# Aural Fabric: an interactive textile sonic map

**Alessia Milo**
Queen Mary University of London
Media and Arts Technology CDT
a.milo@qmul.ac.uk

**Joshua D. Reiss**
Queen Mary University of London
Centre for Digital Music
joshua.reiss@qmul.ac.uk

## ABSTRACT

The Aural Fabric is an interactive textile sonic map created to promote engagement in acoustic awareness towards the built environment. It fosters discussions on the aural environment of our cities by allowing users to experience binaural recordings captured during a soundwalk. The touch of the conductive areas embroidered of the surface on the map can be sensed by two capacitive boards stitched on the map. These are externally connected to an embedded computer processing unit, Bela. The recordings can be intuitively mixed together offering exploratory and performative recall of the material collected.

## CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in interaction design**; • **Applied computing** → *Interactive learning environments*; • **Hardware** → Emerging interfaces;

## KEYWORDS

Aural; Fabric; soundwalks; soundscapes; map; Bela; multi-touch; e-textiles; audio.



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**Figure 1: Aural Fabric on display.**

**History:** The Aural Fabric was originally created for the Sonic Environments conference (https://www.sonicenvironments.org), Brisbane, 2016. Supporting information on the making of the fabric has been documented online at http://auralcharacter.wordpress.com/aural-fabric. The original concept is presented in Fig. 6

**Figure 2: Detail of Aural Fabric and the conductive areas in brown.**

## INTRODUCTION

The Aural Fabric is an interactive interface designed to stimulate reflections on the impact of the built environment on everyday soundscapes. In a previous study we researched how a group of sound-design students verbalised sonic textures encountered during a soundwalk in Greenwich, London [10, 12]. Walking while listening offers terrain to grow educational practices which could be beneficial for students of architecture, landscape, and urban design. Listening attentively during a soundwalk allows one to reflect on space as an active and passive factor in the creation and modulation of soundscapes. Soundscape research was first pioneered by a study on the influences of visual and sonic perceptions while exploring urban environments [17]. Lately, researchers and activists of the World Soundscape Project[13, 16, 18] supported the practice of soundwalking [19] and field recording producing documents, archives, and musical pieces. The ecological validity of being completely immersed in multisensorial contexts, when assessing real locations, supports soundwalking practice as a validation tool to characterise perceptually objective measurements of sound levels [1]. Field recording, allowing to capture sonic material and transfer it to new listeners, can also be employed as an educative surveying creative practice [5]. Acoustic properties such as *reverberation*, *filtering*, and *echo* effects can be discussed in situ and recalled later. Numerical information can be measured and analysed beside qualitative observations in support of design diagrams.

## DESIGN RATIONALE

We aimed at studying whether the soundscapes locally recorded in Greenwich could be communicated to other listeners without asking them to walk in the area. Therefore, we designed an interface able to present the experience of the soundwalk in a novel and intuitive way, yet with a graphical language familiar to the categories we wanted to engage. Moreover, the interface aimed at being portable, resistant, and offering pleasantness of interaction. Maps are traditionally used to convey geographical information (see Box *Why a Map?*), and accordingly, a map was crafted after researching possible solutions employing e-textiles technology (see Box *History*). We designed a portable assemblage that could be rolled and easily transported, to be on display as an aesthetic medium in autonomy, or be used as a tool to conduct research in different contexts (see Box *Description of the System*). The immersive nature of the aesthetic experience, based on binaural recordings, aims at enhancing the spatiality of the locations encountered during the soundwalk. By touching the locations, some users

**Description of the System:** The system, explained in Fig. 4, relies on the capacitive sensing of the conductive areas on the top, whose capacitive charging is transferred to the bottom layer. This consists of an embroidered circuit (see Fig. 3), separated from the top by an insulating layer of felt with holes corresponding to the active locations. The system senses the capacitance produced by the human body, which travels over the conductive threads to the two capacitive boards MPR121 (https://www.sparkfun.com/products/retired/9695) (see Fig. 5). These boards capture the activation data in real time, and send it through $I^2C$ transferring protocol to the Bela embedded computer unit (bela.io), which, in response, triggers the corresponding binaural recordings.

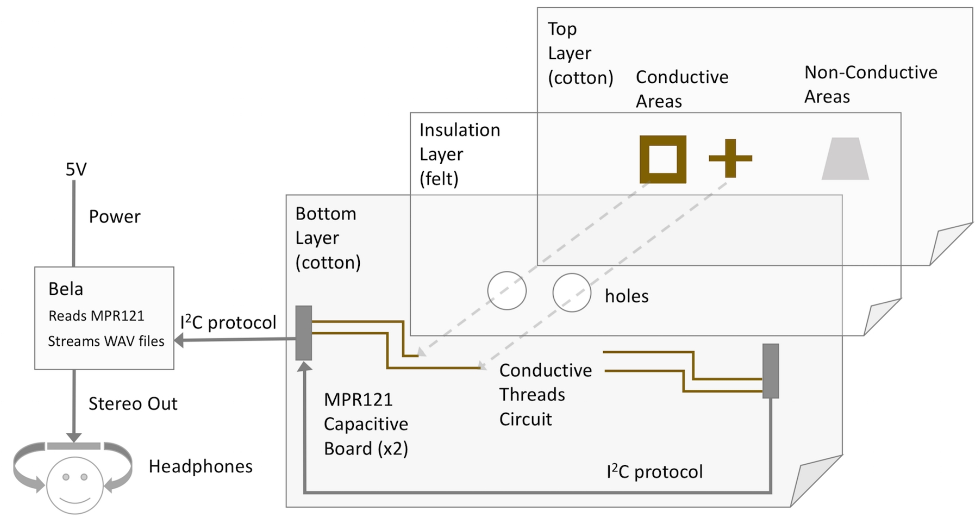


**Figure 4: Functional diagram of the Aural Fabric system.**

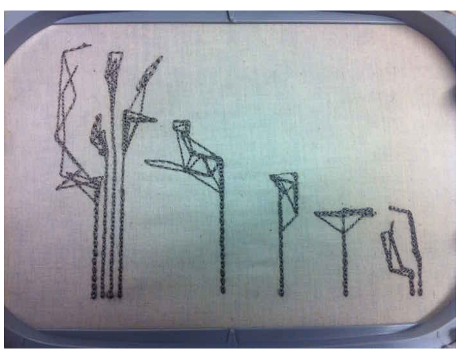

**Figure 3: Part of the circuit on the bottom layer.**

reported to appreciate reverberation effects, detect and recognise differences in the size of the space, or whether the environment was open or close.

The spatial displacement of the depicted elements on a rectangle is derived from manipulating the map of the historical, natural, and touristic part of area, without varying the original proportions. The color-coded appearance, showing the River Thames in light blue thread and the green areas in green, allows to create relationships among locations that can be matched to reality. This area was chosen for presenting a variety of well known environments, more or less natural and populated. Locations were selected to provide examples of different urban activities, with the goal of studying the different combinations of factors which compose soundscapes, and the role of the built environment. The content of the soundscapes accessed by touching the map can be connected with systems of spaces which can imagined or recognised from real life experience, as reported in interviews [11]. Locations can also be mixed together, creating fictional auditory spaces which can be presented in a musical way, by playing the map like a keyboard.

**Why a Map?:** Maps communicate spatial relationships among the elements depicted, are able to convey different levels of information through the use of keys and graphical conventions, and configure content on predefined spatial dimensions. Map are based on *attributes*, "characteristic of a geographic (physical and social) feature described by numbers, characters, images, or sounds" [15]. Auditory and tactile maps can be navigated in absence of vision.

Researchers investigate the contribution of sensorial modalities (visual, auditory, tactile or haptic) and their combination when delivering a spatial message [7]. In wayfinding studies multimodal interaction was found to diminish the time employed in reaching a destination [4]. However, maps can also be explored without a clear outcome in mind.

Physical *raised lines* were traditionally employed to convey Contours and Points of Interests [2], together with interpretation keys such as Braille language, for the use of Visually Impaired people. Nowadays digital technologies allow to design screen-based maps with integrated haptic feedback and render contours as a vibrotactile stimulus [3].

Among interactive maps geographical locations can be associated with the corresponding soundscapes [6, 9]. In maps, sound can also be used to communicate textual information, such as location features and distances [8].

## DISCUSSION AND FUTURE

The Aural Fabric received positive feedback when exhibited, inviting users to listen attentively to the soundscapes hidden in it, and effectively promoting sonic awareness as an educational medium. Because of the differences in the appearance of the locations, we investigated whether all the conductive areas could be accessed on the map, without explanatory information [11]. It was found that without the support of a legend, showing the accurate position of the interactive areas, few less obvious locations were more frequently discarded, possibly for requiring more pressure to be triggered and being less visually evident. Nevertheless, participants found the experience pleasant and became interested in soundwalking and the creation of future maps. Moreover, the tactile differences across the locations, and the multi-touch exploratory nature of the experience, inspired users to suggest future developments. The interface was interpreted as an aid for visually impaired people navigating public spaces [14], a device to craft sonic memories, and a live instrument to perform with the sonic material. Finally, this Aural Fabric was intended as only the first example of a series of collaborative maps to be made in the future by those inhabiting spaces and soundscapes with a story to tell.

## CONCLUSION

We have presented an interactive textile sonic map called Aural Fabric, created to promote sonic studies among design communities and aural awareness towards our built environment. We described its system, consisting of embroidered conductive and coloured threads on cotton, an insulating layer, an embroidered circuit, two capacitive boards, and an embedded computer unit connected to headphones. The interface conveys geographical information through a map-like graphical language and presents soundscapes in response to capacitive sensing. Assessment in the field and in laboratory demonstrated that Aural Fabric, when supported by an explanatory key, successfully communicates the spaces and the soundscapes recorded. Beside promoting sonic awareness towards the built environment, this audio-tactile map, made of e-textiles, offers also new directions to research spatial cognition and navigation, with blind and sighted users.

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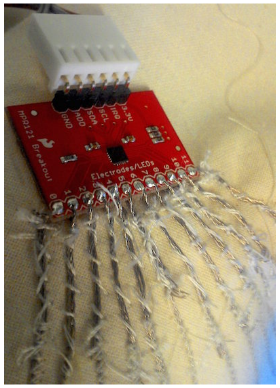

**Figure 5: The capacitive board MPR121: detail of the connections**

**Figure 6: Concept of the Aural Fabric.**


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