

UNIVERSITY OF HRADEC KRÁLOVÉ  
FACULTY OF INFORMATICS AND MANAGEMENT  
DEPARTMENT OF INFORMATION TECHNOLOGIES

## MASTER'S THESIS

### Radio Fingerprint Acquisition Using Smartwatch

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Hradec Králové

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**Prohlášení**

Prohlašuji, že jsem diplomovou práci vypracoval samostatně a uvedl jsem všechny použité prameny a literaturu.

**Declaration**

I declare that I have elaborated this thesis independently and listed all the sources and literature.

Hradec Králové day 26th of April 2018

Bc. David Sucharda

### **Poděkování**

Rád bych zde poděkoval Ing. Pavlu Kříži, Ph.D. za odborné vedení práce, podnětné rady a čas, který mi věnoval.

### **Thanks**

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## **Anotace**

**Název práce: Sběr rádiových fingerprintů pomocí chytrých hodinek**

Diplomová práce se zabývá možnostmi sběru rádiových otisků (fingerprintů) za pomoci chytrých hodinek. Tyto otisky se používají k lokalizaci uvnitř budovy. Hlavním cílem této práce je prozkoumat možnosti sběru otisků a návrh aplikace která bude tento sběr umožňovat. V první části práce je potřeba zjistit, jestli je tento sběr na hodinkách vůbec možný. V další části je zpracování aplikace na mobil a hodinky. A jako poslední část této práce je sběr otisků a jejich analýza. Jeden z osobních cílů je zpracovat tuto aplikaci aby byla co nejvíce uživatelsky přívětivá.

## **Annotation**

The Master's thesis deals with possibilities of collecting radio fingerprints with the help of smart watches. These prints are used in indoor localization. Main aim of this thesis is to explore possibilities of fingerprint collection and creation of application that will allow it. First part is to figure out if this collection is even possible using smart watch. Next part deals with creation of such application not only for watch but also for the phone. And at the end part there is testing of fingerprint collection and data analysis. One of the personal goal is to make this application as user friendly as possible.

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# 1 Introduction

As the technology evolves it unlocks more and more possibilities. Just few years back there were no smart watches or phones but at this time they are important part of our lives. As they evolve there is the need for them to have more functions and features. One of them is to locate it's position on the map. This information is very useful since it can prevent people from getting lost, figuring out path to drive, used by military and countless more cases.

Finding out such position is possible using Global Navigation Satellite System (GNSS). There are multiple implementations of this system like GPS, GLONASS or Galileo. All of these systems provide location using sufficient number (at least 4) of satellites.[1] GNSS solution requires clear path between satellites and the receiving device because signal is not able to pass through buildings. That makes it the main reason why it cannot be used for indoor localization.

There are multiple approaches to find out location inside a building. These can be classified based on used technologies, sensors or different algorithms. Some of the examples are location fingerprinting, triangulation, proximity and dead reckoning.[2] This thesis is focused on method using radio signal strength (RSS) fingerprinting using bluetooth, wireless and cellular networks.

## 1.1 Goals of this thesis

Main goal of this thesis is to explore possibilities of fingerprint collection using smart watch technology. The first question that needs to be answered is if this can be done. Is smart watch capable of RSS data collection? And the answer to this question is yes since smart watches have the similar specifications as low-end smart phones.

One of the goals for this thesis is to create an application for Android phone and wear device which handles fingerprint collection. Problem with smart watches is their diversity in operational system because a lot of watch creators build their own custom systems which can complicate things. Luckily there is new system from Android called Wear 2.0 and it is

basically port of Android system to wearable devices.

And final goal is to test created application and figure out if it's data are useful for indoor localization or not.

## **1.2 Reason for selection of this topic**

The reason behind selection of this topic is rather simple. I was introduced to Android during my studies at the University but it was not any deep knowledge so I decided to go for a study abroad to deepen my knowledge. Part of that study was to work for a company where we developed rather technical heavy Android application. It's core part was using multiple APIs but it was focused only on a single device. So next thing I wanted try was working with multiple kinds of devices and since Android Wear 2.0 is rather new I wanted to test it out. So the main reason is to get more experienced with Android and as a developer.

## **2 Indoor localization using RSS Fingerprints**

This chapter is focused on definition of RSS fingerprint and principle of indoor localization using this approach. There will also be few examples of used methods and their description.

### **2.1 RSS fingerprint definition**

Main point of this method is using previously recorded data to figure out location inside the building. Hence fingerprint term in the name. There is multiple kinds of data than can be recorded like magnetic field strength or light signals but as it was already mentioned this theme is focused RSS. There is also multiple sources of radio signals like bluetooth, wireless or cellular devices and networks.

### **2.2 Principe of this approach**

### **2.3 Localization methods**

## **3 Android Wear 2.0**

This chapter will provide information about Android Wear 2.0 technology. Why it was developed and what are the differences between previous version and other wear technologies.

### **3.1 What is Android Wear 2.0**

### **3.2 Other wear technologies**

## **4 Analysis, design and implementation**

This chapter describes all important information about created application. One of the main parts are hardware and software used for developing and testing of the application. Other part is structure and description of core parts used in the application.

## **4.1 Hardware**

### **4.1.1 Smart Watch**

## **4.2 Software**

### **4.2.1 Android**

**Android Wear**

### **4.2.2 AltBeacon Library**

### **4.2.3 SQLite database**

### **4.2.4 Couchbase database**

### **4.2.5 TileView**

## **4.3 Application structure**

### **4.3.1 Mobile application**

**Activities**

**Model**

**Utilities**

### **4.3.2 Wear application**

# **5 Testing and data analysis**

This chapter goal is to show application testing, data collection and analysis.

## **5.1 Data collection**

## **5.2 Analysis**

# **6 Conclusion**

## **6.1 Application improvements**



# Literature

- [1] Bernhard Hofmann-Wellenhof, Herbert Lichtenegger and Elmar Wasle. *GNSS – Global Navigation Satellite Systems: GPS, GLONASS, Galileo, and more*. Springer Science & Business Media, 2007, ISBN 9783211730171.
- [2] Gabriel Deak, Kevin Curran and Joan Condell. *A survey of active and passive indoor localisation systems*. In *Computer Communications*. Elsevier, 2012, Volume 35, Issue 16, ISSN: 0140-3664.