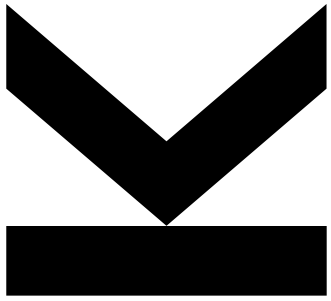
MOBILE COMPUTING (2H, KV)
WS 2019/20

INTRODUCTION & ORGANIZATION



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KARIN ANNA HUMMEL
... MOBILE SYSTEMS RESEARCH

1993-2011

Diploma, Ph.D. in computer science, TU Vienna

SW developer, Siemens Austria, PSE

Researcher/teacher at University of Vienna

2011-2015

Senior researcher and teacher at ETH Zurich

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Since 10/2015

at JKU Linz

Assoc. Prof. since 2017

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EXAMPLE MOBILE SYSTEM

Bachelor thesis: bookshelf inventory

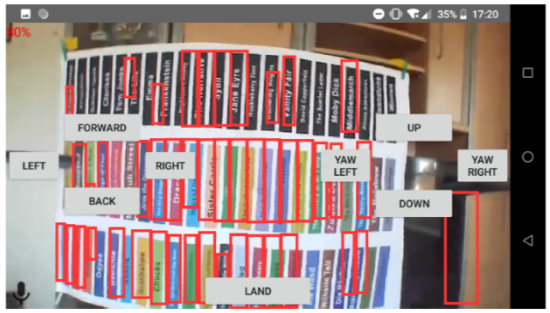
Drone

Flight commands

Drone status, video

Wi-Fi

Smartphone



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Targeted in the lecture

"MOBILE COMPUTING"

… is, in general, "**computing exposed to mobility**" such as

- **Mobile device**: e.g., apps running on a smart phone, smart watch, smart display (smart eye-wear), etc.
- **Mobile robots and vehicles** (e.g., drones, autonomous driving)

- **Executed on-the-move – changing context due to mobility** such as the location → location-based service

- **Communicating on-the-move – communication with mobility support:** wireless communication technologies, roaming and hand-over procedures in infrastructure networks such as the mobile network, Wi-Fi hot-spot areas

- … but also **mobile code**, i.e., code that is moved from one computer to another such as applets, mobile agents

OBJECTIVES / GOALS

To *get the skills to develop mobile applications*.

Thus, students will gain

- **Technical and theoretical background to create mobile applications** using the state-of-the-art mobile technologies for different mobile platforms, OS, and applications frameworks
- **Technical knowledge** about important mobile technologies**:** **wireless communications** and **positioning technologies**
- **Hands-on experience** to develop a user-centered mobile application, make use of sensors

TOPICS

- **Wireless systems and technologies**
  - **Wireless communication technologies**: Principles and selected topics on WLAN, Bluetooth, RFID (Radio Frequency Identification) / NFC (Near Field Communication), 3G/LTE/5G mobile communication and trends such as visible light, car-to-car communication
  - **Positioning**: GPS, indoor positioning, positioning for Io(mobile)T
- **Mobile (Web and native) application development**
  - Mark-up languages, CSS, JavaScript, HTML5
  - Android, iOS – mobile market place
- **Android development**
  - Hands-on: Developing Android apps in Android Studio
- **Project work**
  - **Hands-on: Your project idea and implementation**

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ORGANIZATION

Course combines

- **Lecture part (blocked)**, where active participation is ensured by **one small exam (15 Minutes)**, **two small exercises** (**break-out sessions)**
- **Project work** in teams of 1-3 students
  - Defined and elaborated by students during the course
  - Presented and discussed during the proposal presentations and with lecturer on-demand
  - Delivery of the implementation and documents
- We use Moodle to organize the lecture

GRADING

Grading based on

- **Active participation** during the course
  - All team members have to be present during student presentations, tests
  - Hand-in of two small exercises, short exam
  - In principle, all (mandatory) lectures have to be attended
  - Optional: Android introduction and exercises

- The **grade is calculated** based on
  - **Lecture part (30%) – min. of 15% required**
    - Short exam (10%), Break-out session practical exercises (20%)
  - **Project work (70%) – min of 35 % required**
    - Final project and documentation (50%), presentations (20%)

OVERVIEW OF LECTURE

Date	Lecture
October 09 13:45-14:30 (1)	**Introduction and Course Organization** On your own: discussion of project ideas, formation of teams
October 16 *13:45-17:00 (4)*	**Wireless Technologies and Systems** Practical: Measuring & discussing network performance
October 30 13:45-17:00 (4)	**Developing Mobile Web and Native Apps** Practical: Designing an App **Test: Wireless Technologies and Systems** (15 min)
November 06 *13:45-17:00 (4)*	**Student Presentations of Project Ideas** (incl. basic interfaces/technologies, system design, project plan)
November 13 *13:45-17:00 (4)*	(Optional) Android App Development (1): Introduction Practical: First Android app
November 20 *13:45-17:00 (4)*	(Optional) Android App Development (2): Location, Interface, Multi-threading Practical: Location-based Android app
December 11 13:45-17:00 (4)	**Student Presentations of Mock-ups** (minimum: sketches, parts of UI)
January 8 13:45	**Student Progress Discussion** (individual meetings with lecturer; short presentations of status)
January 29 *13:45-17:00 (4)*	**Final Student Projects Presentations** (and upload of material) – depending on number of student presentations, we may need a second date

EXPECTATIONS

You are expected to work in a **self-managed** way on your project

- ☐ Follow the project plan defined in the first weeks
- ☐ Attend the lecture to get necessary input (e.g., Android basics)
- ☐ Contact lecturer in case of troubles

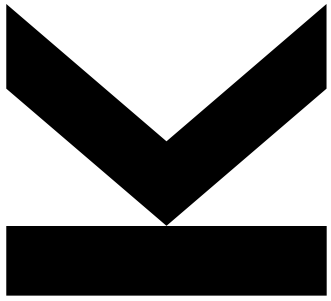
Freedom of choosing the **technology of your interest**

- ☐ Mobile Web development
  - You are expected to have knowledge in HTML, JavaScript, and CSS
- ☐ **Native app development (Android**, iOS)
  - You are expected to have knowledge of **Java** (and/or C-code / Swift)
  - Possible: Python development

And (as this is an advanced course):

- ☐ You need to familiarise yourself with **Android Studio** (or Xcode)

COURSE PROJECT
BASICS



IN THE END: WHY LEARNING ABOUT “MOBILE COMPUTING”?

To conduct an appealing **course project** and to leverage **available technologies**:

- ☐ **With some novelty**: you should find something new
- ☐ **Fitting your interest**: you should like to work on it (and maybe go on to develop the app beyond the course objective)

Suggested FOCUS 2019: **Sustainability and environment apps**

PROJECT EVALUATION CRITERIA

- ☐ **Why** a **mobile** solution? (In contrast to a desktop application)
- ☐ Does the app pass the **grandmother test*) for usability**?
- ☐ Which **particular technologies** are exploited in your app?
- ☐ Did you overcome **challenges** during development?

- ☐ **Student evaluation** of project (last lecture) based on
  - ○ **Attractiveness**: “I like the app!”
  - ○ **Efficiency and usability**: “The app is well structured and easy to understand!”
  - ○ **Expectation**: “The app confirms to my expectations (and does not confuse)!”
  - ○ **Novelty:** “The app surprises me and shows me something new!”
  - ○ **Stimulation:** “I would use the app in future!”

*) Credits to Prof. Ismail Khalil

PROJECT PROPOSAL EXAMPLE

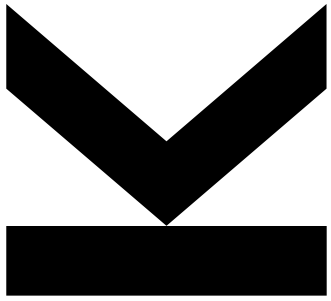
Personal Strength Exercise Trainer

- **Story:** *While being in the gym, at home, or outdoors, the user wishes to train specific muscle groups and to keep track of the number of exercises done; finally the user wishes to share this information in his/her social network.*
- **Design of functionality** – the app should provide
  - An **easy/basic UI** on the smartphone starting scanning and showing the personal progress and history; providing exercise challenges for the user
  - A smart **exercise detection algorithm** that detects and counts exercises based on on-board sensors → native app development
- **Technology** – hardware, software
  - Frontend: Android smartphone (logic, UI) & Android smart watch sensor
  - Backend: Web server, collecting and storing history information, interface the social network of choice

TRENDS IN MOBILE SYSTEMS

- **Machine learning integrated in algorithms –** incorporate machine learning (maybe “deep learning”) into mobile systems based on data collected on the device
- **Internet of Things (IoT), smart homes, smart cities:** things/objects communicate - shift from “broadband” to “low-latency” communication, connecting robots and vehicles (e.g., industry, autonomously driving connected cars, UAVs); **mobile devices as an interface** to the smart home, smart city
- Using **network technologies as a sensor** (e.g., positioning indoors, seeing-through-walls, gesture recognition, mobile phone data)
- Using the **mobile device as a tool for medical self- and long-term diagnosis, persuade towards a healthier/sustainable life-style**

COURSE PROJECT
SUGGESTIONS



For the undecided and students who would like to work closer together with lecturers …

APPS FOR SUSTAINABILITY

Area: Apps for good – suggestions for a more climate friendly life-style; options are:

- ☐ Calculate energy-footprint of movement/transportation
- ☐ Calculate energy-footprint of eating
- ☐ Calculate energy-footprint / waste of products during shopping ...

- ☐ **Aim:** To build a portfolio of apps in the Mobile Computing lecture centred around sustainable living

CO_2 footprint of people
https://mahb.stanford.edu/blog/carbon-footprint/

ENERGY-AWARE APPLICATIONS

Area: Apps that prepare for **zero-external charge**

- ☐ Create apps that are aware of their energy footprint; measure and estimate the battery use
- ☐ In a second step (e.g., master project), one can try to harvest energy for the app / smartphone, smartwatch

- ☐ **Aim:** To evaluate how much energy mobile devices need to do their job.

Solar harvesting with LEDs and BLE
https://www.zhaw.ch/en/engineering/institutes-centres/ines/low-power-wireless-embedded-systems/led-as-energy-harvester/

(DEEP) LEARNING MOBILE DEVICES

Source: http://www.iamwire.com/2018/04/use-of-machine-learning-technology-in-mobile-apps/171948

Area: (Learning as A Means of) Future Software Development

- Use and investigate **machine learning** on mobile devices in a selected field (e.g., road situation detection and alarming for people staring at phones on streets; environmental friendliness)

- **Aim:** To evaluate the **feasibility of machine learning** in a concrete scenario such as image recognition, learning of context, prediction of network quality, learning with small data, etc.

Image recognition applied to pill identification

Source: X. Zeng, K. Cao, M. Zhang: MobileDeepPill: A Small-Footprint Mobile Deep Learning System for Recognizing Unconstrained Pill Images

(a) Desktop with Intel i7-5930k CPU and Nvidia GTX 1080 GPU (b) Nvidia Jetson TX1 (c) Samsung Galaxy S7 edge

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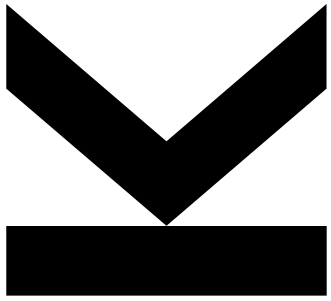
COURSE PROJECT
DELIVERABLES



WHAT SHOULD YOU DELIVER? (1)

Presentation of project idea

- ☐ **Cover slide** with title, all project members, lecture and lecturer name
- ☐ **Description** from user's perspective (functions, why important) – aim of the project; be as specific as possible
- ☐ **Related apps** (and why your app is different)
- ☐ **Technical system overview**: involved components (app, server, sensors) and interfaces used (Wi-Fi, BT/BLE, etc.)
- ☐ **Hardware and software** basics (Android, Web browser in case of mobile Web application, etc.)
- ☐ **Project plan** (deadlines, 1 slide)

Upload presentation slides and present your idea in class

- ☐ About 10 minutes – additional 2 minutes Q&A

WHAT SHOULD YOU DELIVER? (2)

App mock-up presentation

- ☐ UI of the app as **sketches or mock-up UI elements**: be prepared to be asked about how you plan to realize the functions as well
- ☐ About 5 minutes – additional 5 minutes discussion

App progress discussion

- ☐ Discuss status of project with lecturer during individual meetings (upload a status summary with adapted timeplan in Moodle, 1 page)

Final project submission and presentation

- ☐ Present idea, UI, technical overview, and results (if measurements have been performed) – include a demo or show a video
- ☐ Evaluate other student teams

LEARNING PLATFORM & CONTACT

We use **Moodle** as our lecture platform

- ☐ Watch out for announcements / ask general questions using the forum
- ☐ Watch out for course material on Moodle
- ☐ Upload your slides and progress report through Moodle (one day before presentation/discussion)

Contact lecturer through email for individual questions

- ☐ Use subject “MC-2019” <your topic>
- ☐ karin_anna.hummel@jku.at

WELCOME TO THIS COURSE!

- ☐ Be prepared for a lot of hard work
- ☐ Be prepared for a lot of self-study
- ☐ You should write code that works
- ☐ Don’t leave things to the last minute
- ☐ The bigger the size of the team, the more is expected
- ☐ A team stands together or falls together (no-excuses)

We will work together throughout this course

Questions and suggestions are most welcome

Gearing up for a fun semester about mobile computing