SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17107
STSM title: Analysis and development of e-textile interconnection techniques in woven and knit fabrics
STSM start and end date: 2020-11-20 to 2020-12-20
Grantee name: Despina Papadopoulos

PURPOSE OF THE STSM:

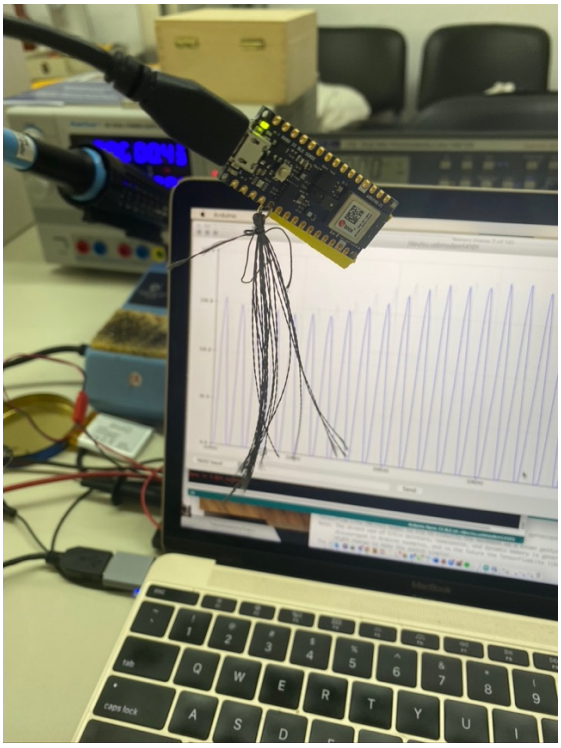
(max.200 words)

The visit to the University of West Attika was structured around knowledge exchange and in order to initiate a dialogue and sharing between engineering practices, design, and a theoretical, humanities-based approach to wearable technology. Such approach aimed to move beyond the functionalization of wearable technology and explore its relationship to human expression and communication in an increasingly technologically mandated environment.

The main focus was on conductive yarns and the desing and minuatirization of components for the construction of wearable technology projects. At the same time, such an exploration can only meaningfully take place when grounded in actual use cases and is able to provide solutions to concrete design challenges. This is particularly important in wearable technology projects, where design and engineering cannot be thought as separate practices due to the intimate relationship wearables have to the human body, their emotional and psychosocial component, as well as the inherent ergonomic demands of the wearable environment.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

Given the timeframe of the visit, we decide to collaborate on Embodied Companion, a project that I was developing prior to my visit, where an Arduino NANO33 BLE Sense using a TensorFlow library is used for gesture recognition as part of a wearable project that aims to reframe human-machine interactions. In this project we are developing a machine learning model that can distinguish a number of gestures, in response to which different regions of a fabric woven with conductive yarns are heated. The composition of the yarns used is such, that they can be modulated to quickly change temperature and therefore move from a high, almost burning sensation, to a comfortable soothing one, attempting to create a more nuanced interface between a machine learning model and affective sensation on the body.

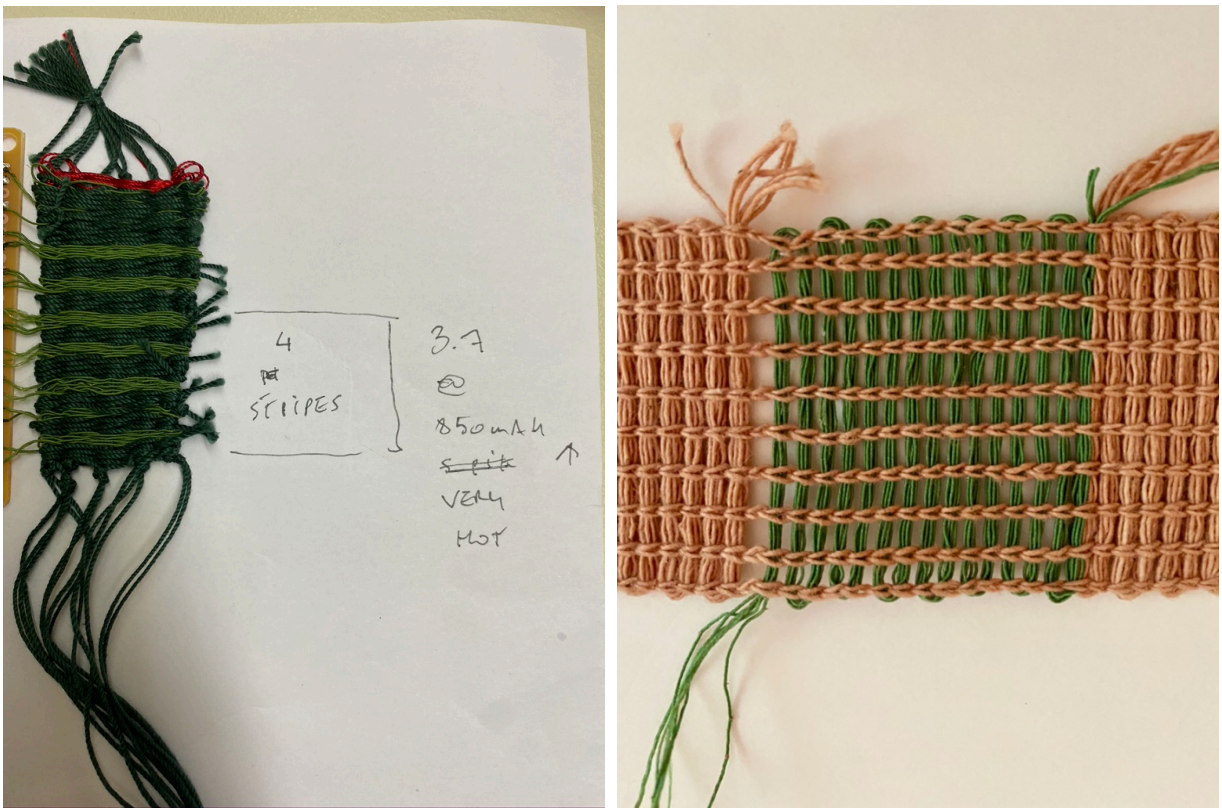


Using an Arduino NANO33 BLE Sense using TensorFlow library for gesture recognition

Woven fabric with conductive yarns: yarns heat on four different sections in response to different gestures

Part of our early exploration was to measure the resistivity of different combinations of yarns, as single strands and in parallel, in order to assess the most effective combination to produce the desired heating sensation and variability, while minimizing battery size, in this case using a 3.7 850mAh rechargeable lithium-ion battery. We also experimented with soldering techniques, a key challenge when working with conductive yarns, and ways to address connectivity issues. These initial experiments were carried out on

swatches of a ribbon produced in a combination knitting & weaving industrial machine, using copper based, insulated conductive yarns.



Experimenting with different lengths and configurations of conductive yarns on a knitting/weaving machine for a heating application. Here using a copper based conductive yarn from Volt yarns.

Unfortunately, given the constraints introduced due to a series of lockdowns in Athens, we were not able to advance solutions around the connectivity of hard-to-soft inter-connects as much as we would have liked. We remain hopeful that now that we have established a good working relationship and collaboration, we can revisit this aspect of the work when circumstances allow it.

We then proceeded to miniaturize the hardware used for the overall construction, focusing on the board that connects from the Arduino to the 4 regions of the fabric composed of the heated conductive yarns, in order to control them using PWM. This was a critical aspect of the hardware development, both for better fit and seamless integration of the electronics in the wearable, but also for aesthetic reasons.

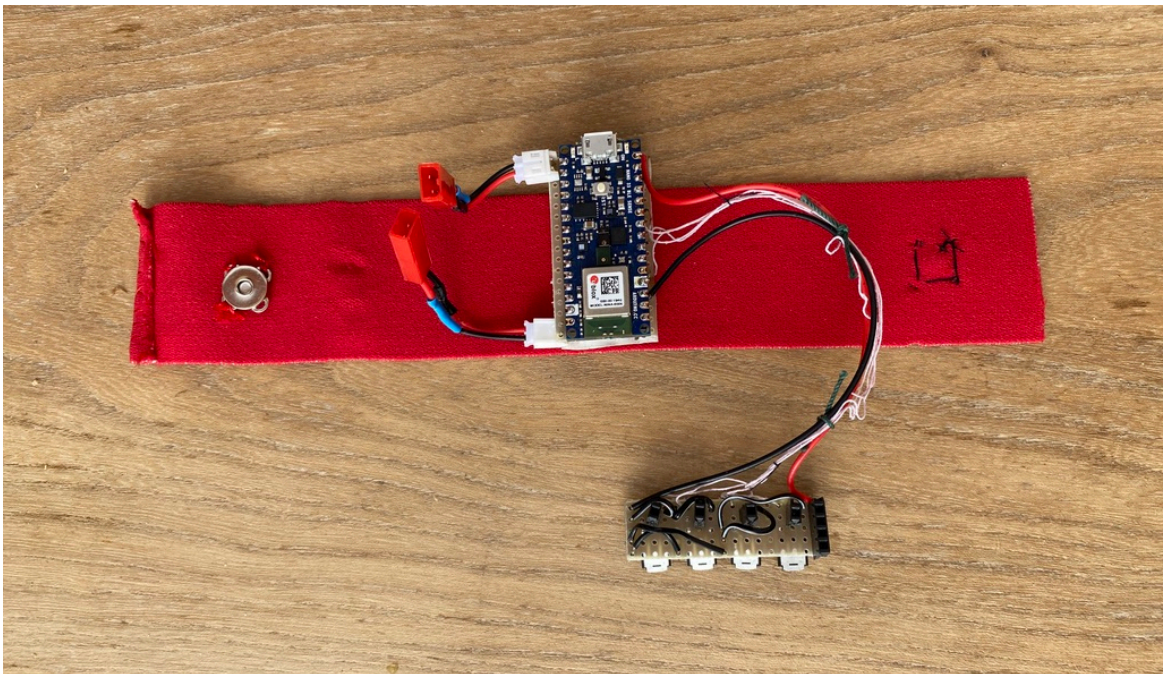
DESCRIPTION OF THE MAIN RESULTS OBTAINED

The new boards are a great improvement of the overall system in terms of electrical engineering and design. The design of the board took place under the leadership and supervision of Anastasios Tzerachoglou, whose support and expertise was invaluable. The design and manufacturing of the PCBs was a natural progression of the close collaboration and ongoing dialogue with Tzerachoglou in all aspects of the project, and a testament to the importance of the integration of design and engineering practices at an early stage and not as parallel and independent tracks.

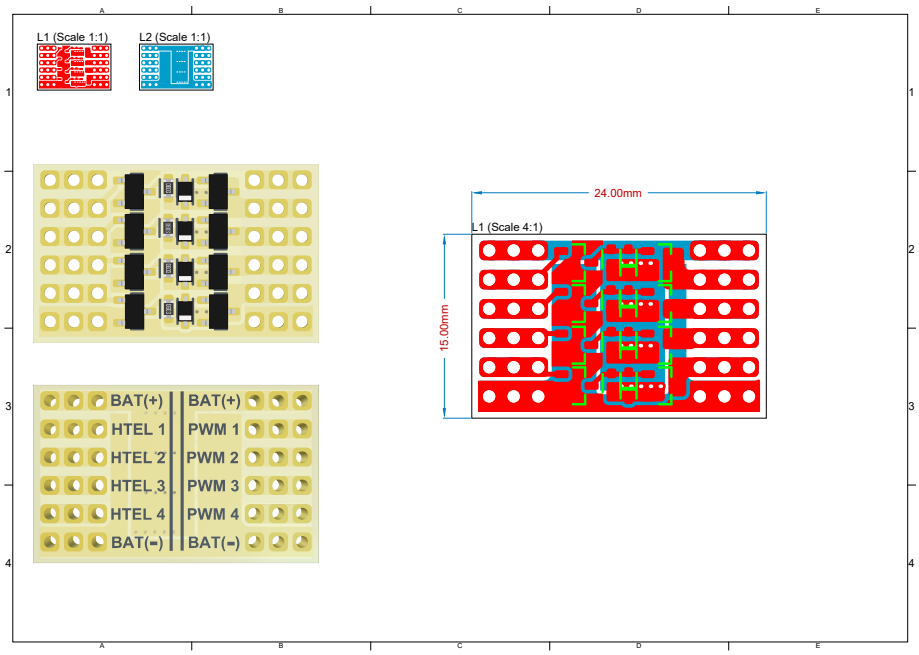
An ongoing and open dialogue and sharing of priorities, design criteria, functional and ergonomic considerations, and shared principles and values on outcomes and modes of working together, emerged as important and critical aspects of a successful collaboration between pracitioners.

While we tend to think of the design of PCBS in terms of electrical engineering, in the construction of wearables the two cannot afford to be thought as separate. The overall construction of the fabric component of the wearable, the particularities of each conductive yarn and its solderability and connectivity, but also the aesthetic dimension of the PCB itself, are critical in how the wearable will perform and be perceived by its user. Even if the user does not have direct access to the PCB board and the board is not exposed, it is still important for it to look compelling from a design point of view, in the same way that parts of a garment that are not necessarily seen by the user, still maintain a high degree of craftmanship and aesthetic quality.

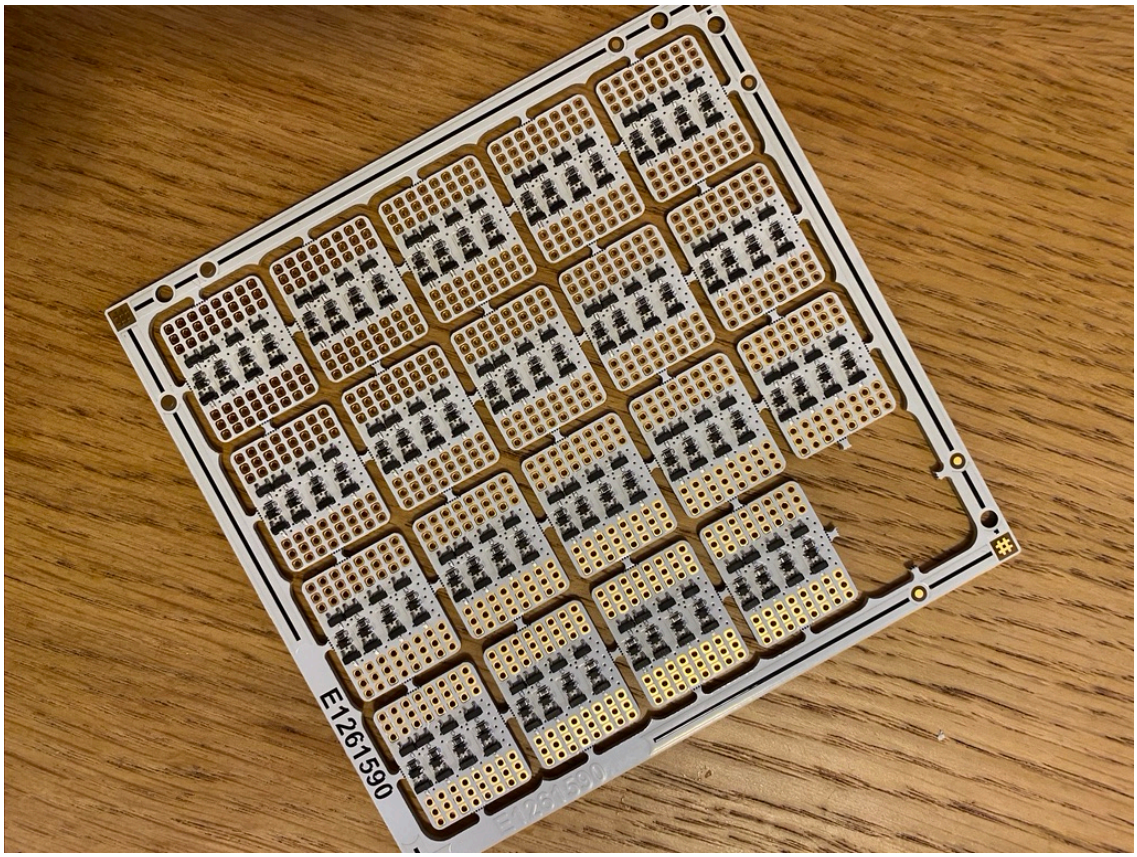
The new boards fulfilled all of these criteria and in fact we now consider making them indeed a visible part of the final construction, as to accentuate how the art of engineering relates to a design practice and the importance of approaching electronics as a design component on its own right, much like we look at zippers, buttons and other functional components in garments.



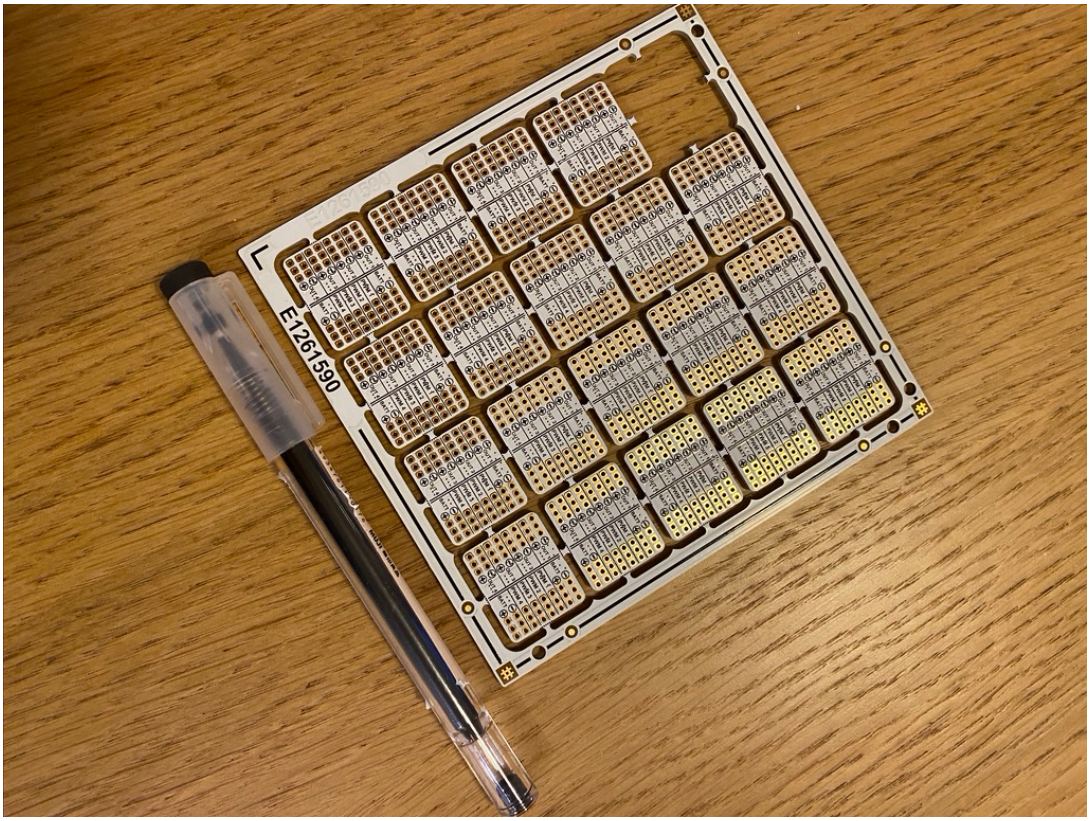
Early prototype of Arduino connected with conductive yarns and wire for power and ground, to control board for heating yarns on fabric woven with conductive yarns.



PCB design for replacement of control board



Final, miniaturized control boards – front view



Final, miniaturized control board – back view

FUTURE COLLABORATIONS (if applicable)

We have planned a series of workshops and lectures for the coming term, that I will be delivering to the faculty, student body, and alumni of the University of West Attika whose content is based on conversations and meetings with different members of the faculty at the University, most notably with department head Dr. Priniotakis, PhD candidate Anastasios Tzerachoglou and textile engineer, Pr. Emmanoyla Sfyroera. These will take take place online in the form of a series of lectures as well as one online workshop for current students, where they will be asked to develop a project at the intersection of wearables, engineering and textiles and then conduct online crit sessions. The online lectures and workshop are planned with Anastasios Tzerachoglou and Dr. Priniotakis to ensure that they fit with the current curriculum, and hopefully provide the interaction and dialogue that online learning has made so difficult.

The workshop, where enrolled student will participate, will focus on a design and engineering challenge that proposes wearable technology solutions that will address the social and emotional challenges of COVID. The online lectures will be given to both current students as well as alumni, focusing on the following topics:

- The history of wearable technology
- Wearable technology and the human body
- The future of wearables
- Challenges and Opportunities in Wearables