

Höhere Technische Bundeslehranstalt Kaindorf an der Sulm

Abteilung Informatik

Diplomarbeit

im Rahmen der Reife- und Diplomprüfung

Königskarte



informatik

Leon Edlinger
Paul Gigler
Andreas Weissl

5BHIF
2024/2025

Betreuer: Prof. DI Johannes Loibner, BSc
Projektpartner: Prof. DI Robert Müllerferli
Datum: MISSING DATE

All rights reserved. No part of the work may be reproduced in any form (printing, photocopying, microfilm or any other process) without the written permission of all authors or processed, duplicated or distributed using electronic systems. The authors assume no liability for the functions of individual programs or parts thereof. In particular, they assume no liability for any consequential damages resulting from the use.

The reproduction of utility names, trade names, product descriptions, etc. in this work, even without special marking, does not justify the assumption that such names are to be regarded as free within the meaning of trademark and trademark protection legislation and may therefore be used by everyone.

Statutory declaration

I declare under oath that I have written the present diploma thesis independently and without outside help, have not used sources and aids other than those indicated and have identified the passages taken from the sources used literally and in terms of content as such.

Ort, Datum

Leon Edlinger

Ort, Datum

Paul Gigler

Ort, Datum

Andreas Weissl

Abstract

Abstract in English

Kurzfassung

Kurzfassung in Deutsch

Thanks

It would not have been possible to carry out this thesis to this extent without the active support of a number of people. We would therefore like to thank everyone who supported us in the implementation of this thesis.

...

Table of Contents

1	Introduction	1
1.1	Team	2
2	Technologies	3
2.1	LaTeX	3
2.2	Frontend	3
2.2.1	Dart	3
2.2.2	Flutter	3
2.3	Backend	5
2.3.1	Java Spring	5
2.3.2	PostgreSQL	5
2.4	Version Control	6
2.4.1	Git	6
2.4.2	GitHub	6
2.5	Map Data	7
2.5.1	OpenStreetMap	7
2.5.2	Graphhopper	7
2.6	Development Tools	8
2.6.1	VS Code	8
2.6.2	IntelliJ	8
2.6.3	Android Studio	8
2.6.4	Postman	8
2.6.5	Figma	8
2.7	Deployment	9
2.7.1	Docker	9
2.7.2	Uberspace	9
2.7.3	Webmin	9
3	Research Questions	9
3.1	Leon Edlinger	9
3.2	Paul Gigler	9
3.3	Andreas Weissl	9
4	Spring Framework	9
4.1	Spring Boot	9
4.2	Spring Data JPA	9
4.3	Lombok	9
4.4	Advantages	9
5	Area Borders	9
5.1	Purpose of Area Borders in the App	10
5.2	Overview of the Convex Hull Algorithm	10
5.3	Use Cases of the Convex Hull in Industry	10
5.4	Alternate Methods for Area Border Calculation	10
5.5	Rationale for Choosing the Convex Hull Method	10
5.6	Integration of the Algorithm into the Backend	10
5.7	Challenges and Adjustments	10
6	Structure of the Backend	10
6.1	Controller Layer	10
6.2	Service Layer	11
6.3	Repository Layer	11
6.4	Persistence Layer (Entity Classes)	11
6.5	Applied Design Principles (DTOs)	11

7	Defining usability	11
7.1	Why it is important	11
7.2	Fundamental concepts of usability	11
7.3	Challenges in designing for a broad user spectrum	11
8	Usability in context of maps	12
8.1	Basic Analysis of the Google Maps interface	12
8.2	Identifying Flaws in Googles Design	12
8.3	How could specific user groups struggle with this design	12
9	Adaptive algorithms and real-time data integration	14
9.1	Theoretical Framework	14
9.1.1	Traditional Methods for Address Database Management	14
9.1.2	Adaptive Algorithms: Concepts and Applications	14
9.1.3	Real-Time Data Integration Frameworks	14
9.2	Technical Framework	14
9.2.1	Data Sources	14
9.2.2	Adaptive Algorithms	14
9.2.3	Evaluation Metrics	14
10	Traditional Methods for Address Database Management	14
11	Adaptive Algorithms: Concepts and Applications	14
12	Real-Time Data Integration Frameworks	14
13	Implementation of the Backend	14
13.1	Config of Spring Boot (application.properties)	15
13.2	Entity Classes (Structure/Purpose)	15
13.3	JPA-Repositories (DB Access and CRUD Operations)	15
13.4	Service Classes	15
13.5	Rest Controller (API Endpoints and their Functions)	15
14	GraphHopper Setup	15
14.1	Why use GraphHopper?	15
14.2	Configuration	15
14.3	Local hosting	15
15	Working out the Wireframes	15
15.1	Map View	15
15.2	List View	15
15.3	Possible improvements for future versions	15
16	Functional implementation behind the application	16
16.1	Address-Provider	16
16.2	HTTP-Requests	16
16.3	Implementation of the Flutter Map Component	16
17	The app in use	17
17.1	Introducing new users	17
17.2	The app in operation	17
17.3	User Feedback	17
18	Final Thoughts	18
18.1	Leon Edlinger	18
18.2	Paul Gigler	18
18.3	Andreas Weissl	18
19	Meetings	19

20 Working Hours	20
21 Source code directory	21
22 List of figures	22
23 List of tables	23
24 Bibliography	24
25 Abbreviation	25

1 Introduction

TODO: Is halt die frage ob ma den anfang einfach so schreiben, war ja eigentlich net ganz so xD

Mobile apps are utilized for virtually all aspects of daily life in the modern world. So after we noticed that there is no application that allows the efficient planning of campaigns like the "Sternsinger-Aktion" we asked ourselves why, and furthermore, how hard it is to create an App with intuitive usability with the main purpose of simplifying the process of managing such a campaign and gaining a general overview of the progress made by the groups.

The app needs to comply with specific criteria we defined in cooperation with Prof. DI Robert Müllerferli. He is the main organizer of the campaign in the parish of Lieboch and helped us to work out the key aspects our project should implement. In the finished product, every user should be able to scan a QR-Code, through which the area of this group gets assigned to the device. These areas must be dynamically adjustable, so an admin can coordinate the workload of each area more efficiently. The areas also need to be clearly visible by an outline which gets drawn through "Border" addresses. These border addresses get calculated by an algorithm implemented by us. It should be visible at a glance if there is an "specification", which can be assigned by admins, set for an address. This should be realized through the use of different icons instead of the default icon. Apart from the app itself, we also implemented a web-portal through which administrators can manage and supervise the campaign.

TODO: vielleicht noch was rein bezüglich der borders und dann unten nurmehr drauf referenzieren?

The research part of this thesis will be dedicated to how components should act and look, so that new users can use this tool without requiring a long "onboarding" phase. It should feel familiar to interact with elements and the borders of what users can and can not do need to be clearly defined. Because our application also needs a reliable data source to guarantee the consistency and accuracy of marked addresses, we researched ways to keep our database up-to-date, without the need of much manual intervention. After defining the project requirements, we noticed that we need to calculate which addresses are border addresses. So we decided to take a look into different algorithms for this task and compare them concerning their efficiency, decide on one of them and implement it.

This thesis contains an in-depth description of our thought and development process, as well as any other steps we took to achieve our goal of a functional mobile application that can be used by volunteers in course of the "Sternsinger-Aktion 2025" taking place in the parish of Lieboch.

1.1 Team

This thesis was created by three Students attending the BHIF20 at the HTBLA Kaindorf Computer Science Department.

TODO: andis bild anpassen

Leon Edlinger



Database, Admin-Panel

Paul Gigler



Deployment, Mobile App

Andreas Weissl



Backend

2 Technologies

Development would not have been possible without making use of many tools, frameworks and environments. In this chapter each tool used in the creation of our software will be described briefly.

2.1 LaTeX

Hier kommt eine Beschreibung zu Latex hin

2.2 Frontend

2.2.1 Dart

Dart is a programming language initially designed for web development, with the goal, of replacing JavaScript, in mind. Today it gets used in a variety of software products, mainly because of the flutter framework. It can be compiled for many platforms and architectures (ARM, x64, RISC-V, JavaScript or WebAssembly) and is loved for its combination of High-Level Features, with practical language features like Garbage collection and optional Type annotation. It was developed by Google and is now an open-source project.

(Flutter for Beginners, n.d.)



2.2.2 Flutter

Flutter is an Open-Source software development framework. It allows programmers to compile their application for different platforms including Web, macOS, IOS as well as Windows and any type of Linux-based systems, all from one code-base, written in Dart. This allows for more efficient and faster cross-platform development. Another benefit of Google's toolkit are the highly customizable predefined UI components. Developers can mix and match these components however needed which makes them an applicable choice.

We chose flutter mainly for these reasons, but also because of our previous experience with Java to which Dart is quite similar. Through it, we were able to get started quickly, learn what we need along the way. Having a design through the components was also very helpful and saved us some time.

("flutter/README.md at master · flutter/flutter", 2025) (Dagne, 2019)



2.3 Backend

2.3.1 Java Spring

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.3.2 PostgreSQL

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.4 Version Control

2.4.1 Git

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.4.2 GitHub

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.5 Map Data

2.5.1 OpenStreetMap

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.5.2 Graphhopper

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet,

2.6 Development Tools

2.6.1 VS Code

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

2.6.2 IntelliJ

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

2.6.3 Android Studio

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

2.6.4 Postman

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

2.6.5 Figma

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

2.7 Deployment

2.7.1 Docker

2.7.2 Uberspace

2.7.3 Webmin

3 Research Questions

3.1 Leon Edlinger

3.2 Paul Gigler

3.3 Andreas Weissl

4 Spring Framework

The backend leverages the **Spring Framework**, a comprehensive framework for enterprise Java development. This section explores its key components and advantages.

4.1 Spring Boot

Spring Boot simplifies configuration and deployment with embedded servers and opinionated setups. This reduces boilerplate code and accelerates development.

4.2 Spring Data JPA

Spring Data JPA provides abstractions for database interactions, streamlining CRUD operations and custom query creation.

4.3 Lombok

Lombok reduces boilerplate code by generating getters, setters, and other methods at compile time, improving code readability and maintainability.

4.4 Advantages

Using Spring enhances productivity, reduces setup complexity, and ensures scalability, making it ideal for this project.

5 Area Borders

The area borders feature addresses the research question by implementing computational geometry algorithms for precise geographical boundary calculations.

5.1 Purpose of Area Borders in the App

Accurate area borders are essential for defining regions based on user input, supporting the app's mapping functionality.

5.2 Overview of the Convex Hull Algorithm

The convex hull algorithm identifies the smallest convex polygon enclosing a set of points, making it a suitable choice for this project.

5.3 Use Cases of the Convex Hull in Industry

Applications of convex hulls in mapping, computer graphics, and robotics highlight their importance in solving real-world problems.

5.4 Alternate Methods for Area Border Calculation

Alternative methods like Voronoi diagrams and alpha shapes were considered but found less suitable due to complexity or computational demands.

5.5 Rationale for Choosing the Convex Hull Method

The convex hull algorithm offers a balance of simplicity, efficiency, and accuracy, aligning with the project's requirements.

5.6 Integration of the Algorithm into the Backend

The algorithm is implemented in the service layer, ensuring smooth integration with other backend components.

5.7 Challenges and Adjustments

Challenges included handling edge cases like collinear points, which were resolved through specific algorithm adjustments.

6 Structure of the Backend

The backend follows a layered architecture to promote separation of concerns, scalability, and maintainability. This section outlines the roles of each layer.

6.1 Controller Layer

The controller layer acts as the interface for incoming HTTP requests, delegating them to appropriate service methods.

6.2 Service Layer

The service layer contains business logic, validating data and coordinating interactions between controllers and repositories.

6.3 Repository Layer

Repositories abstract database operations, allowing the backend to interact with the database without explicit SQL queries.

6.4 Persistence Layer (Entity Classes)

Entity classes define the data model and its mapping to the relational database, ensuring a consistent schema.

6.5 Applied Design Principles (DTOs)

Data Transfer Objects (DTOs) enhance encapsulation and optimize data transfer between layers and external clients.

7 Defining usability

Since my research question "How can user-experience principals add to an intuitive map displayment for nonprofit activities in which people of different technical know-how levels collaborate?" is all about usability, I want to introduce you to its basic concepts and challenges but also provide some examples on how usability can impact a software's revenue and perception.

The expression "user-experience" most often gets used in the context of UI/UX. It is the part of software-design that is responsible for the feedback and "experiences" the user has, while using the application. Strictly speaking consists UI/UX of two parts, the user-interface and, as mentioned before, the user-experience. **User-Interface** (Nielsen, 2024)

7.1 Why it is important

7.2 Fundamental concepts of usability

7.3 Challenges in designing for a broad user spectrum

8 Usability in context of maps

8.1 Basic Analysis of the Google Maps interface

8.2 Identifying Flaws in Googles Design

8.3 How could specific user groups struggle with this design

9 Adaptive algorithms and real-time data integration

9.1 Theoretical Framework

9.1.1 Traditional Methods for Address Database Management

9.1.2 Adaptive Algorithms: Concepts and Applications

9.1.3 Real-Time Data Integration Frameworks

9.2 Technical Framework

9.2.1 Data Sources

9.2.1.1 GPS Data

9.2.1.2 External APIs

9.2.1.3 User Inputs

9.2.2 Adaptive Algorithms

9.2.2.1 Fuzzy Matching

9.2.2.2 Machine Learning Model

9.2.2.3 Rule-Based Filters

9.2.2.4 Dynamic Duplicate Resolution

9.2.2.5 Real-Time Address Normalization

9.2.3 Evaluation Metrics

9.2.3.1 Accuracy

9.2.3.2 Latency

10 Traditional Methods for Address Database Management

11 Adaptive Algorithms: Concepts and Applications

12 Real-Time Data Integration Frameworks

13 Implementation of the Backend

The backend implementation combines theoretical concepts with practical solutions to ensure functionality and scalability.

13.1 Config of Spring Boot (application.properties)

The `application.properties` file configures essential settings, including database connections, logging, and server parameters.

13.2 Entity Classes (Structure/Purpose)

Entity classes define the application's data model, using annotations to map fields to database tables.

13.3 JPA-Repositories (DB Access and CRUD Operations)

Repositories simplify database access by providing methods for CRUD operations and enabling custom queries.

13.4 Service Classes

Service classes encapsulate business logic, coordinating data flow between controllers and repositories.

13.5 Rest Controller (API Endpoints and their Functions)

REST controllers define API endpoints, processing requests and returning responses to ensure seamless interaction with the frontend.

14 GraphHopper Setup

14.1 Why use GraphHopper?

14.2 Configuration

14.3 Local hosting

15 Working out the Wireframes

15.1 Map View

15.2 List View

15.3 Possible improvements for future versions

16 Functional implementation behind the application

16.1 Address-Provider

16.2 HTTP-Requests

16.3 Implementation of the Flutter Map Component

17 The app in use

17.1 Introducing new users

17.2 The app in operation

17.3 User Feedback

18 Final Thoughts

18.1 Leon Edlinger

18.2 Paul Gigler

18.3 Andreas Weissl

19 Meetings

Protokolle der Meetings, vielleicht auch ein zeitplan wann immer und wie lang

20 Working Hours

Arbeitspaket-Nr.	Beschreibung	Dauer
1	Einführung und Einarbeitung	8 h
2	Grundkonzept erstellen	8 h
3	Struktur der App festlegen	6 h
5	Wifi-Socket in App implementieren	39 h
6	Write-Funktionalität in App implementieren	14 h
7	Read-Funktionalität in App implementieren	19 h
8	Trim-Funktionalität in App implementieren	10 h
9	Konfigurationsmöglichkeiten für Flug in App implementieren	16 h
10	Höhenregelung-Funktionalität in App implementieren	14 h
12	Graphische Darstellung der Flugdaten	18 h
14	App testen und debuggen	19 h
26	Gesamtkonzept testen und debuggen	16 h
Summe		187 h

Table 1: Arbeitszeitznachweis

21 Source code directory

Source Code directory, kein plan was des is

22 List of figures

23 List of tables

1	Arbeitszeitznachweis	20
---	--------------------------------	----

24 Bibliography

Dagne, L. (2019). Flutter for cross-platform app and sdk development.

Flutter for Beginners. (n.d.). https://books.google.at/books?hl=de&lr=&id=pF6vDwAAQBAJ&oi=fnd&pg=PP1&dq=benefits+dart+language&ots=dZJWUGVs4x&sig=a196WqhXmQzuy23cmcKpEplqn_k&redir_esc=y#v=onepage&q=benefits%20dart%20language&f=false

flutter/README.md at master · flutter/flutter [[Online; accessed 23. Jan. 2025]]. (2025, January).

<https://github.com/flutter/flutter/blob/master/README.md>

Nielsen, J. (2024). Usability 101: Introduction to Usability. *Nielsen Norman Group*.

<https://www.nngroup.com/articles/usability-101-introduction-to-usability>

25 Abbreviation

ADC	Analog Digital Converter
API	Application Programming Interface
BLE	Bluetooth Low Energy
CPU	Central Processing Unit
DAC	Digital Analog Converter
DAVE	Digital Application Virtual Engineer
DSP	Digital Signal Processor
FPU	Floating Point Unit
FPV	First Person View, First Pilot View
GPIO	General Purpose Input/Output
GPS	Global Positioning System
GUI	Graphical User Interface
HDMI	High Definition Multimedia Interface
I ² C	Inter-Integrated Circuit
IDE	Integrated Development Environment
IP	Internet Protocol
RPI	Raspberry Pi
SD	Secure Digital
SPI	Serial Peripheral Interface
USB	Universal Serial Bus
TCP	Transmission Control Protocol
UART	Universal Asynchronous Receiver Transmitter
WLAN	Wireless Local Area Network
WPA	WiFi Protected Access
XML	Extensible Markup Language