# WearaFab: Digital Fabrication for Wearables Toolkits

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Fig. 1. Illustrations with the HiveTracker [1], PolySense [2], Lenticular Objects [3], and MorphSensor [4].

We present a set of wearable toolkits for applications ranging from motion capture to dynamic display design or health applications. From embedded electronics to 3d printing via eTextiles and materials science, our research leans towards accessible and replicable smart fibers to democratize conformable wearable devices.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**.

Additional Key Words and Phrases: Digital Fabrication, Motion Capture, eTextiles, Materials Sciences, Wearable Electronics, 3d Printing.

## 1 INTRODUCTION

Wearables have been the subject of extensive research for decades both in HCI [5,6] and other research communities. For example, in-fiber electronics systems were recently proposed by Loke et al. [7] and textile displays were achieved by Choi et al. [8] with record-breaking definitions. With these in mind, we discuss in the following how we contributed to the field, and how we anticipate our next steps.

## 2 HIVETRACKER & POLYSENSE: WEARABLE MOTION CAPTURE TOOLKITS

Capturing 3d movement has been explored for more than a century. For example, factory worker gestures had been studied for productivity optimization with long exposure photography in the early 1900s. However there is still no satisfying solution to 3D movement capturing, and it is still explored in diverse fields, from neuroscience to robotics and entertainment. With dance motion capture in mind, we built a wearable toolkit for accurate indoor positioning, the HiveTracker [1]. Using lasers, this miniaturized system (Fig. 1.1) allows 3D positioning with sub-millimetric precision. It embeds a 9DoF IMU for 3D orientation and to add robustness against optical occlusion, but eTextile sensors can also help: PolySense [2] is an accessible process to augment materials with electrical properties. The glove in Fig. 1.2 is connected to a microcontroller, and a VR model visualizes the measured movements. Further on-skin approaches were explored with resistive or capacitive sensing. These wearables can be patched onto different body parts to document movements or augment dance by sonification or visualization.

## 3 LENTICULAR OBJECTS & MORPHSENSOR: FREE-FORM RESPONSIVE DISPLAYS AND SENSORS

Because of their size and shape constraints, wearable devices benefit from free-form display and sensor modules. The Lenticular Objects [3] project presents a method that fabricates lenticular displays with a free-form shape, which makes 3D objects appear differently under different viewpoints (Fig 1.3). This is accomplished by 3D printing lenticular lenses across the curved surface of objects. By calculating the lens distribution and the corresponding surface color patterns, the designers can determine which appearance is shown to the user at each viewpoint. MorphSensor [4] enables designers to morph existing sensor modules of pre-defined two-dimensional shape into free-form electronic component arrangements that better integrate with the three-dimensional shape of a prototype (Fig 1.4). MorphSensor provides a useful tool for prototyping wearable devices because of its small size and flexible surface geometry. MorphSensor builds onto existing sensor module schematics that already define the electronic components and the wiring required to build the sensor.

## 4 CONCLUSION

Our wearable research spans from eTextiles to free-form display technologies, and from 3D printing to embedded electronics. We speculate that in the near future, persistent fiber displays will be as common as e-paper is replacing books, or we can at least ask, what could be the e-ink of fibers? Generic eTextile ecosystems that integrate sensing and actuation capabilities inside fibers are also starting to get accessible, so we can also ask: what could be the Arduino of fiber electronics? We hope to participate in writing the next volume of this evolution with the HCI community.

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