Stymphalian Birds: Sensing Beyond the Human Body with Feathers

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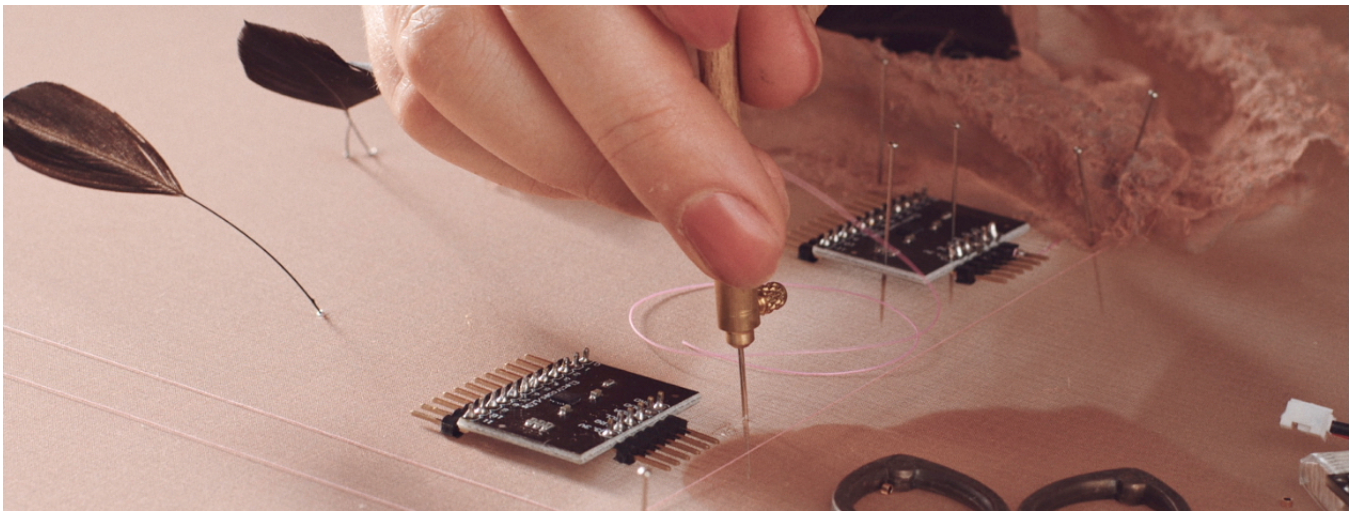

Figure 1: The circuit is embroidered using Lunéville embroidery technique. Credit: T. Daeffler.

ABSTRACT

Stymphalian Birds is a research project which explores the influence of feathers as sensors in our environment and on our bodies. In this research, complex haptic interactions with feathers are sonified in acoustic soundscapes using conductive hybrid feathers at the crossroads of electronics, Haute Couture and natural dyeing. The wearers of dresses made of Stymphalian Birds experience the societal impacts of sensing beyond the human body with feathers in a society where social distancing guidelines must be followed.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; • **Applied computing** → *Arts and humanities*; • **Hardware** → Sensors and actuators.

KEYWORDS

Media Arts; E-textiles; Tangible Interaction; Digital Craftsmanship; Featherwork; E-featherwork; Embroidery; Material Functionalization; Traditional Crafts; Natural Dyeing

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1 INTRODUCTION

Stymphalian Birds – human-eating pets of Artemis in Greek Mythology – are said to have metallic feathers. Using their feathers as arrows, they incarnate a dangerous beauty.

Stymphalian Birds is a research project which explores the influence of feathers as sensors in our environment and on the body. In this research, complex haptic interactions with feathers are sonified in acoustic soundscapes.

The project is taking several different shapes from installations [2] to dresses presented here (see Figure 2). The Stymphalian Birds research project combines traditional handcrafts with digital technologies, chemical processes and elements created by nature. These four different approaches seamlessly connect traditional featherwork and Lunéville embroidery with state of the art fabrication

Figure 2: A conductive feather (left), women wearing dresses made of Stymphalian Birds (right). Crédits: T.Daeffler, A.Le Chah

methods [7] from materials science which make the feathers electrically conductive and interactive (see Figure 1). The combination of electronic circuits and the physical transformation of the feathers to give them electrical conductivity will now permit these flexible sensors crafted by nature to detect touch and respond to it by sound. The results are futuristic electronic textiles which stand upon old craftsmanship traditions, preserving antique savoir-faire.

Stymphalian Birds were created at DataPaulette, an independent eTextile laboratory in Paris which is both situated within the broader culture of hackerspaces, as well as being connected to the Parisian textile scene.

Stymphalian Birds invites us to reconsider interactions of living beings with their environment introducing the immediate periphery of the body as an interface. The project explores the ability of cyber organisms to be sentient beings communicating across boundaries. Nowadays the COVID-19 pandemic is reshaping our everyday interactions, proximity between people appears as an even more sensitive issue. The wearers of dresses made of Stymphalian Birds, divided between seduction and hypersensitivity, experience the societal impacts of conductive hybrid feathers at the crossroads of electronics, Haute Couture and natural dyeing in a society where social distancing guidelines must be followed.

2 CONTEXT

2.1 Featherwork

A large variety of feathers compose the plumage of birds. Contour feathers, which forms most of the surface of the bird, are alternated with filoplumes which fulfill the role of sensory receptors. Suzanne Amador Kane shown that the birds' crests are sensors in addition to being adornments [9].

Feathers have always been used to enhance the shape of the human body [11]. Numerous contemporary fashion brands and couturiers including Alexander McQueen, Chanel or Ann Demeulemeester have investigated birds' panache into women's fashion. In the western society, applying birds' panache to women expresses seduction [16].

Figure 3: The feathers were prepared using natural dyeing methods, featherwork and polymerization. Credit: T. Daeffler

However, the rarity of *plumassiers* and the inherent beauty of feathers have led artists and designers to reconsider featherwork and to augment it with new poetic interactions. Following the path paved by Royal Hawaiian featherworks [3] and *plumassiers* like Maison Lemarié[1], contemporary artists and designers Ricardo O'Nascimento and Ebru Kurbak [12] or Rebeccah Pailes-Friedman in BioWear [13] have explored kinetic featherworks.

2.2 Social distancing

Nowadays, within the context of the COVID-19 pandemic, social distancing guidelines must be followed. In former days, fashion was playing a massive role in social distancing. Einav Rabinovitch-Fox reminds us that the crinoline, a cage hoop skirt, was worn by women in the mid-19th century to create a barrier between genders and keep distance with other individuals[14]. This dress is massively back to the catwalks in 2020 with quite a few fashion brands[15]. The recent project Well-distance-being by Sep Verboom employs the traditional technique of rattan weaving to propose an outfit to avoid physical interactions and connect with positive vibrations in the meanwhile. [17]

2.3 Textiles, craftsmanship and electronics

Unlike feathers, which serve as special adornments, textiles are everywhere. In a room, we can find them on the wall, on the floor, hanging.

Textiles are connected to our body, from birth to death, from nappies to burial sheets [8]. Textiles are the medium of our closer bulwark and protection in the way the feathers are for the birds. However, similar to feathers, textiles first and foremost also act as an adornment, rather than modesty and protection. While some human cultures might not use clothing, humans will never be without adornment [5]. Stymphalian Birds uses silk, to have two animal based materials and creates a biomimetic design, mimicking the protective cocoon. Just as feathers are crafted by birds, silk is crafted by the silkworm – both are designed by nature. Like feathers, silk is a protein fiber and both are considered as luxury objects [4]. As technology becomes ever more closely integrated in our lives, electronics are starting to permeate the textiles which accompany our lives as well, both those worn on the body [6] and in the environment around us [18]. Mastering textile craftsmanship and traditional techniques such as featherwork, embroidery and natural dyeing can contribute to deepen the field of possibilities in electronics. Following this direction, The Embroidered Computer by Ebru Kurbak and Irene Posch, is handmade through traditional gold embroidery and does not incorporate any regular electronic components. This piece demonstrates the possibility to make a computer from scratch through long-established alternative materials and skills [10].

2.4 Conductive Polymers

Feathers offer an experience by themselves, thanks to their capacity to react to touch, their flexibility to react like a spring, their softness and their delicate shape and details. The combination of electronic circuits and in-situ polymerization to give electrical conductivity to a feather enhance this experience and will now permit it to detect touch and respond to it by sonic feedback. Polymerization is commonly used to functionalize textiles, for example for creating bio-compatible batteries[1]. The feathers used in Stymphalian Birds were polymerized according to simple instructions provided by Honnet et al. [7] and natural dyeing methods.

3 IMPLEMENTATION & INSTALLATION

The author will present two dresses. The process of creating these artifacts will be shared as a curiosity cabinet – a mini exhibit. The curiosity cabinet will include various polymerised feathers and the tools for eFeatherwork. People will be invited to interact with the textiles, touch the feathers and manipulate them to know more about the embroidered circuit. When someone will touch a feather, it will trigger sound feedback. The sound will be extracted from a library of harmonious metallic sounds. Users can interact with

[1]https://www.lemarie-paris.com/en/history/

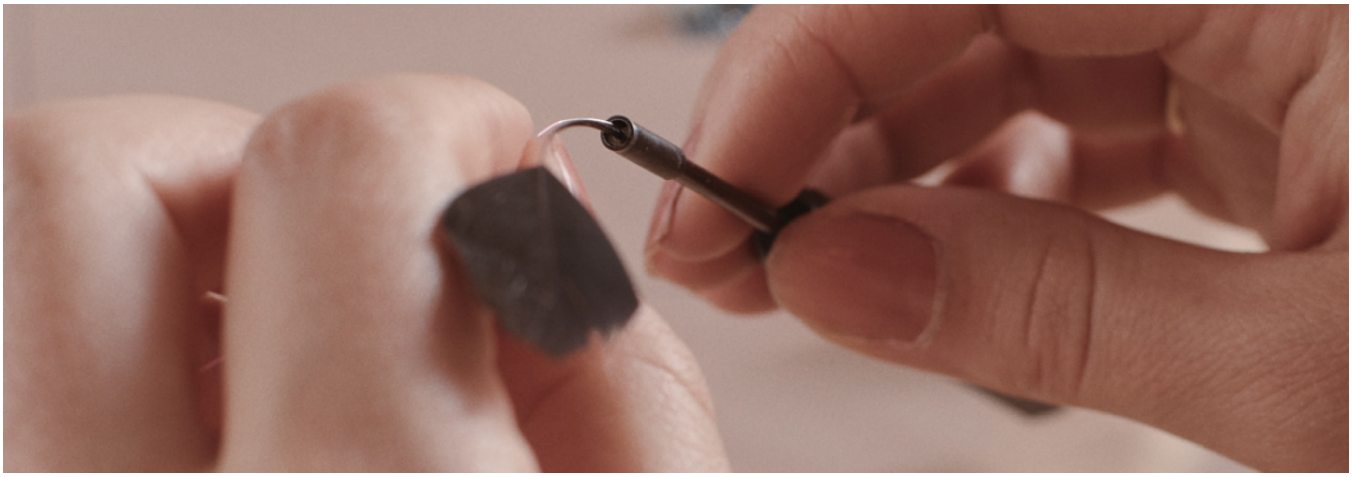

Figure 4: The feathers are connected using the standard electronic method of wire wrapping. Crédit : T. Daeffler

multiple feathers at the same time to create a melody. More details regarding the process and the final results can be found online[2].

3.1 Conductive feathers

The feathers were prepared using natural dyeing methods, traditional featherwork and polymerization [7]. The rooster tail feathers were stripped to both mimic filoplumes, and for the lightness and playfulness of the resulting shape (see Figure 3). Each feather is a flexible sensor designed by nature and each feather tip appears as a suspended electrode above the textile. When an external body approaches, these newly created biometric sensors will be the first in contact ; this is the biomimicry of filoplumes which fulfill the role of sensory receptors on birds.

Before being polymerized with Pyrrole and Iron (III) Chloride to make them electrically conductive (see Figure 3), using a method presented by Honnet et al. [7] the feathers are treated following natural dyeing techniques in order to improve the future feathers' conductivity. Feathers are protein based fibers composed by keratin, the following steps can be applied to hairs including human-hairs and wool, silk, horns, claws and nails but also to cellulose based fibers to provide a cleaner surface before starting the polymerization process.

The feathers are immersed for 12 hours in distilled water in order to gorge the fibers. After this soaking time, the feathers are scoured; sodium percarbonate is added following a 1:1 ratio with the weight of the dried feathers. The bath is heated during 30 minutes to slowly reach 85°C and then maintained at the same temperature for 30 minutes. During this process, the feathers will bleed the greases and primers that are on their surfaces. Then, the feathers are washed and the same process without the sodium percarbonate is reproduced in order to clean the potential residues. This treatment with sodium percabonate improves the results of the polymerization by reducing the resistivity by three and ensures results which are similar from one bath to another, but also between similar feathers in the same bath. It is true that, without this scouring step, the conductivity of similar feathers from a same bath can be highly different.

After the polymerization process, in order to give back their original aspect to the feathers, they are exposed to steam and are beaten on a surface to open their barbs following traditional featherwork techniques.

The feathers' shape, comprising a stripped rachis (stem) in opposition to a well furnished tip, is notably affecting the conductivity of the feathers. Additionally, the rachis is getting thinner while approaching to the feather tip, which proportionally increase the feather's resistivity. To improve the feathers' conductivity, in addition to factors listed by Honnet et al. [7], the appropriate reaction time needs to be find regarding to the amount of Pyrrole and Iron (III) Chloride used: while the feathers start to gain conductivity during the process, a prolonged polymerization will highly increase feathers' resistivity. The results noted with feathers align with the ones obtained by Baptista et al. [1] on cellulose acetate nanofibers, proving that polypyrrole tends to form aggregates on the surface while the dosages and polymerization time are not well balanced. Finally, polymerising the feathers a second time will double their resistivity.

3.2 Embroidered circuit

Consequently, the feathers were wire wrapped and hand embroidered, using the hook technique from Lunéville. These progressive steps in textile design enable the creation of a standalone system in which the feathers are sensors which react to touch by emitting sounds. Several silk *chiffons* were needle-punched together to create a textured surface. This textile is then stretched onto an embroidery frame. The textile then forms the substrate for the flexible circuit, to which the feathers are embroidered.

Each feather is a flexible sensor designed by nature, each is unique and each preserves its intrinsic flexibility. As the rachis of feathers are similar to standard pins used for circuit-boards, the feathers are connected using the standard electronic method of wire wrapping using a hand wrapping tool and a very thin 36 AWG insulated wire matching with the textile substrate (see Figure 4).

[2]Project page: https://audreybriot.fr/stymphalian-birds

The circuit is designed in advance and transferred on the textile which has been previously stretched onto the frame. The connected feathers are laid out according to the circuit, the cables are pierced thought the textile and are crimped on the underside using crimping beads from jewelry. This results in the top side exposing the tip of the feather, the rachis (the stem) and the wrap, while the electrical wire is hidden bellow. Following the French embroidery Lunéville technique, the hook, held on top of the frame, makes a chain stitch with the wire underneath. Each feather is connected using this technique to three MPR121 capacitive touch controller boards.

The touch controllers are read by an Arduino Nano microcontroller, by using radio transceivers, the data collected are processed in PureData.

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