the headdress or the *sikke* were worn by Mevlana and his followers, eventually developing into a more conical shape that represents the tombstone of Mevlana. The different layers of cloth are an important characteristic of the diversity of Turkish traditional clothing (Koç, 2011). The *sema* often begins with the dervishes walking around the *samahane* three times 'wearing black cloaks which represent their tombs and their worldly attachments' (Friedlander, 1974 pp. 70). In Figure 1, the costume of the Mevlevi Dervish is seen in its open turned position. There are three sections that make up the entire costume not including the black overcoat; a white *destane* or jacket, the *salwar* or thin trousers, and the *tennure* which is the long dress/skirt portion fastened at the waist by a belt. The *sikke* made out of felt is visible, as are

the musicians behind the dancers who are also wearing the *tennure* along with a black overcoat. Contemporary versions of the costume come in a variety of colors, sometimes with embroidered inscriptions in Arabic on the back of the jacket.

As a variation to the traditional costume of the Mevlevi, *Dervish Sound Dress* uses colors and fabrics that are not common to a traditional dervish costume. This interpretation of the *tennure* draws inspiration from the rich Ottoman textiles of the 15th and 16th centuries. Each portion of the garment mirrors the Mevlevi garment made up of similar parts yet combines them in a contemporary way. The design and use of textiles is further described in chapter 4.



Figure 1: Mevlevi Dervish performing in Istanbul (2015).

2.4 The Dervish in Contemporary Culture and Performance Practices

In recent years, countless dervish performances have emerged. Artists and musicians have created their own interpretations and unique performances that are inspired or influenced in some way by the traditional practice of the *sema*. The context in which dervish performances have occurred in these recent decades has changed dramatically since its origins. Countless dervish performances in Turkey can be seen in theatres, performance halls, at private gatherings, including traditional circumcision ceremonies - all of which are outside the context of the *tekke*. New dervish lodges comprised of intellectuals and performance artists who are open to new interpretations of the practice of the *sema* have also begun to flourish. It has

also been popularized in the subcontinent where Turkish dervish groups have traveled to perform the *sema* for audiences who are unfamiliar with the practice.

Dervish Sound Dress is a study in appropriating a sacred practice with a view to create contemporary performance whilst revering the Mevlevi traditions. The garment explores wearable technology and new performance practices, therefore the context of where the dress can be performed may change. It is not necessarily intended to be performed in front of audiences in a theatre setting; it can be used in other settings that provide a visual accompaniment to be experienced by the wearer or onlookers. Similar explorations of this kind are being produced worldwide whether in a spiritual context or in a theatre performance setting. Contemporary performance Turkish artist and dancer Ziya Azazi, although not using any technology in his practice, appropriates aspects of the *sema* in his work. His *Dervish in Progress*⁹ as seen in Figure 2 uses methods of the *sema* by creating a dance performance that evokes a spiritual journey. The dress evolves while Azazi turns and removes layers of fabric until he becomes enveloped by it disappearing into the earth. The result is a dynamic music and body performance. Like Azazi, a surge in secular ‘turners’ has surfaced worldwide, similarly appropriating the Mevlevi traditions offering workshops with huge followings on social media, as seen in Figure 3. The costume and garment of the Mevlevi is evident yet the performance context changes. In Mevlana’s time the *sema* was performed mainly by male dervishes. Nowadays it is common for both men and women to perform in a traditional *sema*. It is also evident that explorations of using new methods of technology and music combined with these traditions are becoming increasingly popular worldwide.

⁹ www.ziyaazazi.com

Figure 2 has been removed due to Copyright restrictions

Figure 2: Ziya Azazi performing *Dervish in Progress* (Azazi, 2010).



Figure 3: Rana Gorgani, ranagorgani.com (2018). (Permission to reproduce this image has been granted by Rana Gorgani)

The Bollywood film *Johda Akbar* from 2008, as seen in Figure 4, is an example of appropriating the dervish performance in a scene where the Mughal Emperor Akbar becomes involved in a trance as he is observing the dervishes perform before him. He engages with the dervishes and becomes immersed in the spiritual 'whirling' experience.

Figure 4 has been removed due to Copyright restrictions

Figure 4: A scene from the film *Jodha Akbar* where Akbar performs with dervishes (Hritik Films, 2018) Screenshot by author.

Artists and performers globally have begun to explore the beauty behind the *sema* and have interpreted the performance in different settings, whether at music festivals, the theatrical stage or performed for private groups who are interested in learning the art of ‘turning’.

Musician and performer Mercan Dede often collaborates with traveling dervish Isha Kurun who turns in various spectacular locations. Dede uses an electronic approach to Sufi music, and Isha Kurun often wears colorful and dazzling *tennure* such as the mirrored *tennure* in Figure 5 an example of digital art combined with the traditional movement of the *sema*.

Figure 5 has been removed due to Copyright restrictions

Figure 5: Isha Kurun performing in a mirrored *tennure* (Kurun, 2018).

The Egyptian *tanoura* performance has also gained momentum in the last two decades; this is a type of performance that is derived from the Turkish *sema* which has now become a popular, spectacular exhibition of wild and accelerated turning combined with lively and colorful costumes and rhythmic music involving several instruments. Performer Mohamed Ghareb in Figure 6 uses LED's to light up the skirts in which he performs. The display is a dynamic show of lights as the skirts unfold into two separate pieces and spin above his head and on his waist. The music that accompanies the performance is rhythmic and fast-paced captivating audiences.

Figure 6 has been removed due to Copyright restrictions

Figure 6: Mohamed Ghareb performing in an LED *Tanoura*, (Chile, E. 2016) Screenshot by author.

These contemporary performance practices derived from dervish traditions inform *Dervish Sound Dress* in terms of how the act of turning can create compositional momentum using music, body movement and digital art.

2.5 The Turkish *Tambur* and Computer Music Compositions

Music is the key factor in a successful *sema*. The *semazen* must whirl with the recitations and the musical compositions of the musicians and become at one with the entire piece from beginning to end. There is a rhythm that is felt which the *semazen* or dervish uses to assist them in a fluidity of movement and concentration. Traditionally, several instruments are used during a *sema*; most notably the ney (a flute-like instrument), a *khudum* which is a percussive instrument and the *tambur* (a classic stringed instrument). Historically, these instruments and the genre of *Klasik Türk Müziği* or Classical Turkish Music were instrumental in compositions created for the *sema* in the Mevlevi *tekke* or lodges (Bates, 2011 pp.31). According to Eryaman, (2012) the *sema* consists of listening to music and participating in whirling movements and chanting to reinforce ecstasy and attain a mystical state. In traditional performances, the musicians improvised melodic compositions called 'taksim' and determined the direction of the *sema* based on their mystical feelings (Friedlander, 1974). For the ceremony to be validated, three important elements must exist: music, dance and oneness with God (Friedlander, 1974).

The softness of the *ney* compositions are the preferred instrument for the *sema*. However, the *tambur* is the instrument used in this project for the sound component. Organic sound samples are taken from *tambur* musician Celaluddin Çelik in Istanbul in November of 2017. The Turkish *tambur* is a seven-stringed fretted instrument with a very long thin neck and a large wooden shell usually made from Persian walnut or Indian rosewood among others. The strings are plucked using a tortoise shell plectrum. The instrument itself is very sensitive to temperature changes and therefore, depending on the environment, the resonance can change as well. The tension of the strings is quite strong and are stretched very tightly along the wooden base. When played, melodies are made up of a range of semitones and microtones known as *makam*¹⁰.

The musical element of *Dervish Sound Dress* seeks to implement reflections of the *tambur*. When the *tambur* samples are manipulated using sound-shaping software, the timbre of the instrument is amplified by using time-stretching, echo, and reverb effects. The *tambur* is a uniquely ambiguous instrument; it requires great skill and years of training to produce melodic arrangements and the relationship that the musician develops with their instrument is symbiotic. The sound samples and melodic compositions that are created from the *tambur* evoke the mystical spirit of the *sema* yet, arranging them in an anomalous way using computer music sound techniques. The compositions are discussed further in chapter 4.

2.6 Dervish Sound Dress; A Performative Wearable

Although numerous dervish orders have existed globally over the centuries, the specific focus and inspiration behind the project is based upon the Turkish Mevlevi Dervish order often referred to as the 'Whirling Dervishes' (Lifchez, 1992). The aim is to reflect the conical shape of the garment when it is turned and explore how sound can relate to that movement and shape. These reflections will also be examined in terms of how dervishes move their arms and position themselves during a *sema*. These various movements and echoes of traditional Turkish Classical movement inform the design process of the dress. *Dervish Sound Dress* mingles disciplines by contrasting technology and the sacred and creating artistic expression from it. This is explored through designing a garment that uses a range of sounds, melodies and rhythms utilizing active haptic mechanisms and proprioception for the wearer. *Dervish Sound Dress* uses organic sound samples of the Turkish *tambur*. The motive is to emulate

¹⁰ *Makam* are a set of musical modes made up of scales using 7 notes that are repeated and are often used in Turkish, Persian and Arabic music. <http://www.maqamworld.com/en/maqam.php>

the vibrations that are felt while a musician plays an instrument, and the emotional response that the musician and a performer, such as a dervish, feel using sonic arrangements of the *tambur*. By combining the areas of wearable technology, costume design, computer music and performance, a musical journey which is felt and created by the performer can also be experienced by the viewing/listening audience, thereby immersing them into a unique sound experiment.

The motivation to create this garment is to explore how the body can be used to create choreographed melodic sounds. Exploring dervish movements in a contemporary context could impact new forms of performance similar to those previously mentioned. The sound feature of *Dervish Sound Dress* gives a variety of musical possibilities for the wearer to explore. It also reminds the listener that the melodies produced resemble an uncommon instrument. Compositions can be made by using the dress in different ways, such as touching two buttons at the same time to create a blend of sounds or using the arms to add to a sound or melodic tone that are already in progress - this improvisational fluidity forms the overall composition of *Dervish Sound Dress*.

The materials used in constructing *Dervish Sound Dress* are inspired by the rich colors and textiles of the Ottoman period dating from the mid-16th century. In Figure 7, an example of Ottoman ornate silk kaftans worn by the Sultanate shows in detail the elaborate patterns in the colors of gold, blue and red. Many *entaris*¹¹ or kaftans that were worn by the Ottoman Sultans were also appropriated by the dervish orders in Turkey, although their garments were far less ornate and detailed. In Figure 8, an eighteenth-century silk jacquard *entari* is shown made with scalloped sleeves in contrasting colors. The different layers of cloth are an important characteristic of the diversity of Turkish traditional clothing (Koç, 2011). In Figure 9 the traditional garments worn by the Mevlevi consist of an ensemble of a white jacket that is tied around the waist, a belt or sash, and a large white circular skirt with long trousers underneath. As the skirt opens during a 'turning' performance, the more magnificent the silhouette becomes.

¹¹ The *entari* is a traditional Turkish garment that consists of layers of robe-like dresses.

Figure 7 has been removed due to Copyright restrictions

Figure 7: Kemba kaftan with star pattern, late eighteenth century Topkapi Sarayi Muzesi (Atil 1987).



Figure 8: An Ottoman silk jacquard *entari* from mid-sixteenth century Istanbul, (2017).

The performative aspect of *Dervish Sound Dress* provides an opportunity for the wearer to experience a garment that emits tactile sensations while moving or turning as a dervish. This could lead to a theatrical performance or simply an exploration of feeling and making musical

sounds. The garment is intended to be used on either male or female, professional performer or not, a dervish, or those wishing to experience the unique sensations of creating musical compositions using a piece of wearable technology that is based on a sacred form of body movement. *Dervish Sound Dress* is a piece of wearable technology; it is an interpretive art performance piece that implements technology into clothing.



Figure 9: A Whirling Dervish Ceremony in Istanbul (2015).

Chapter 3

Previous Work on Wearable Technology

The focus of this chapter is to introduce other work in the field of wearable technology which includes fashion designers, artists, performers and sonic artists. The intention is to survey the developments of wearable garments and how *Dervish Sound Dress* relates to this work.

3.1 Wearable Technology in Clothing History

Wearable technology can be defined as the use of technological interfaces that are interlinked with textiles for fashion or practical functionality. Humans have had a desire to develop technology that extends the functionality of the human body (Olsson, 2008). Wearable tech also falls under the umbrella of 'smart' accessories such as wristwatches, headgear, eyewear and footwear. Wearable fashion technologies are in fact 'designed' garments accessories, or jewelry that bring together aesthetics and style with functional technology.

Fashion and technology have been linked for longer than humans are aware of. For centuries people have been constructing ways of using devices or technology in one form or another and integrating the use on the body. An example of this is pocket-sized sundials discovered in the 11th century. The first eyeglasses, recorded in the thirteenth century, and metal fibers and yarns have been used by different cultures since around 2000 B.C. (Kettley, 2015. pp. 11). In more recent history, a device that is worn close to the body is the Sony Walkman, invented in Japan in 1979. The portable device was designed to carry music with the individual wherever they chose to. This item of wearable technology was used in close connection with the wearer by either being clipped to a belt, held by hand, or worn strapped over the neck. The Walkman was a technology of desire, of freedom and, most importantly, the self (Lees-Maffei, 2004). Having access to music wherever the wearer chooses to go is a huge leap in technological advancement and in personal interaction with a wearable device. Designers, musicians and artists have looked towards using technology to comment on how technology informs relationships between humans and computers. Loïe Fuller's *Electric*

Dresses from her dance experimentations and performances of the 1920's are examples of wearing tech on the body (Birringer, 2009). In the late 1880's the Electric Girl Lighting Company¹² presented girls who could be hired to entertain guests in different venues while wearing gas lights or electric bulbs on their heads with batteries concealed in their clothing. Artist and performer Benoit Maubrey's work investigates the intersections of electroacoustic music and clothing in works such as *Audio Jackets*, where he outfitted jackets with speakers emitting mobile sound as sculpture and performance (Clarke, 2005). Visual artist and performer Nam June Paik initiated works such as the *TV Bra* as a performance piece using technology that was worn on the body. His work often references Buddhism and the spiritual associations of prayer and contemplation juxtaposed against contemporary mechanical devices in several iterations of his *TV Buddha* piece (Lee, 2010). Japanese artist Atsuko Tanaka is famous for her *Electric Dress*- a dress designed to overwhelm the senses- and arguably produced the first wearable technology garment in 1956 by wrapping dozens of lightbulbs and wires over the body in a performance setting (Kunimoto, 2013).

3.2 Innovations in Wearables

The changing landscape of technology and how societal and economic pressures of using technology in varying ways to suit consumer interest and demand is what the future holds. The possibilities of exploring emotive textiles and garments can change the shape of the capabilities that wearable technology can provide. The scope for creating textile interfaces that engage a global audience should be intuitive, and compatible with emotional adapters (Quinn, 2010). Where fashionable technology refers more directly to the sense of style that a person reflects while wearing a garment that is designed with a mode of conveying an amplified fantasy, wearable technology deals with wearing objects that have been electrically engineered or programmed in such a way that the wearer can interact with the garment. Berzowska (2005) remarks that a 'wearable' garment should be constructed in a way that makes sense to the wearer; that it is practical for use on the body and does not interfere with functionality. Moreover, it should be attractive and a seamless integration in the cloth so that the wearable computer is less fragile. The explorations of the intersections between wearable technology and fashion are inevitable. Fashion designers who are using smart textiles or integrating fashion and technology in some way require collaboration with electrical engineers and programming professionals. Architect and interaction designer Behnaz

¹² <https://www.flyingcarsandfoodpills.com/electric-girls>

Farahi¹³ uses 3D printing technology combined with sensors that analyze the behavior of the human body resulting in imaginative fashion creations.

Technological innovations have made it possible to allow for processing power to double, components to become miniaturized, and alternative energies to become viable options (Seymour, 2009). Fashionable wearables require new offerings from computational technology where innovation is much more advanced than in clothing design technology (Zhang, 2016). Technological advancements in using smart or conductive threads and textiles, energy harvesting as well as biomimicry, chemical, Nano, and bacterial textiles are breaking ground in the research for new implementations of wearable tech.

3.3 Wearing Music and Fashion Technology

The growing interest in making technology become a part of the body is evolving daily where devices are being used in clothing to monitor and perform a variety of different functions. Seymour (2009) discusses that wearable fashion technologies are in fact ‘designed’ garments, accessories, or jewelry that bring together aesthetics and style with functional technology. Companies are developing devices that have the capability of being linked to garments where the garment seemingly becomes the device or the interface. Integrating technologies seamlessly with the body poses numerous challenges, including the intuitive nature of computing, cost effectiveness and practical functionality. So far, humans are only just beginning to examine the possibilities of how wearable technologies will affect the lives of humans. Devices created to enhance music listening have also become an integral commercial market for developers of new wearables.

Innovations have been made to carry music with the wearer as a wearable device or article of fashionable clothing or accessory, such as the BOSE *SoundWear Companion*¹⁴. It is a neck band that is essentially a state-of-the-art speaker worn around the neck. The *SubPac*¹⁵ is designed as a backpack that allows the wearer to feel musical vibrations by embedding haptics and proprioception receptors. The backpack can be used to augment tactile and auditory experiences in concert settings or private listening situations by relaying the reverberations of musical sounds to be felt directly on the body. This gives the listener an

¹³ <http://www.behnazfarahi.com/bodyscape/>

¹⁴ https://www.bose.co.uk/en_gb/products/speakers/portable_speakers/soundwear-companion.html

¹⁵ <http://subpac.com/about/>

opportunity to engage in a participatory experience with music; to heighten the senses. *BodyRocks*¹⁶ have developed small stone-like wireless devices that can be worn in different parts of clothing such as on the chest, the abdominal area, the arms and legs. The 'stones' emit haptic vibrations that give the sensation of music being felt all over the body. By adding a physical dimension to listening to music, wearers are immersed in a unique way of experiencing musical sounds by putting it onto their bodies and skin. *Dervish Sound Dress* is less about a practical gadget that can be a commercial device used for personal entertainment. It employs some of these aspects of innovative wearable technologies however, it is constructed as a wearable body instrument to be used for artistic performance purposes.

3.4 Fashion as an Interface

Commercial interest in fashionable wearables is increasing, as seen in clothing using embedded technologies that are becoming more evident in the areas of sport, healthcare, rescue services and security (Seymour, 2010). The possibilities of exploring emotive textiles and garments can change the shape of the capabilities that wearable technology can provide. The scope for creating textile interfaces that engage a global audience should be intuitive, and compatible with emotional adapters (Quinn, 2010). Where fashionable technology refers more directly to the sense of style that a person reflects while wearing a garment that is designed with a mode of conveying an amplified fantasy, wearable technology deals with wearing objects that have been electrically engineered or programmed in such a way that the wearer can interact with the garment. Our interactions are changing with wearable technologies as we are changed by them (Cranny et al, 2008). Fashion designers in the last three decades have begun to explore using multidisciplinary approaches, using wearable technology to make commentaries on what humans wear on their bodies, and why. Creating clothing using technology that is functional or even meaningful has not been the focus for researchers, artists and designers; however, these innovations are becoming more viable and appealing for consumers (Seymour, 2010).

Fashion designers are embracing the demand for commercializing their products, making them accessible for the mass market. Integrating software interfaces into clothing is becoming more streamlined and less gadget-like. Innovations using this type of technology have been developed in garments such as the Levis Commuter X Google Jacquard trucker

¹⁶ <http://bodyrocksaudio.com/>

jacket. Designed for cyclists to navigate themselves easily and to perform basic functions like answering a phone or changing music selections, the jacket provides simple garment construction with a solid and user-friendly interface. The user can program the textile interface, so that their gestures essentially have meanings that activate the preferred functions (Arthur, 2016). Anouk Wipprecht uses fashion as an interface in her designs. Her *Synapse Dress* (Figure 10) is outfitted with sensors that react to the wearer's brain waves (Cass, 2016).

Figure 10 has been removed due to Copyright restrictions

Figure 10: *Synapse Dress* (Cass, 2016).

Designers have explored integrating technology with garment construction to produce awe-inspiring art creations that are worthy of being shown in venues such as galleries or museums; some are even theatrical in nature. Some are conceived as technical demonstrations and collaborations with software companies looking to further expand the wearables market.

3.5 Fashion, Digital Art and Performance

The designers/artists in this chapter use similar systems that *Dervish Sound Dress* employs. The work exhibits the possibilities of exploring new developments using the body and wearable technology in the areas of sonic art, performance and costume/fashion design. Fashion designers are collaborating with engineers and scientists to create groundbreaking designs and technological advancements. Seymour (2009) remarks that the importance of collaboration between designers and engineers is key to developing technology and wearable garments.

Turkish designer Hussein Chalayan explores the idea of transformation and metamorphosis using textiles and technology. Chalayan's work lies in his ability to explore principles that are visual and intellectual, charting the spectral orientations of urban societies through tangibles like clothing, buildings, aeroplanes and furniture; and through abstractions such as beauty, philosophy and feeling (Quinn, 2003). The *Remote-Control Dress* (Figure 11) is an experiment in wearing a garment that transforms from one intangible object to a tangible one. The dress is inspired by the workings of an airplane; the hard-edged lines of airplane wings outfitted with grommets, echoing the silhouette of a linear object. It is the first known piece of fashion that has embedded sensors and wireless capabilities. The dress was built by means of technology similar to that used by aircraft engineers, to mirror the systems that make remote control airplanes fly (Quinn, 2002). Once the dress is in position, a remote controller is then used to change the shape of the dress; 'airplane wings' start to shift as though they are ready for landing or take off, suddenly revealing a beautiful tulle-like soft fabric underneath. Loschek (2009) remarks that the dress is not an investigation between the body and technology, but a means to experiment with the way the body can develop in a spatial relationship with its surroundings.

Figure 11 has been removed due to Copyright restrictions

Figure 11: *Remote-Control Dress* (Chin, 2006).

American designer and artist Melissa Coleman created *The Holy Dress* as an expression of questioning how technology touches issues surrounding privacy, intimacy and different forms of display (Pailes-Friedman, 2016). The dress is designed as a lie detector, capable of sensing changes in the wearer's emotional state or level of stress. If the dress detects that the wearer is lying, it reacts by punishing the wearer with an electric shock (Criado, 2016). *The Holy Dress* as seen in Figure 12 is the antithesis of *Dervish Sound Dress*. Its philosophy relies heavily on the Christian notion of original sin and repressing emotions whereas *Dervish Sound Dress* emphasizes the peaceful and contemplative movements and tradition of the *sema*. The dress invokes images of the Crucifixion. It uses sensors that are wired throughout the outer wire layer of the garment and lights that flash when the wearer's emotions are heightened. The haptic feedback is provided as a shock sensation against the skin rather than a pleasant feeling of vibrations when it detects that the wearer is stressed.

Figure 12 has been removed due to Copyright restrictions

Figure 12: *The Holy Dress* (Coleman, 2012).

Founded by design duo Francesca Rosella and Ryan Genz, Cute Circuit is a company that creates design excellence in the fields of wearable technology and interaction design (McCann, 2009). They have developed garments using haptic mechanisms embedded in textiles. *The Hug Shirt* is an innovative garment that uses haptic technology to send vibrations from one wearer to the other who are wearing the shirts. The participants can both feel the sensation of being embraced from a distance without being physically touched. *The Sound Shirt* (Figure 13) is made with the use of haptic vibrations to emulate a live orchestral performance that is 'felt' on the body rather than heard by the wearer. Different instruments can be felt on various parts of the shirt. The importance of how music can be felt as a sensory experience is evident in their work. *The Sound Shirt* is another example of how using haptic sensors can affect the wearer's emotional state. It is designed to help hearing impaired persons 'feel' music by translating music into vibrations (Ayque, 2016).

Figure 13 has been removed due to Copyright restrictions.

Figure 13: *The Sound Shirt* (CuteCircuit, 2016).

Imogen Heap is a British musician/performer whose work with the Mi. Mu¹⁷ gloves are changing how electronic music is performed live. The gloves are designed using numerous flex sensors and can handle gestural movements by implementing conductive textiles connected to a computer using a wireless interface. The gloves are essentially an extension of Heap's body and are programmed with sensors and actuators to react to her movements and gestures to produce synth sounds. Her performances involve singing while using the gloves, which can be programmed to a wide variety of instruments including drums, synths and other percussive instruments. The gloves (Figure 14) enable the musician to perform music by making gestures with their hands rather than by plucking a string or playing notes on a keyboard (Hobson, 2015). Through gestural recognition sensors, the gloves control a variety of functions and sounds are emitted through a loudspeaker system wirelessly. The added effect of haptics relays a vibration to the wearer prompting them to change the action of the glove, depending on the sound produced. Since the inception of Mi. Mu gloves, other gesture recognition gloves such as the Specktr¹⁸ glove which is a MIDI controller, have been developed and are used by artists and musicians.

¹⁷ <https://mimugloves.com/>

¹⁸ <https://www.specktr.com/?lang=en>

Figure 14 has been removed due to Copyright restrictions

Figure 14: *Mi.Mu gesture-control glove*, (Mi.Mu Limited, 2015).

The designs and works mentioned all relate to *Dervish Sound Dress* in some way by using haptic mechanisms for enhancing sensory output, aesthetic design characteristics, or for use in gesture-controlled musical performance. *Dervish Sound Dress* combines all of these elements while also referencing a rich sacred cultural tradition and re-interpreting it in a unique way. By engaging in a new dialogue between the relationship of the body to musical generation based on gestural actions, new implications for creating unique digital musical instruments can be explored. This can impact how music is performed through the use of expressive gestures hence subsequently allowing the performer total control over the dynamics of a body instrument. There is a huge potential for developing how portraying emotions by creating musical composition through body movement can redefine a wearer's expression which can lead to the evolution of new performance styles. There can also be physiological implications that can benefit the wearer by using vibrations that correspond to sounds that are initiated.

3.6 Gesture Recognition and Making Music with the Body

Gesture recognition technology has grown exponentially over the last decade in the areas of biometrics, virtual reality, digital music instrument design, and game design. The integration of gesture recognition technology in wearables for the purpose of making sound and music for performance is an area in which research is developing incrementally. Kanga (2016) writes that gesture related studies in multimedia performances have become a major area of exploration for computer-generated musical investigations. When referring to musical

gestures, it is the observations of how movements are made while manipulating an object or an instrument that help to better understand the experience of making music (Gritten, 2006). The next generation of interfacing the body with computer mechanisms has seen developments in products that analyze body movement through the use of light capturing sensors (Takahashi, 2015). Analyzing gestural behavior can lead to further research in exploring how gestures can autonomously control devices and interfaces for sound creation.

Wearables in the context of performance or theatre are tapping into new expressions of Human Computer Interaction or HCI using gesture recognition. Creators in the fields of music, theatre, performance and digital interaction arts are conscious of connecting the body to an interface to be used as a control center. Sound designer Balandino di Donato¹⁹ uses the Myo band²⁰ in sound and body movement performances to create musical compositions; a similar device to the Mi. Mu glove used by Imogen Heap. The Myo band is a wearable device that is pulled onto the forearm with electromyographic sensors that detect muscle movements. The device transfers data via Bluetooth signal. The sensors contain an accelerometer, gyroscope and magnetometer to recognize gestures which can be used in a variety of applications including gaming, audio/visual entertainment or for use in controlling presentations such as in PowerPoint.

Transforming gestures into sound patterns can allow the performer a physical and embodied relationship with musical schemes (Caruso et al. 2016). These cognitive progressions enable the performer to use the body to enact exchanges that are measured and analyzed using computer systems. More sophisticated and interactive devices such as virtual instruments allow the performer to control specific parameters where the composition can develop and change according to their interpretation (Winkler, 2001).

Cadoz (1988) describes the integral relationship between the performer and the instrument in terms of gesture; the production of sound has both symbolic and concrete functions. These are understood when the action of gesture is employed and sound is produced. Correlating the two in a digital music instrument is an arduous task with many variables involved, including capturing gestures and processing that data to then create sounds. Gestures that are created by touching or pressing have the added advantage of haptic representation (Miranda, 2006). This tool can be an essential feature in designing a wearable device that

¹⁹ <http://www.balandinodidonato.com>

²⁰ <https://www.myo.com/>

behaves as a digital music instrument or DMI. Using the entire body or a garment as an instrument by analyzing gestures is not a new concept, as seen in Yamaha's Miburi²¹ body instrument created in 1994 as a commercial exploration by the company. The body instrument was a gateway to create other more streamlined instruments that are gesture-controlled however, Miranda (2006) discusses that specifying gestures to create sound is problematic and therefore requires further systemization.

Dervish Sound Dress is effectively a digital music instrument worn on the body controlled by mapping gestures and sensors to create musical sounds. The diagram in Figure 15 describes the basic operation of the garment.

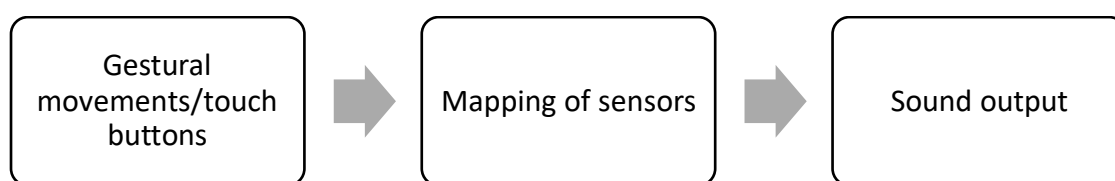


Figure 15: Diagram of operation of *Dervish Sound Dress*.

Computer scientist and musician Rebecca Fiebrink²² created Wekinator²³; a free, open source machine learning software. It allows users to create new musical instruments using gestures, to create gesturally-controlled animations and other interactive systems where the computer responds in real-time to human controlled gestures. Establishing software such as this opens a frontier for new developments in gesture recognition technology and music creation. Further exploration is needed into how garments like *Dervish Sound Dress* can control varying degrees of sounds including timbre and pitch. The sensors in the dress are mapped using Max/MSP²⁴ software and each sensor is programmed with a fixed sound sample. The aim is to analyze gestures that are more nuanced in real-time to create sounds that are computer synthesized and are controlled by a variety of body movements.

Chapter 4

²¹ <https://en.wikipedia.org/wiki/Miburi>

²² <https://www.doc.gold.ac.uk/~mas01rf/homepage/>

²³ <http://www.wekinator.org/>

²⁴ <https://cyclimg74.com>

Design, Composition and Performance of *Dervish Sound Dress*

Dervish Sound Dress is described in this chapter in terms of the concept, design and process of building a prototype to a finished wearable piece of technology which has been performed by a contemporary dervish performance artist. Outlined will be the use of fabrics, embedding sensors, testing the sensors for accuracy and observing performances of the dress. Also discussed are compositional techniques that informed the overall design of the dress using computer music compositions. This chapter also focuses on the implicit relationship of the musician and the instrument that is performed near the body.

4.1 Design and Construction of *Dervish Sound Dress*

Dervish Sound Dress is a costume that combines music, performance art, sound design, wearable technology and cultural traditions. It is designed as an art piece or a costume that emphasizes the structure and silhouette of a traditional Mevlevi Dervish costume. Although the movements that are made by the wearer are interpretive, the gestures that are mapped to the sensors are based upon the gestures made by a Mevlevi Dervish.

The conceptual beginnings were to experiment with movements that a dervish makes during a *sema*. The issue of how to integrate sound in a costume posed some technical challenges and decisions. The solutions evolved after performing a number of tests on fabric swatches and a prototype examining how sensors could be effectively integrated on a dress. The sounds that are emitted from the dress are samples from a Turkish *tambur* that have been enhanced and manipulated in some way using sound shaping software. Ideally, the wearer can experience the dress and create compositions by using different sensors and body movements. Based on these movements, the placement of the sensors was significant in terms of how sound evolves from the dress.

The dervish does not touch parts of their body while they are turning; they spread their arms and revolve continuously. *Dervish Sound Dress* reflects these movements but also engages

the wearer into an interactive dialogue with the garment. Therefore, exploring the way the body can be used to generate sounds became a part of the overall musical composition. Initially, the concept was to insert sensors along the length of the skirt portion of the dress and along the sleeves of the jacket/bodice. It was determined that having too many sensors may have been difficult in capturing one particular gesture. Therefore, the focus was to place sensors in areas that generated a desirable range of movement. For example, flex sensors at the elbows would generate enough useable data to decipher threshold values. The accelerometer sewn at the hemline of the skirt provided favorable results in capturing the rotation and height of the dress to coordinate sound with.

The original sketches of the design of the garment (Figure 16) depict the garment as a whole piece. After evaluating the functionality of having a one-piece garment, the design was modified to be made into different parts (Figure 17). The wiring and concealment of the microcontroller unit is more practical when taking the dress on and off. It is constructed in four pieces; a lined jacket, two skirts, one of which is worn over the skirt that is wired with an accelerometer/gyroscope sensor, and a belt that stores a microcontroller unit. Providing easy access is crucial when assembling the different parts of the dress by designing a convenient system to connect the microcontroller by storing all parts in the sash/belt. There is also a sash that is tied around the head to be worn as a decorative head piece reflective of the *sikke* worn by Mevlevi. The patterns were designed to fit up to a size 16 (U.K. – combined male and female block patterns) standard body size with the skirts made to be adjustable for a taller or shorter wearer. The skirts are constructed in a circular pattern to allow ample conical shape while turning. Arm bands have also been constructed to give better contact of the flex sensors with the inner elbows.

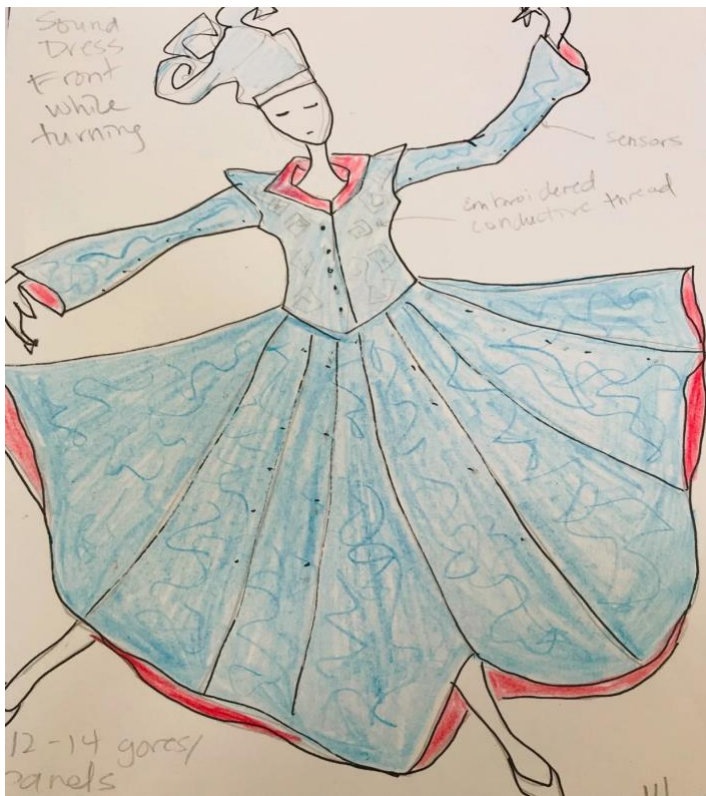


Figure 16: Initial design, November 2017.



Figure 17: Semi-final version of pattern pieces, May 2018.

The aim of the design was to reflect upon the silhouette of the *tenurre* worn by the Mevlevi Dervishes using different materials and colors. The dress is constructed from a pale blue jacquard fabric with red contrasting lining which is exposed when the dress becomes fully rotated. Before cutting the intended finalized fabric, a prototype (Figure 18) was made to determine the fit of the garment as well as the use of the conductive thread buttons and flex sensors. The sizing and the cut of the prototype was made to a size 14 (U.K.) standard size and was not adjustable which later informed the construction of the final version. The goal was to design the dress in a way that can be worn by a range of body types and sizes. The conductive thread buttons are sewn in a circular pattern on the bodice of the dress and are attached to a capacitive touch sensor. The circular shape compliments the shape of the skirt when it is opened and is also a reflection of the orbital patterns that dervishes create when performing *sema*. The conductive thread was loosely sewn on by hand which did not provide enough resistance when attached to the capacitive touch sensor. Therefore, in the final version, thicker amounts of thread were used to ensure acceptable contact with the sensors.



Figure 18: Prototype of *Dervish Sound Dress* displaying touch pad buttons on bodice.



Figure 19: Nearly completed jacket bodice with conductive thread buttons.

After successful implementation of sensors and pattern cutting, the dress was cut according to the designed patterns and sewn together. Figure 19 shows the jacket portion of the dress before the collar and lining have been attached.

4.1.1 Design and Construction Findings

The objective was to use materials that are stable and yet comfortable to wear and move in. Initially, the prototype was wired using thick insulated wiring which proved to be cumbersome and not flexible. Thinner wire was attached, which made it easier to bend and sew into the lining of the dress. Thin insulated wire was used which was effective in concealing the wiring in the lining of the dress, but it also proved to be very fragile. The sensors often broke off from the wiring and had to be re-soldered. After determining that movement in the dress using thicker, more robust wiring did not affect the comfort of the wearer, some of the wires were replaced to prevent breakage.

Before the final version of the dress was cut and sewn, a series of tests to evaluate the effectiveness of the sensors was done. In addition, the conductive thread proved to be a challenge to sew with (Figure 20). Using a sewing machine was ineffective since the thread was too thick and easily broke the needles. Hand sewing or embroidering the thread was the best method.

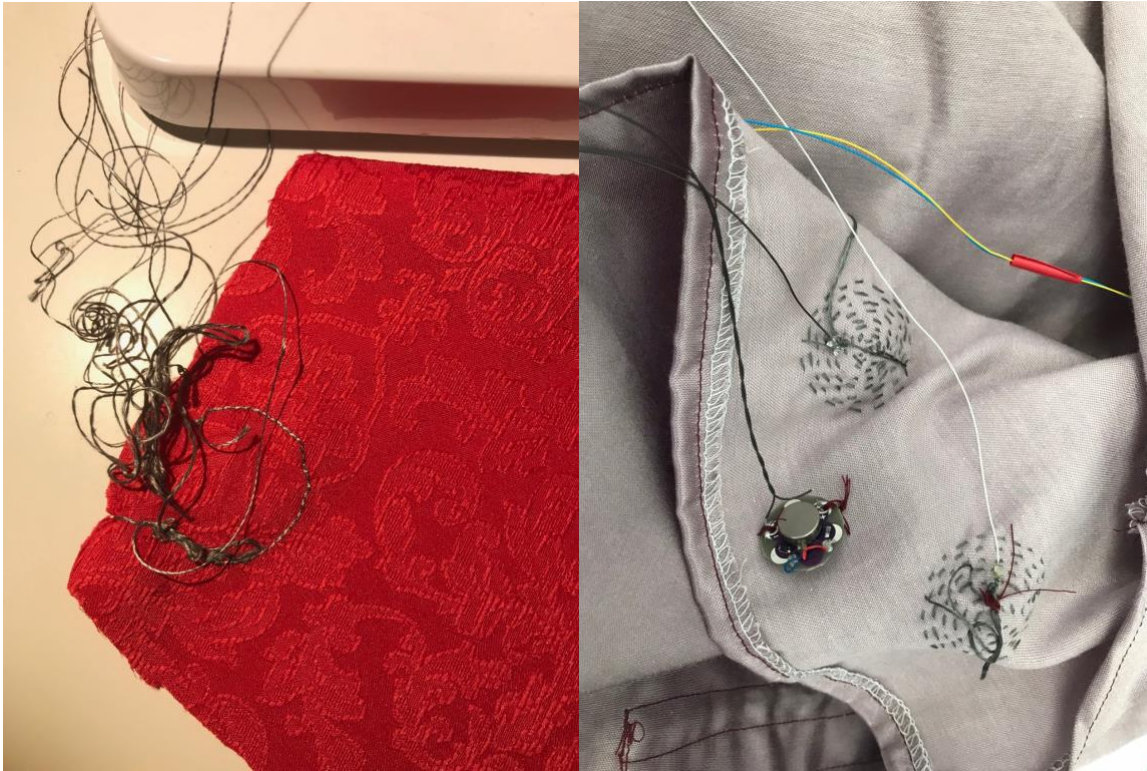


Figure 20: Testing conductive thread with sewing machine on left and haptic motor with conductive thread on right.

A detailed image as seen in Figure 21 shows the hand embroidered conductive thread button on the sleeve.



Figure 21: Detail of final version of dress sleeve and embroidered conductive thread button.

4.2 Implementation of Hardware, Sensors and Mapping Gestures

To achieve the performative element of how the dress can be used by following a composition, the sensors were mapped to certain gestures and movements that are based on dervish movement. These sensors were then attached to various parts on the dress that could provide the most efficient data and intuitive use. The sensors are programmed using an Arduino UNO microcontroller unit and mapped using Max/MSP by Cycling '74 software. In Figure 22, the entire components are shown, which are stored in the belt or sash of the dress.

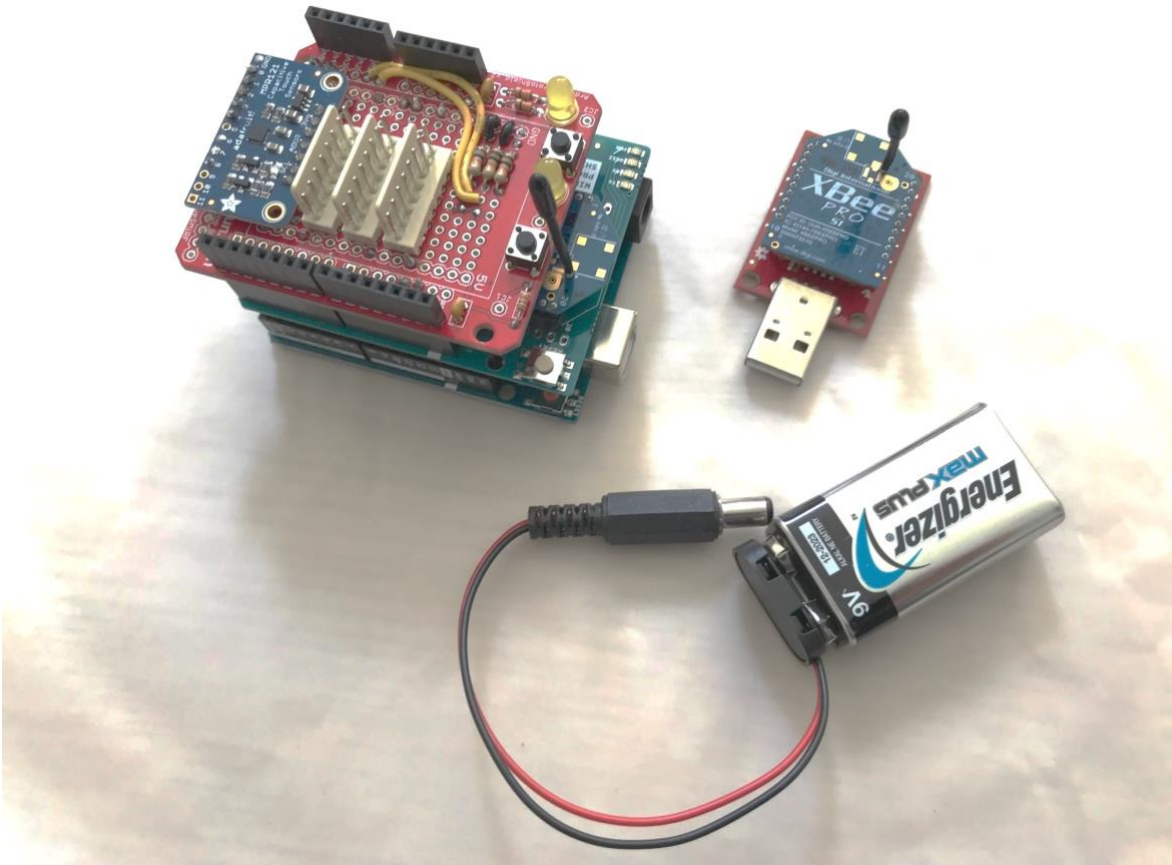


Figure 22: Arduino microcontroller, wireless dongle and 9-volt battery pack.

The components include an XBee wireless module and dongle with a breakout board and Arduino wireless proto shield. The advantage of using this system is that the wireless module communicates wirelessly with the Arduino board and sends and receives data over a serial port on a laptop or computer eliminating the need to rely on a separate wireless network. The wiring of the Arduino was done to compactly fit each of the three connectors; one for the skirt, and two for the jacket, a left and right side to differentiate. All parts were soldered to the main board and attached to the wireless proto shield. The dress enables the performer in free, unrestrictive movement.

Figure 23 outlines the sensor mapping process and the software and hardware components used. The sensor data is preprocessed by mapping the sound samples to each individual sensor and analyzing the data output from it.

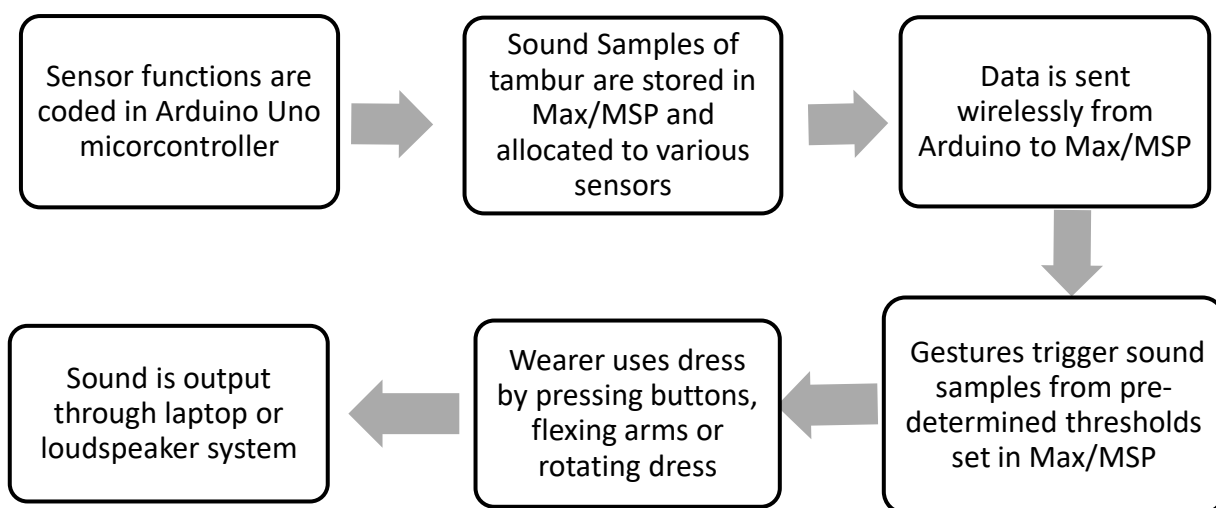


Figure 23: Sensor Mapping Process.

The patch created in Max/MSP uses basic buffer storage objects for pre-made sound samples of the *tambur*. The patch (and a snapshot) can be accessed on the accompanying CD. Each sensor on the dress is mapped to a different sound file and can be used interchangeably from a bank of sound samples. In total, there are six sensors attached to the dress: two flex sensors, a capacitive touch sensor connected to the dress via conductive thread, a gyroscope/accelerometer/compass and two haptic motors. There are 5 conductive thread cochlear shaped buttons sewn onto the jacket of the dress, four of which are on the bodice and one on the left sleeve. When the buttons are pressed, haptic motors are also triggered for the purpose of correlating the excitation sensation of an instrument and the gestural action. The sensors all perform according to how the wearer moves or touches the buttons which trigger sound. The gyroscopes/accelerometers/compass sensor measure the speed and position of the dress as it is turning by examining the rate of change of values. This controls volume so that when the wearer turns or moves slightly, the sound crescendos and then decrescendos when movement or position changes. This allows some variation in the progression of the overall composition by layering sounds. All other wiring is concealed in the lining of the jacket/bodice and on the top portion of the inner skirt. The buttons operate on a 0 to 1 'touch on' 'touch off' mechanism; this allows the wearer to turn the sounds on the buttons off and on according to their preference. The wearer must apply slight pressure and hold the hand in place on the button in order to let the sample play as well as to feel the haptic vibrations. Flex sensors are placed in the sleeves close to the inner elbow and trigger sound when the arms are fully extended. When arms are folded or bent at an angle and crossed at the chest, sound is switched off.

The list of gestures and corresponding sound files are outlined in Table 1. When both arms are flexed, sound is not present until they extend over a pre-determined threshold of values. These values reflect the bend resistance range and voltage output between 45 and 400. When testing the flex sensors in the elbows, it was noticed that a value between 140 and 160 was suitable data for capturing a point where musical sound can be triggered in accordance with the sound evolvment. A mid-range of values is mapped to the flex sensors so that when the arms extend, the sound samples are emitted and when flexed closed again, the sound is turned off. As the skirts rotate, sound lingers in and out until it is in a fully turned position where the volume increases releasing a melodic ambient composition. All of the sound samples can be accessed on the accompanying CD in the Appendix.

	Gesture/touch button	Movement	Touch/Haptic	Wav file name	Threshold value
1	Sleeve Button		√	BUTTON5DRONE.wav BUTTON5aBEAT.wav	
2	Right arm extends	√		FlexRight1NewEcho.wav	>250
3	Left arm extends	√		FlexLeft2CTMelodicecho.wav	>250
4	Right arm flexed in	√			<250
5	Left arm flexed in	√			<250
6	Skirt slow rotation	√		Skirt1Extended.wav	None
7	Skirt full open rotation	√		Skirt1Extended.wav	None
8	Touch button one		√	BUTTON1.wav	None
9	Touch button two		√	BUTTON2.wav	None
10	Touch button three		√	BUTTON3.wav	None
11	Touch button four		√	BUTTON4.wav	None

Table 1: List of Gestures for sound output.

The finalized version seen in Figure 24 shows the wires attached to the connectors which fit into the Arduino unit. The connectors easily clip into the corresponding part on the Arduino and can be removed from a concealed pocket in the sash when assembling the dress. The wearer must first put the jacket on and then the skirt, whereupon the sash is simultaneously attached into the abdominal region of the wearer.

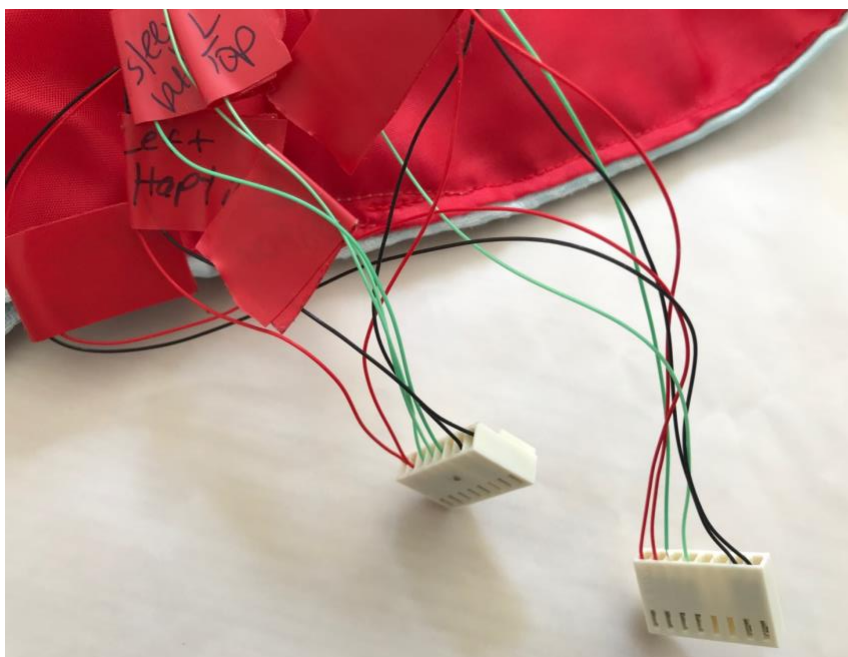


Figure 24: Wires and connectors labelled at back seam of jacket.

4.3 Sound Sampling of the Turkish *Tambur* using Composers Desktop Project

As mentioned previously in chapter 2, the Turkish *tambur* was the instrument chosen to derive samples from to create unique and ambient compositions. The instrument is tonally rich and vibrant and when played, is capable of creating a wide range of microtones. It is one of the essential instruments used in a *sema* as well as in classical Turkish music. The objective was to express the character of the *tambur* whilst creating mosaics and ambient electronic sounds. Some of the compositions in the sound samples are created to resemble a drone sound, other ambient voices as well as mosaics created from a single string pluck of the instrument. As a rhythmic accompaniment to the *tambur* melodies, samples of the *khudum* have also been explored and shaped into atmospheric echoes. To create each sound that is mapped to the sensors, samples were taken from the source provided by skilled *tambur* musician Celaluddin Çelik. These organic sound samples were manipulated using CDP (Composers Desktop Project)²⁵ sound shaping software. Sound Shaper is a software connected to CDP which allows the user to transform and edit external sound samples to create wav files while also creating original sound files, textures and effects. Created in part by musician and computer music composer Trevor Wishart in 1986, it is managed in

²⁵ <https://www.composersdesktop.com>

collaboration with other composers and computer technicians including Archer Endrich and Richard Dobson.

The samples of the *tambur* were loaded into the Sound Shaper program and a variety of functions were performed. For example, sound sample 'BUTTON5DRONE.wav' is mapped to the sleeve button. The function used for creating the sound involved cutting a single pluck from the original *tambur* samples and then processing by adding a time-stretched echo which was then looped. The purpose for this sound sample is to initiate a continuous background ambient effect to the overall composition; other sounds and melodies can then be 'layered' on top of this sound. 'BUTTON1.wav' is mapped to one of the buttons on the jacket's bodice. The sound was extracted from the *tambur* sample, then processed by adding reverb. Other sounds that had similar processes were also created by adding a pan element so that sound follows the circular progression of the skirt as it rotates from one end of a speaker to another. The shape and position of the skirt while it is at its peak turning point during a *sema*, was the inspiration behind capturing the momentum using an accelerometer/gyroscope. The sound sample 'SKIRTEXTENDED.wav' is a looped sample with a pan and reverb/echo process that increases and decreases in volume based on the direction of the skirt and momentum. This looped sample is mapped to the skirt as a way to give a sense of expectation as the skirt evolves and rotates with increasing sound. These shapes are all reflections of dervish movements and the sound elements compliment the shapes by echoing one after another. Experimenting with how the composition can progress from one arm movement to another or the acceleration of the skirt and touching the different buttons, is determined by placing the sensors in locations that can be intuitive and easy to use.

The haptic motors are also mapped to the conductive thread buttons. When sound is emitted by being touched, haptics are triggered on the bodice and on the sleeve. This provides a tactile sensation and signal to the wearer that the sound has been initiated much like the immediate sensation and reverb effect of a string being plucked or a sound that is made by being blown into an instrument. Evaluating this relationship between the wearer and the garment is similar to how a musician relates to their instrument. This embodiment is not only a practical component to *Dervish Sound Dress*, it reinforces the fact that there is no disconnect between the wearer and the sounds that they initiate.

The sensor placement within the garment and where sound is initiated from as the composition evolves is described in Figure 25. Table 2 describes the type of sensor and its functions and hardware components.

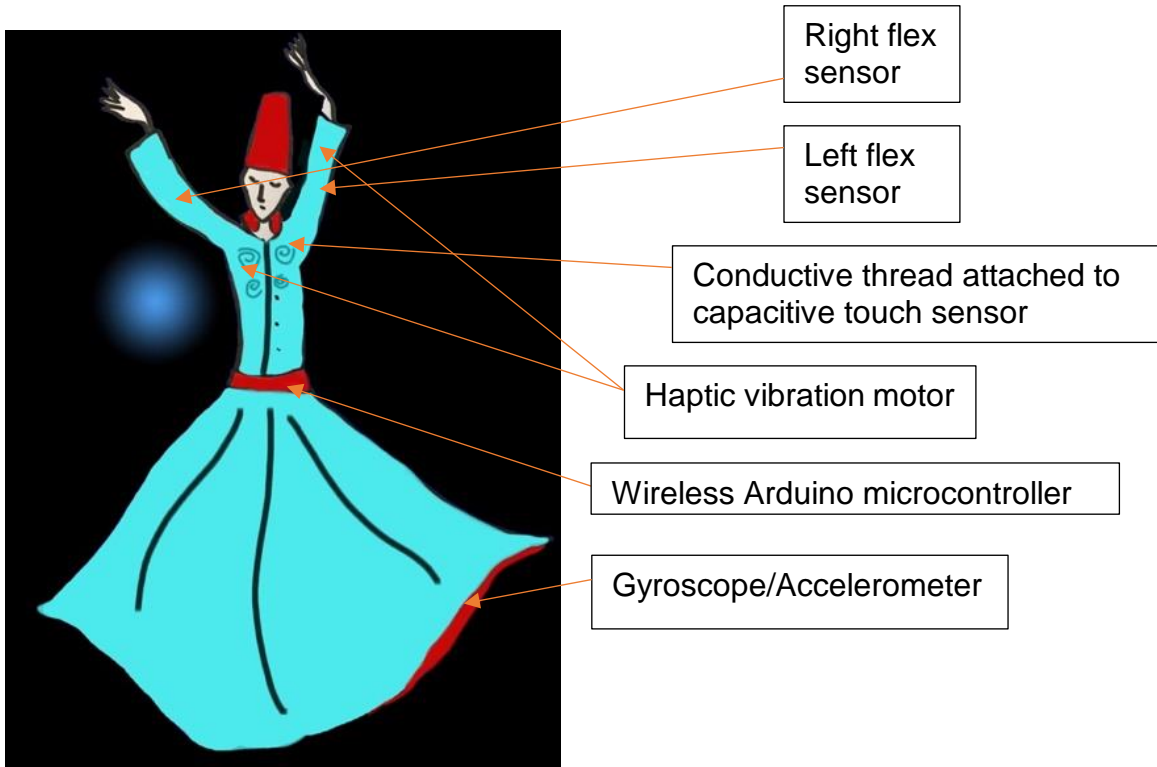


Figure 25: Design concept and sensor placement for *Dervish Sound Dress*.

Sensor/hardware component	Description of Function
Flex Sensor Right(R) and Left (L)	Flex sensors in sleeves detect movement and produce sound when sensor value reaches a certain threshold.
Conductive thread 'buttons'	Attached to capacitive touch sensors, the buttons are programmed with synthesized musical tones and melodies.
Haptic vibration motor	When buttons are touch, vibrations are released; haptic sensors are placed in the lining of the bodice and on the left sleeve.
Wireless Arduino microcontroller	Stored in the belt of the dress and programmed wirelessly.
Gyroscope/Accelerometer	Detects angle and velocity of the dress. Based on increasing values as dress moves, volume of sound sample changes.

Table 2: Description of sensors and hardware component function.

4.3.1 The Composition

The progression of a dervish during a *sema* begins with the body in a static position with arms crossed at the chest, right over left. As the dervish turns, the momentum increases and the arms unfold outward. The movement is almost somatic in that the dervish are fully immersed in the experience and meaning of their actions/movements. There is a confidence that the outcome of this movement will result in a metaphysical interaction. This subtle progression builds up into a climactic splendor which is heightened by the energy of the music and the rhythm created by the dervishes as they continuously propel themselves side by side in perfect rotations.

The composition of *Dervish Sound Dress* is interpretive, yet a formula can be followed if the wearer desires to turn in the dress. To create a story with the dress, the composition can begin by moving around a space or performance area in a large circular pace, the arms are crossed at the chest similar in the way that dervishes prepare for a *sema*. This activates the accelerometer on the bottom of the skirt which is mapped to a looped sound sample and increases and decreases in volume depending on the speed and height of the skirt as it is moved. The wearer can then begin to rotate, slowly releasing one arm which expels another sound sample. The second arm can extend emitting another melodic sound, both of these being triggered by extending the flex sensors at the inner elbows. The sound increases as the skirt rotates; now the wearer can add the rhythmic and ambient drone button mapped to the sleeve button. This can continue by layering even more sounds by touching the spherical buttons on the bodice on and off until a polyphony of sounds and melodies are each playing off one another. To end the composition, the wearer can decelerate the rotation and slowly come back to standing position where all buttons have been turned off and sound is no longer present. This composition is an impression that echoes the movements and routine of a dervish while performing a *sema*. When using the dress, this formula or composition is explained to the wearer which can provide them with the experience of turning as a dervish with corresponding sounds. All of the sounds can be used interpretively according to how the wearer perceives them.

4.3.2 Operating *Dervish Sound Dress*

A series of tests using the dress were done with a skilled dancer, a young boy, other colleagues in the lab and other non-skilled participants with little or no knowledge of the dervish or computer music. The tests were run to see how the system works as a whole; how the sensors work against the body within the cloth, checking the comfort and ease of

movement in the dress, trying different combinations of buttons to release a variety of sounds, and to test the motion and acceleration of the dress while sound was output. The other testing required analysing how the haptic sensors felt on the body when activated. The dress provides the wearer with a means to formulate a composition based on pre-programmed sounds and melodies. As one arm unfolds and then the other, sounds are triggered. If the wearer chooses to turn, the sensor on the skirt releases sound according to the velocity of turning. When combinations of buttons and flex movements occur, the result is a climactic cacophony of sound. These interpretative movements based on the *sema* may result in an embodied experience for the wearer as well as the viewing audience also listening to the sound creations. Operating the dress is described in a sketch given to the wearer as a guide as shown in Figure 26. The wearer receives oral instructions on how to use the different parts of the dress i.e.: 'button positions, press firmly on buttons, flex arms in and out, rotate or move in the dress'. The operation of the dress is described in the accompanying DVD in Part Two seen at timeline 08:33.

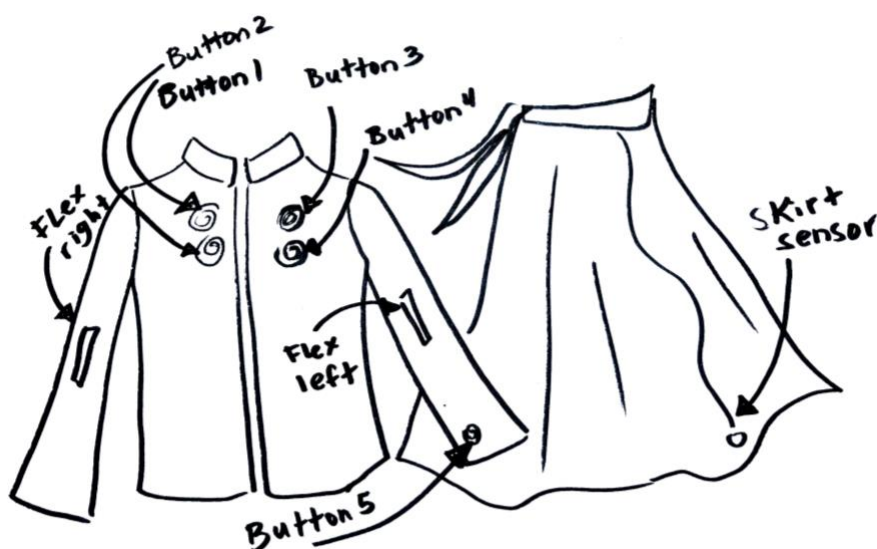


Figure 26: Sketch of *Dervish Sound Dress* and placement of sensors.

Dervish Sound Dress was first tested on a skilled dancer (Figure 27); the dress was adjusted to fit her size and she moved comfortably and unrestricted in the dress. She preferred a more contemporary dance approach to experimenting with movement in the dress rather than turning in a more continuous manner. The way in which she used the buttons was intriguing by creating layers of sound at a time by touching with her hands and other parts of her body such as her head to initiate sound.



Figure 27: Skilled dancer testing the garment, August 22, 2018.



Figure 28: Performance test without over-layer skirt, August 22, 2018.

The dress worn by a young boy (Figure 28) who had previous knowledge of the Mevlevi Dervishes and the turning practice and enjoyed the rotating crescendo of sounds. He was comfortable in the dress and assembling and attaching the various parts were straightforward. Adjustments were made to shorten the sleeves and the skirt.

Table 3 outlines observations made during each trial or performance of the dress. The general feedback was positive; however, there were also comments made by the wearers that need to be addressed, such as positioning of haptics, addition of haptics, more buttons and sizing. There were six participants in total who tried the dress on, some of whom had basic knowledge of the dervish *sema*. The participants tested the dress in a blacked-out dance studio space with no other attendees, and two of the participants tested the dress outdoors in settings that looked like ‘stages’, also using existing ambient environmental sounds.

Test #	Participant	Observations	Positive Feedback	Negative Feedback
1	Non-skilled participant (Adult)	Flexed arms, tapped buttons, rotated skirt, static movement	Easy to use buttons	Did not like haptics against chest area
2	Skilled dancer/performer (Adult)	Several dynamic body movements, flexing arms in and out, tapping buttons with hands and forehead, full rotation of skirt	Haptics augmented experience, enjoyed vibrations, used buttons intuitively, opened muscle awareness on body, ‘language’ between body and dress	Felt disconnected from skirt and jacket since there were no haptics on skirt
3	Non-Skilled participant (young boy)	Emulated traditional dervish movements, slowly progressed with arms opening, full and fast rotation of skirt	Buttons and flex sensors easy to use and intuitive, enjoyed creating compositions	Dress had to be adjusted a few times to the participants size
4	Non-skilled participant (Adult)	Rigid movement, some turning, very slow progression	Flexed arms several times to create sound with ease	Was too conscious of button placement, did not press firmly enough to initiate sound, did not enjoy turning
5	Non-skilled participant (Adult)	Slow and fluid movement; touched buttons several times to trigger sound	Felt that haptics added a layer of awareness to the sounds	Turning was not comfortable due to dizziness
6	Non-skilled participant (Adult)	Movements made were similar to dervish <i>sema</i> , slow progression with rapid turning	Interchanged buttons and flex sensors, haptics alerted the usage of touch buttons	Turning in dress was difficult due to dizziness

Table 3: Dress test observations

4.3.3 Observations

The first trial performances indicated that further streamlining of all components was essential to ensuring stability of the garment. Issues included wires breaking off several times from the sensors or the connector plugs. These needed re-soldering and stabilizing with shrink wrap as well as securing onto the fabric with regular thread. Since re-wiring the dress, the resistance for the flex sensors improved greatly. One of the haptic sensors was moved to the arm leaving one at the chest. This gives better stimulus to the arm button.

Not all of the wearers of the dress felt inclined to turn as a dervish would or follow the composition that was explained to them beforehand, instead they used the dress as a tool for enhancing a dance or movement experience. The participants who tested the dress also found the contact between the hand and the conductive thread buttons to be irregular. When the buttons were pressed, the pressure of the hand to the bodice or chest area and the sleeve button needed more force. More conductive thread was embroidered making for better contact and easier use without the need for forceful pressure. All other sensors are effective although the flex sensors needed reinforcing at the base with cardboard or plastic to limit bending strain. The flex sensors were replaced due to inaccurate input of data.

The other issues that have been addressed are proper sound mixing to avoid high pitches during speaker output, and fixing glitches within the Max/MSP patch so that there are no peaking sounds or interference. Attaching another haptic sensor to the skirt, possibly in the hip region, may give a more effective interaction with the bottom half of the dress, amplifying the relationship between the wearer and the skirt, similar to the jacket/bodice.

4.4 Emotional Exchanges using Haptic Feedback

From its inception, enabling haptics was one of the more important features of designing *Dervish Sound Dress*. It is this element that helps define it as an instrument on the body in that the wearer feels emotionally and physically connected to the device. Tactile sensations have a meaningful purpose in the way in which humans use and comprehend technology. Haptics provide a connection between the user and the interface that allows for better response and control similarly to how a musician interacts with an instrument.

Papetti et al (2018) remark that an instrument is a tool for executing not only sounds but an interactive method of receiving vibrations from the instrument to the player where it establishes a “very intimate, rich haptic exchange with their instruments, resulting in truly embodied interaction that is hard to find in other human–machine contexts”. Merchel et el (2018) also write that vibrations on the skin are an important way of perceiving music that can come from listening to music, experiencing it at a concert or exchanging tactile sensations with an instrument.

Haptic feedback can be described as a sensory vibration that is felt when a sensor is triggered on a garment or an electronic device. Haptic or tactile feedback communicates information to the wearer by using vibrations through tactile touch. According to Demidenko (2017), “implementation of haptic feedback technology within wearables will lead us into a new era, where we will be able to carry virtual world and feel it”. Haptic technology has been changing the way in which humans interact with technology. Tactile sensations on the body have a tremendous effect on how humans perceive not only objects but also sound vibrations. Haptic technology can assist the wearer by providing cues that are given by gestural recognition. When an instrument is played, whether plucking or blowing strings, using a mouth piece to force air, or striking a keyboard, the musician must sense the action as a tactile reverberation to complete the relationship. This also builds a meaningful emotional exchange and instantaneous stimulus between musician and instrument. The physiological changes that occur are a result of the communication of feeling and emotion (Meyer, 1956). For a musician, these factors are aroused by sensations created when sound vibrations are communicated from the instrument to the hand and body. The interface of *Dervish Sound Dress* is woven into the garment and can be controlled by the user by touching and moving and anticipating vibrations.

The implementation of haptic mechanisms in wearable devices is gaining new ground and advancements are continuously being made to integrate haptics into clothing. As seen earlier in the example of *The Sound Shirt*, haptics used in garments allow the body to be alerted to tactile cues. The use of haptics, as is seen in the developments of new wearables, will allow humans to experience a more personal relationship with technology than ever before (Rabimov, 2017).

Designing wearables that perform as digital instruments by implementing haptics, changes the scope for garments that can behave as interactive musical systems. The physical

perception between instrument and body is a natural occurrence. Castagne et al (2004) discovered that the 'energetic coupling' between the player and the instrument is due to the physical connection that is made. This affective emotional exchange between performer and instrument is better understood through the use of haptic feedback, because the act of physical movement while engaging with an instrument produces tactile sensations. The performer feels a sense of control while performing the action (Rebelo, 2006). Papetti et al (2018) refer to haptics in musical performance as a way to enhance performance control, and therefore expressivity. This vibration feature in a wearable garment that is placed close to the body such as in the chest region where components are touched and vibrations are felt, can have an impact in relaying information to the performer that alerts them to change position and be aware of other movements. The friction that is created between the touch sensation on the body is an important function of haptic mechanisms; without it, there would be no intuitive relationship between body and instrument (Hayward, 2018).

4.5 Absorbing the Sonic Environment

The fluid composition and evolvment of *Dervish Sound Dress* is a performance that is initiated and interpreted by the wearer. The sound can be output to a loudspeaker system in a controlled theatre setting via wireless connection where an audience may also experience the performance, or it can take place in other venues where the available sonic environment is also absorbed into the composition. These created sonic spaces lend themselves to a diversification of listening traditions by taking the dress out of a sound-controlled theatre or a space such as the *semahane* or *tekke*. This type of sound installation, which is an art form in itself, can be site-specific or not since the physical, environmental space is altered by uncontrolled sonic parameters (Ouzounian, 2006). This can further augment the auditory experience by interacting with the vibrations and sounds that are present in the surrounding space (Evens, 2005).

When a *sema* begins, the dervish must follow a path or an order to how they move. The steps are initiated with slow precision as they find their place on the *semahane* floor and begin to turn as they are moving in a larger circle, each dervish following the other. There may be up to two dozen dervish performing in one *sema*. The movement of the dervish is subtle; the arms extend and then remain in position for the length of the maintaining momentum. The gestures that a dervish makes during a *sema* are based on the readiness

of the dervish, both mentally and physically. Once the *sema* has been approved and initiated by the *semazenbaşı*, the performance begins, and each dervish aligns themselves in succession and progress into a wave of movement; each following the other until they all turn with the music and the rhythm. The sonic space also becomes a part of the performance; as does the breath that initiates the sound of the *ney*, the quiet prayers that echo from each dervish to the next, and the rhythmic beating of the *khudum* that sets the tone of the *sema*.

In *The Soundscape*, Schaffer writes about the sonic spaces in our living environments and our landscapes and how this affects the way we perceive sound. Schaffer (1977) discusses that even the sounds of the wind and the sea contribute to how sounds become amplified and add layers to existing sounds, creating ambient compositions. Schaffer also mentions the notion of 'Sacred Noise' having meaningful symbolism and memory inducing nostalgia. When in the space of a *semahane*, the sound environment is absorbed by the dervishes. The musical compositions as mentioned in chapter 2 are generally improvisational *taksim* that are made by various instruments such as the *ney* or *tambur*. The sonic environment that contributes to the performance also includes the sounds of the feet pressing against the wooden floor, the subtle quiet prayer recitations of the dervish as they turn, the melodic singing of other *semazen*, among other ambient sounds that contribute to the entire experience. These layers all form different compositions each time *Dervish Sound Dress* is performed, creating an unlimited variety of sonic possibilities in different spaces.

4.6 The Garment as a Body Instrument; Creating Celestial Patterns

In the opening scene of Bela Tarr's film *Werchmeister Harmonies* (2000), one of the characters gathers a group of others in a tavern and physically positions them into a circle to explain the workings of an eclipse. The actors rotate around each other forming individual circular patterns representing the sun, moon and the earth. The context of the performance is in a shady beer tavern with drunken participants, yet for a moment the message feels positive and almost sublimely poetic. These are the same patterns that are chosen by the dervishes when turning. It is reflecting on the orbital patterns of the planets in the universe. It is this physical movement that like the Islamic prayers, becomes part of the meditative experience. The performance of the *sema* is not just about the turning aspect of it, it is about the repetition, the recitation, the remembrance of the planets, the universe and everything there is.

Dervish Sound Dress offers the experience of taking extremes and putting them together to create a contrast; a form of artistic expression using expressive body movement and music based on a sacred tradition. The patterns harmonize with the sonic environment that is created in the space by the wearer.

The initial experiments of the dress were catalysts to develop garments that generate musical sounds to formulate compositions using body movement. Seamlessly integrating technology and textiles to create a streamlined, intuitive interface which is performer controlled is the focus of this project. Implementing haptics which act as sensory indicators on the dress when sound is emitted, allows the wearer to feel the sound vibrations. Introducing haptics as a tool for stimulating and enhancing the sensory experience of the wearer can lead to an effective and tangible output. Essentially, the garment is a wearable body instrument which contains an interface that is controlled by the wearer. Echard (2006) discusses how the physical relationship performers have with their instruments plays a major role in the interaction aspect of creating music and sound. Davidson (1993) mentions that bodily gestures have musical connections. These sonic cues that are stimulated to the body from hearing or feeling music immerses the body to move along with music using actions (Leman, 2008 pp.97). Reybrouck (2006) writes that musical instruments are an extension of the human body which have perceptual and effectual purposes which assist better interaction. Whether the wearer is a musician or not, by integrating the body with an instrument the interaction becomes an embodied experience instead of being physically disconnected from an instrument.

Dervishes use their belief as extensions of their body; a way to attain spiritual elation when entering a *sema*. Their bodies become instruments as they absorb the music and rhythms that propel them into continuous rotation. A recent explosion of subcultures worldwide in places such as Iraq, Iran, Egypt and U.S.A. have begun to explore 'turning' based on the Mevlevi Dervishes, using contemporary music styles, digital art and costume. Some perform this practice to gain stamina in their dance practices, others use it as a form of new interpretive performance art and dance, and some may attempt to understand why a dervish turns and what it may mean to them. Others may even turn or whirl in hopes of achieving a metaphysical relationship with the divine; the possibilities are limitless. Nowadays, Mevlevi Dervishes practice their turning or whirling in many different settings outside the context of the *sema*. Some of these performances are accompanied by pop music blaring and flashy light shows. It has also become a commercial industry in Turkey where dervishes are hired

to perform in shopping malls or other tourist venues, where audiences react to the whirling in either awe or indifference. Whatever the reason for wanting to ‘whirl’, it is evident that the traditions of the Mevlevi are continuously being re-interpreted. Interest in forming circular shapes in performances reflect the infinite rotations of the earth and stars. The buttons on *Dervish Sound Dress* as seen in Figure 29, emphasize these expressions of continuous energy; the never-ending orbiting of all things in the universe.



Figure 29: Detail of conductive thread hand sewn buttons in circular patterns.

4.6.1 The *Dervish Sound Dress* in Motion

Dervish Sound Dress has been documented on video showcasing the function and performance of the garment as a wearable piece of technology. The DVD is made into two parts: Part One consists of a short experimental film of *Dervish Sound Dress; Outside the Tekke*. It introduces the garment and follows it in different settings while the performer turns while the subsequent portion documents the boy turning and a short demo of how the dress operates. The demo can be seen at timeline 01:42 on the DVD. Part Two presents *Dervish Sound Dress* performed by Sercan Çelik (at 04:25) with an instructional portion followed by an interview.

Dervish Sound Dress was ‘test’ performed in an informal stage setting with four onlookers on October 12, 2018. The performer was a young 11-year-old boy who had previously practiced coordinated movements of the composition mentioned in chapter 4.2. Each of the movements coordinated with the sounds that were triggered culminating in a layering of sounds. The wearer moved in the dress similar to how a dervish would make movements and used the various sensors interpretively. He did not allude to the fact that he was actively pressing buttons or flexing arms to initiate sound output; the performance was fluid and intuitive. In Figure 30, the wearer can be seen in the dress touching one of the capacitive touch buttons on the jacket.



Figure 30: Test performance of *Dervish Sound Dress*, Plymouth, October 12, 2018.

On October 20, 2018 *Dervish Sound Dress* was performed in a test performance in Istanbul, Turkey by Turkish *semazen* (dervish) Sercan Çelik. Çelik is a performance artist and practicing dervish who is interested in contemporary interpretations of the *sema* and the practice of turning. A professional dancer and practicing dervish since the age of 12, Çelik’s movements (Figure 31) while testing *Dervish Sound Dress* were direct reflections of dervish movements. Similar to the previous wearer of the dress, Çelik was given an outline of the composition mentioned in chapter 4.2. however, he was also encouraged to use the dress freely to develop his own interpretation of how the dress can work for and with him. The composition that he created while using the dress was dynamic with continuous fluidity. He moves with circular precision infinitely whilst using the various buttons and flex sensors in the

sleeves interchanging sounds. Çelik commented that he felt that the sounds he was able to make based on his gestures amplified his movements and made it possible to augment his own practice as a contemporary dervish. Çelik used the dress intuitively and rotated while using his arms to change his positions and gestures. He commented that the act of touching the body while turning and feeling vibrations while outputting sound was interesting for him. This helped to develop a relationship between his gestures, movements and his body due to feeling vibrations. Ultimately, Çelik's reaction whilst using the dress was very successful in that he remarked the dress can potentially drive him into a trance-like state in a unique way which is an important part of his practice. Being able to have control over the music by using his gestures and body movements can be an immersive experience for him as well as audience members.

At timeline point 05:56 in Part Two of the DVD, an explanation of how the dress works i.e.: using various sensors and buttons, can be seen. At 06:21, the workings of the dress are described in terms of how the sensors are mapped and how it is controlled via Arduino and Max/MSP. At 08:34 Çelik demonstrates the use of the dress by flexing his arms as well as touching the buttons. His movements and use of the buttons while turning can be seen at 09:49 where he rotates in the skirt releasing another melody triggered by the accelerometer.



Figure 31: *Dervish Sound Dress* performed by Sercan Çelik, Istanbul, October 20, 2018.

Çelik gives an interview which can be seen at timeline 11:25. Çelik is questioned about how he feels while wearing the garment as well as how the dress can amplify his current performance practice as a contemporary dervish. He also mentions that the haptic vibrations reinforce the sensation of producing a sound by using gestures. These sensory reverberations can confirm that the dress can be used as a body instrument that can create musical compositions using movements and physical gestures. This finding is the pinnacle of the research for this project in that it is evident that using *Dervish Sound Dress* can indeed potentially enhance new performance practices for a contemporary dervish while using a piece of wearable technology that creates musical sounds.

Chapter 5

Conclusions

The final chapter concludes the thesis and discusses future work and implementation of concepts based on *Dervish Sound Dress*.

5.1 Summary

This thesis has addressed the topic of developing a wearable instrument that creates musical sounds based on the wearer's gestures and body movements. The research questions put forth in section 1.2 have been addressed as follows.

'How can technology be integrated into a garment as an expressive body instrument to augment new performance practices?'

Throughout the three main sections of the thesis, the methods and theory behind constructing the garment as an expressive body instrument have been discussed and developed. In the second chapter the inspiration for the dress design as well as contemporary interpretations of Dervish performances were examined. In Chapter 3, wearable and fashionable technology were investigated in terms of developments over the last few decades. Chapter 4 focused on the design of *Dervish Sound Dress* from concept to a finished prototype that was tested and ultimately performed by various wearers including a practicing dervish. Experiments included empirical analysis of how sensors work against the body using materials such as conductive thread and sensors that capture gestures and movement. An intuitive body instrument garment was constructed using sound and haptic feedback which also emphasized the exchange between digital art, culture and technology, music and performance and fashion/costume design. Technology was interlaced with fabric to create a garment that can be used as an expressive body instrument to augment new performance practices.

'How can a sacred tradition such as the sema be used to create a unique contemporary sonic art experience using body movement, sound, gestural recognition and haptic feedback?'

The investigation of this research question centered upon formulating a methodology and framework for creating *Dervish Sound Dress*. The garment is a reinterpretation of a sacred tradition combined with wearable technology, for the purpose of investigating new performance practices. The sacred tradition of the *sema* was used as an inspiration to create a unique contemporary sonic art experience that uses sound, gesture recognition and haptic mechanisms for an immersive and interactive experience. The movement and momentum of a dervish performer and mapping sounds to those movements was captured. Creating compositions based on these movements as well as sound samples of the *tambur* that were manipulated in sound shaping software, were described in Chapter 4. Gestures were analyzed to optimize these movements that were mapped to various sound samples. *Dervish Sound Dress* performed by Turkish performance artist and practicing dervish Sercan Çelik as described in subchapter 4.6.1., provides evidence that a sacred tradition can be reinterpreted and used in new performance practices that amalgamate technology and body movement with innovative costume design. In the interview portion of the film (11:25) Celik described how the dress is an exciting exploration of dance and technology where the wearer can have control over the outcome of the sound by utilizing gestures and motion. Implementing haptic feedback proved effective in communicating the action of the dress with the wearer when creating musical sounds. These reverberations allowed the dress to function as an instrument enhancing the wearer/performer relationship.

Dervish Sound Dress is the catalyst in creating new performance garments or costumes that use sonic space, gestural movements and wearable technology. The goal was to enable existing technology and apply it to creating a garment that is an exploration in new digital instrument design. Refinement requires further research into making garments that are capable of processing sound through the use of intelligent textiles. By providing an interface that can function with the wearer in an intuitive way, this concept can generate new forms of artistic expression for use in many artistic disciplines including dance, theatre, sonic art performances, fashion technology exhibitions, opera and many more to enhance the wearer and audience experience.

5.2 Future work and research

The performances of the dress reflect upon the sacred tradition of the Mevlevi Dervishes. These glimpses have taken the dress outside the context of the traditional *sema* and have created new spaces to observe a wearable technology garment. *Dervish Sound Dress* appropriates - yet respects - the sacred traditions of the Mevlevi Dervishes. The breadth for designing garments that function as a body instrument brings this project into the future by coalescing the practice of sound design, interface development, digital art and smart textiles. Based on conclusions of experiments conducted in the initial performances of *Dervish Sound Dress*, the aim for future work will be to analyse the options for using smart fabrics rather than attaching sensors to the garment. The result will be a less restrictive design from the reduction of hardware bulk allowing the performer to move with more ease. The garment will be a streamlined, intuitive interface which is performer controlled. These experiments can lead to coordinating new performances involving multiple performers. Constructing garments using smart textiles will need to be cost-effective to make them viable for production. Current textiles on the market are expensive and still developing. With 3D printing technology, conductive textiles, and nanofibers that are being developed such as thermoplastic polymers, the possibilities for integrating soft sensors into textiles is expanding.

Music is a multimodal vehicle that is encountered by means of auditory sensations as well as by the movement of the body. Future developments of garments such as the *Dervish Sound Dress* will be to implement real-time gesture-controlled sounds rather than using pre-recorded samples. These can be collaborative interfaces that can communicate with each other using computer sound synthesis methods. The goal is to use machine learning algorithms to generate real-time sounds using gestures that can be heard through a loud speaker system or an independent mode of carrying sound on the body. Future work will also involve using sound synthesis methods for generation of gesture-controlled sounds.

After searching in Turkey for dervishes or performers who use elements of the *sema* in their practice, it was found that many dervishes prefer to adhere to the traditional ritual of the *sema* and in keeping with those traditions, are committed to carrying out the practice of turning for the sake of obtaining a spiritual connection with the divine. Those who were approached in *tekke* in London and in Istanbul felt that using *Dervish Sound Dress* would interfere with the traditional structure of the *sema*. Therefore, it was imperative to find a dervish who was

receptive to implementing technology into their practice and using it to enhance their turning performance. The intention of the garment is not to assume that a wearer can embody the metaphysical experience of a dervish searching for a devout link to the divine, rather it explores these concepts through artistic expression and musical interpretations. The postlude to the test performance by dervish/performance artist Sercan Çelik, raised exciting questions about how to continue developing performances of *Dervish Sound Dress*.

There is potential and interest developing in Turkey to make several garments to have a *sema* performed by dervishes in a collaborative performance setting within a contemporary *tekke*. The research that extends from this project will be to use new technologies in the area of wearables to explore creating digital music interfaces that behave on an action response by a wearer. This research can examine the intuitive link between the body and movement that drives a system to generate sound.

The future of fashionable garments or costumes that use wearable technology such as the *Dervish Sound Dress* (Figure 32) can be built with much more enhanced technological capabilities. These innovations could further impact how garments can function as an extension of the body; an instrument, capable of autonomously making musical compositions by using gestures.



Figure 32: *Dervish Sound Dress*.

Appendix:

CD of Sound Samples and DVD of *Dervish Sound Dress*

CD Contents:

Turkish Tambur Sound Samples

1. BUTTON1.wav
2. BUTTON2.wav
3. BUTTON3.wav
4. BUTTON4.wav
5. BUTTON5aBEAT.wav
6. BUTTON5DRONE.wav
7. FlexRight1NewEchoTambur1m.wav
8. FlexLeft2CTMelodicecho.wav
9. Skirt2Extended.wav

Max/MSP patch

MASTERDERVISHPATCH.maxpat
MasterDervishPatcht.png

DVD Contents:

Part One:

Short film of *Dervish Sound Dress; Outside the Tekke and Mayez Rahman Test Performance and Demo* (Plymouth, October 12, 2018).

Part Two:

Sercan Çelik Performance and Interview (Istanbul, Turkey, October 20, 2018)

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