Augmented Humans Interacting with an Augmented World

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Research Questions:

1: How can we visually detect devices of interest in real time from an ego-centric perspective?

2: How can we detect fine-grained gestural input from wearable sensors?

3: How can we reason which device command should be carried out?

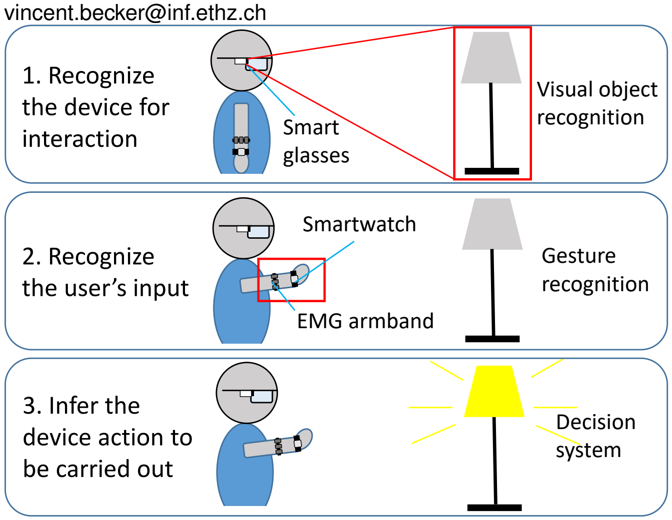

Figure 1: Recognizing the user's interaction intention with wearable computers.

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Abstract
Our research explores a seamless interaction with smart devices, which we divide into three stages: (i) device recognition, (ii) user input recognition, and (iii) inferring the appropriate action to be carried out on the device (cf. Figure 1). We leverage wearable computers and combine them into one interaction system. This makes interactions ubiquitous in two ways: While smart devices are becoming increasingly ubiquitous, our wearable system will be ubiquitously available to the user, making it possible to interact everywhere, any time.

Author Keywords
HCI; Wearable Computing; Smart Devices

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces

Introduction
Miniature computers have become an essential part of our lives. They can sense, process, communicate, and act, and are embedded into everyday devices and tools, and can even be worn on the human body. Augmented devices offer more convenient and intelligent services, computers augmenting humans enable instant information access. Yet, interactions between these two sides, the augmented hu-

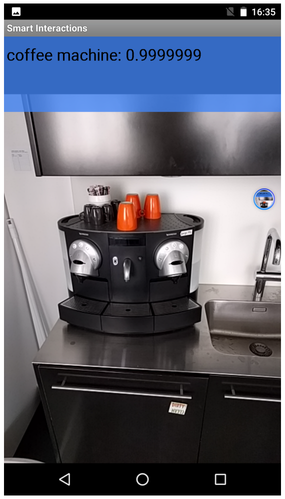

Figure 2: Visual object recognition running on a smartphone.

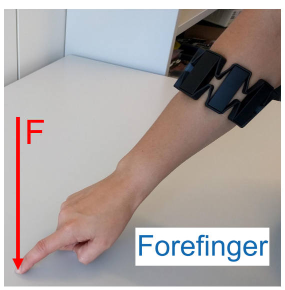

Figure 3: Finger identification and force estimation using a wearable EMG armband.

man within an augmented world, are still very different from human-human and from device-device interactions. Our research aims at bridging this gap by employing machine learning on wearable devices. This has the benefit of taking an ego-centric perspective, naturally perceiving what the human perceives: cameras can see what the human sees, body sensors can recognize gestures. Moreover, the controlled devices do not require built-in sensing and intelligence, as the knowledge is acquired by the ego-centric system. Hence, the device can become as simple as possible, outsourcing its interface to a wearable system [3].

Research Goals and Expected Results

We explore techniques to support the interaction process with smart devices. We structure our work around the different interaction stages as shown in Figure 1 and reflected by the research questions (c.f. sidebar). We plan to apply and advance visual object recognition algorithms based on deep learning in order to recognize smart devices from wearable cameras such as those incorporated in smart glasses. One main goal is to enable a fast recognition, even on resource-constrained devices. We have created a prototype for a smartphone camera [1], which we will further develop and port to smart glasses. An addition we consider, is to combine the object recognition with a wearable eye tracker in order to more precisely know what the user is interested in.

We further investigate novel wearable gesture recognition systems. We are specifically interested in electromyography (EMG) of the forearm, which enables the recognition of fine-grained hand gestures. We created a system to recognize the user's finger in touches and estimate the applied force [2] (cf. Figure 3). We are further developing a full-hand gesture recognition system based on EMG and are also investigating other modalities and devices such as smartwatches.

After having built the visual object recognition and gesture recognition subsystem, we plan to combine them to enable the entire interaction pipeline. Our current prototype [1] demonstrates this concept as it combines device recognition and gestural input. A crucial question is whether we can build a decision system, which interprets the performed gesture and maps it to a command for the currently controlled device without hard-coding such a mapping.

Finally, we are examining the potential of visually augmented reality (AR) for interaction with smart devices. It complements our efforts of recognizing human input by the possibility of visualizing device output. AR can show information about the capabilities of a device or its state on the spot, which otherwise would not be perceivable.

Making the interaction of humans with smart devices more similar to natural communication could make the devices more usable and easily accessible to more people. It would give humans immediate access to information about and control over the devices, at any time with little mental and physical effort.

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