Augmenting Augmented Reality

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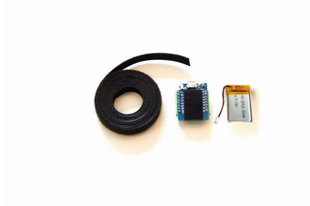
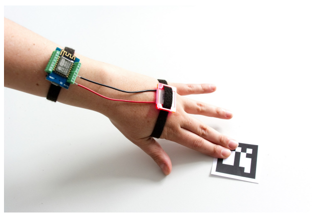
Abstract
Today's Augmented Reality (AR) devices enable users to interact almost naturally with their surroundings, e.g., by pinning digital content onto real-world objects. However, current AR display are mostly limited to optical and video see-through technologies. Nevertheless, extending Augmented Reality (AR) beyond screens by accommodating additional modalities (e.g., smell or haptics) or additional visuals (e.g., peripheral light) has recently become a trend in HCI. During this half-day tutorial, we provide beginner-level, hands-on instructions for augmenting an Augmented Reality application using peripheral hardware to generate multi-sensual stimuli.

Author Keywords
Augmented Reality; Virtual Reality; Wearables; Actuators; Multimodality.

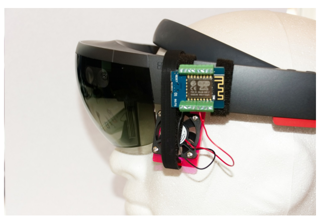
Introduction
In recent years, augmenting the so far primarily visual user experience of Virtual and Augmented Reality through additional sensory stimulation has drawn a lot of interest. Researchers started to explore how the user experience in Virtual and Augmented Reality could be extended to include thermal and olfactory stimuli [3, 4], haptics [1] as well as peripheral light [2].



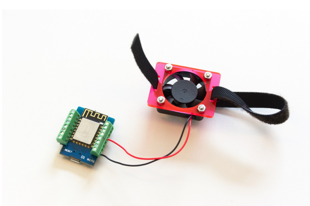
(a) A NodeMCU board and a small battery pack can easily be made wearable using VelcroWrap.



(b) Peltier elements can augment AR by providing thermal feedback.



(c) An airflow experience can be prototyped by attaching a small fan.



(d) Using terminal blocks and laser-cutted frames enables quick and easy prototyping.

Figure 1: Overview of materials and prototyping ideas for the tutorial's hands-on activities.

However, the entry threshold to implementing this kind of "augmented" Augmented Reality is relatively high: researchers need to be familiar with the development of state-of-the-art Augmented Reality, as well as have experience with programming developer boards, using them for (wireless) communication, and using various sensors and actuators for what is commonly known as hardware prototyping.

During this tutorial, we will provide beginner-level instructions and accompany the attendees during their first steps towards "augmenting Augmented Reality".

Covered Topics

The tutorial will comprise two parts. First, we will provide an overview of Augmented Reality (AR) and AR applications beyond the visual. In addition, we will point out challenges in implementing such experiences as well as available hardware and software choices. Second, we will guide a hands-on activity where participants will receive step-by-step instructions for interfacing a state-of-the-art head-mounted display (Microsoft Hololens) with a peripheral hardware platform (Node MCU). Based on this, participants will explore various options of how the created interface can be used to extend the design space for Augmented Reality applications, including the use of light, vibration, shape-changing elements, as well as heat and airflow.

Intended Audience and Learning Goals

The tutorial targets beginners, and does not require any prior knowledge of developing Augmented Reality applications or hardware prototyping. However, we will design the tutorial to particularly engage both, researchers developing for AR without prior knowledge in hardware prototyping as well as researchers experienced in hardware prototyping, but without AR experience.

The tutorial is designed to provide the attendees with the required basics to start their own, more comprehensive projects. After attending the tutorial, the participants

- can use Unity3D as a tool for creating a simple marker-based AR application for the Hololens.
- can interface the Hololens with a NodeMCU developer board.
- can control various actuators via the Hololens and a connected NodeMCU.

Tutorial Activities

The full-day tutorial is designed as a course that guides the participants through the process of linking a state-of-the-art head-mounted display (Microsoft Hololens) with a hardware platform producing multi-sensory stimuli. The course will be a mix of brief presentations covering Augmented Reality, and available hardware for augmenting AR, as well as hands-on activities. The tutorial is structured as follows:

Introduction (09.00 - 10.30)
Introductory presentation covering the tutorial's agenda and organizers, as well as an intro on (augmenting) Augmented Reality (AR) and recent work in the field.

Coffee break (10.30 - 11.00)

Wearable Sensors and Actuators (11.00 - 11.45)
As not all participants will be familiar with wearable sensors and actuators, we will provide an overview of existing technology, and how it might be used to enhance Augmented Reality. Where applicable, we bring along demonstrators for the participants to try out and experience their effects.

Developing HoloLens Applications (11.45 - 12.30)
We will guide the participants through the set-up process and assist them in familiarizing themselves with the Hololens

and with Unity3D. A brief presentation will cover basic principles of application development. We provide pre-installed notebooks, but also installation files, as well as plug & play installations on USB sticks.

Lunch break (12.30 - 13.30)

Hands-on Session I (13.30 - 15.00)
Hands-on system development. Following step-by-step instructions, the participants develop a small marker-based AR application for the Microsoft Hololens. Then, we'll assist them interfacing their application with a NodeMCU. Lastly, they equip the NodeMCU with one (or more) actuator module(s) of their choice.

Coffee break (15.00 - 15.30)

Hands-on Session II (15.30 - 16.30)

Wrap-up and Closing (16:30 - 17:00)
We'll collect the participants' feedback and provide additional starting points and materials.

Tutorial Materials

During the tutorial, the participants will work in groups of three. We will provide each group with a NodeMCU developer board[1], a Microsoft Hololens and a notebook running Unity3D[2], and a pre-configured Arduino IDE for programming the NodeMCU board. For attendees who want to use their own notebooks, we will provide USB sticks with a plug & play development environment as well as installation files and instructions. Furthermore, the participants will have the choice of a variety of wearable actuators. For easily attaching the actuators to the body or the Hololens we will supply Velcro wrap and laser-cutted construction elements (see Figure 1 for examples). In addition, we will provide print outs with easy-to-follow step-by-step instructions for the participants to take home. As a follow-up on the tutorial, these instructions will also be uploaded to `https://www.instructables.com/`.

[1] http://nodemcu.com, last retrieved June 22, 2018
[2] https://unity3d.com/, last retrieved June 22, 2018

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Instructors

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