Teaching Wearable Device Development with the Wearables Development Toolkit

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***Abstract*—This paper introduces the Wearables Development Toolkit (WDK), a set of tools to support the development of wearable device applications. It lowers the entrance barrier to wearable device development. We discuss our experiences in leveraging the WDK to teach wearable device development to students of computer science.**

***Index Terms*—software engineering, wearable computing, wearables development toolkit**

I. Introduction

The growing number of students of computer science calls for new teaching methodologies that are able to cope with larger number of students while maintaining the teaching quality. Digital technology has made it possible to transmit content to large numbers of students. However, actively engaging students in the learning process remains a challenge. Courses where students actively work on a project are usually associated with high supervision costs and therefore scale less well to larger number of students. A particular challenge for instructors is combining their teaching and research responsibilities.

Our research focus is on wearable computing. We develop wearable device applications, which make use of sensor data to extract relevant information from the user or her context. For example, we developed a wearable device that uses a motion sensor to detect lameness in dairy cattle [1], [2]. The development of wearable device applications requires multidisciplinary highly-specialized knowledge (e.g. electrical engineering, computer and data science).

The WDK is a collection of wearable sensors (see Figure 1) and tools to facilitate the development process of wearable device applications. The toolkit is meant to guide students during the development process and to enable them to study possible design solutions while saving time in implementation details. In this paper, we discuss our experience in teaching wearable application development to students of computer science using the WDK.

II. Wearables Development Toolkit

Figure 2 shows the different activities in the development process of a wearable device application. Most wearable device applications extract information from sensor data. The development process usually starts with the collection and annotation of data. After this, developers usually develop and evaluate different signal processing and machine learning methods. Finally, the application is deployed into the actual device. The WDK consists of four components: the *Wearable Sensors Platform*, the *Data Annotation Tool*, the *Visualization tool* and the *Evaluation tool*.

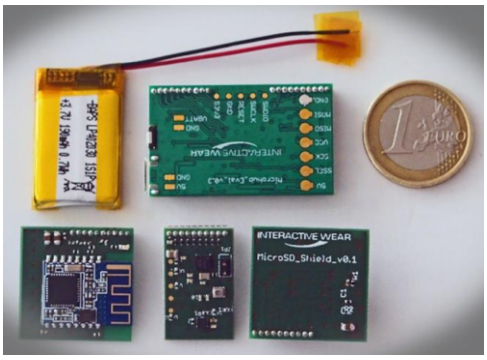

Fig. 1. Wearable sensor kit developed by InteractiveWear. Source: http://www.interactive-wear.com/

The *Wearable Sensors Platform* is a collection of wearable sensors which can be plugged into a sensor hub and configured over an iPhone App. This enables users to collect data without having to design or assemble a new sensor or to develop a firmware that stores data. Figure 1 shows the sensor hub and different hardware components. The *Data Annotation Tool* is used to automatize the data annotation process by synchronizing and displaying the sensor data together with reference markers enabling the user to annotate events in the time series signal. Figure 3 shows the *Data Annotation Tool*. The *Visualization tool* enables users to understand the sensor data as well as the effects different signal processing methods have on the data, which is critical for most activity recognition application. The *Evaluation tool* lets users quickly configure a chain of computations in order to assess its performance. The WDK is open source[1].

[1]https://github.com/avenix/WDK

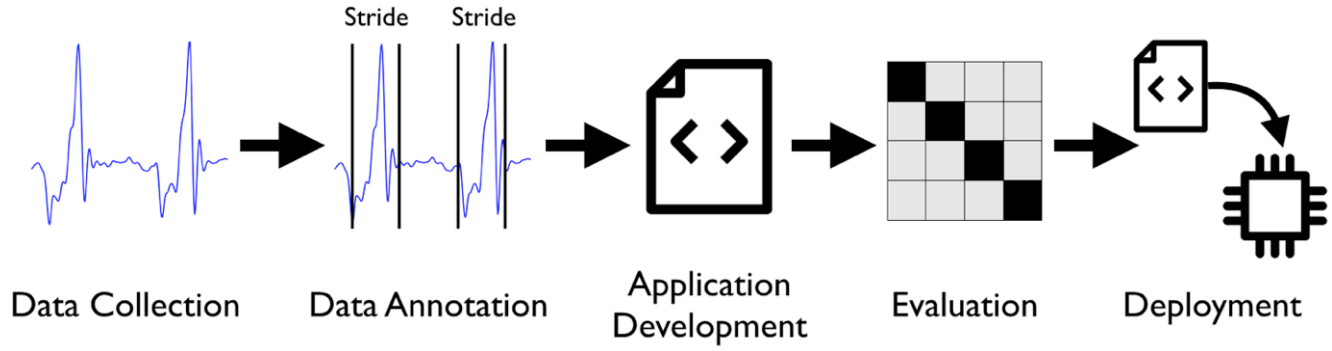

Fig. 2. Wearable device development activities.

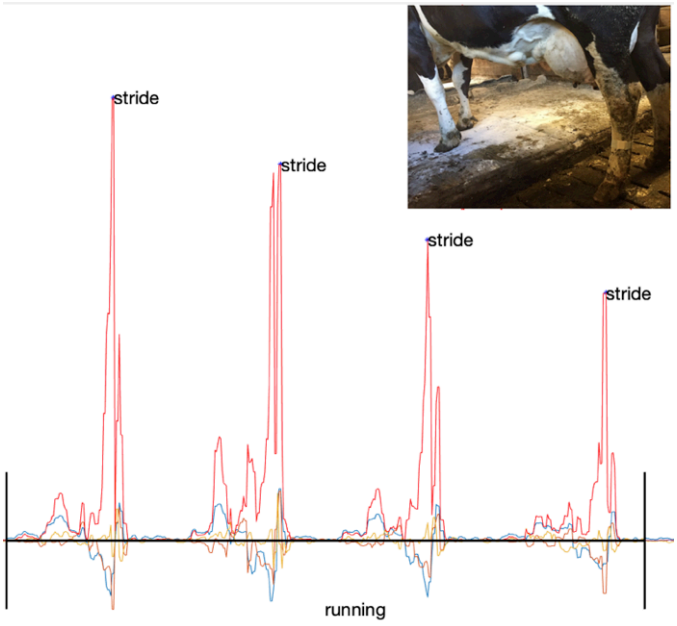

Fig. 3. Data Annotation Tool displaying the acceleration collected by a Inertial Measurement Unit attached to a limb of a cow. The strides performed by the cow have been annotated.

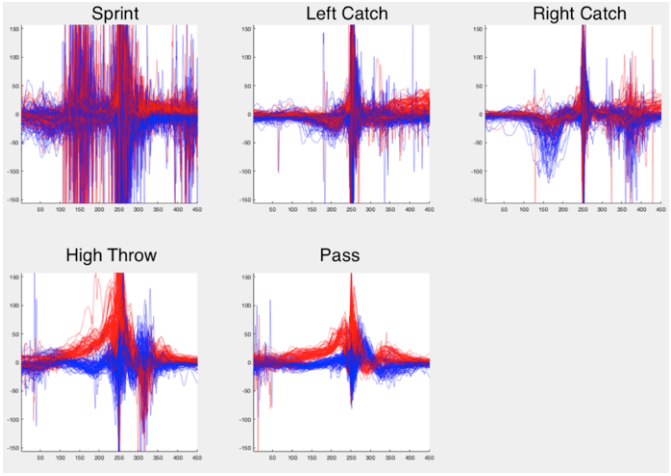

Fig. 4. Data Visualization Tool displaying the acceleration of a lacrosse goalkeeper while performing several training exercises.

III. Teaching Method

Since 2011, we have supervised over 30 Bachelor's and Master's theses in computer science at the Technical University of Munich. Most of these theses comprise the development of a wearable device application or a feature of the WDK itself. In this section, we describe how we leverage the number of students to contribute to our research in wearable device development.

In the beginning of each semester, we provide students a tutorial on activity recognition with wearable devices[2]. Students are usually able to finish this tutorial within a day. Afterwards, the students start working on a particular application. As students start engaging in activities for which the WDK can spare them time, their instructor demonstrates the relevant tools within the toolkit. As students use the WDK, new requirements for the toolkit are identified, which are usually analyzed by an instructor and implemented by other students in the next term.

[2]Tuorial on activity recognition with wearable devices: https://github.com/avenix/ARC-Tutorial/

IV. Conclusions

The WDK enables students to reuse functionality and focus on the novel aspects of their projects. The different tools and documentation guide students through the development process, thus relieving instructors.

References

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