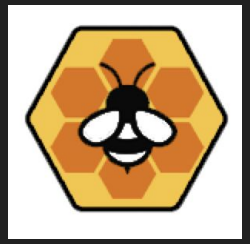
A Novel Mobile App for the Next Generation of Beekeepers



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CS&P 2021

Agenda

- Introduction
- Modern Challenges
- The New App
- Preliminary User Evaluation
- Improvements
- Alpha Test
- Summary

Introduction

- The **western honey bee** is the most important species for crop pollination
- **Beekeepers** with their western honey bees collect honey and migratory beekeepers pollinate plants and crops

- **Wild bees** make sure garden plants and wildflowers get adequate pollination

Modern Challenges

- Pesticides, parasites, climate change, lack of flowers, air pollution
- Managed honey bees can harm wild pollinator species

- Beekeepers should monitor these challenges with...

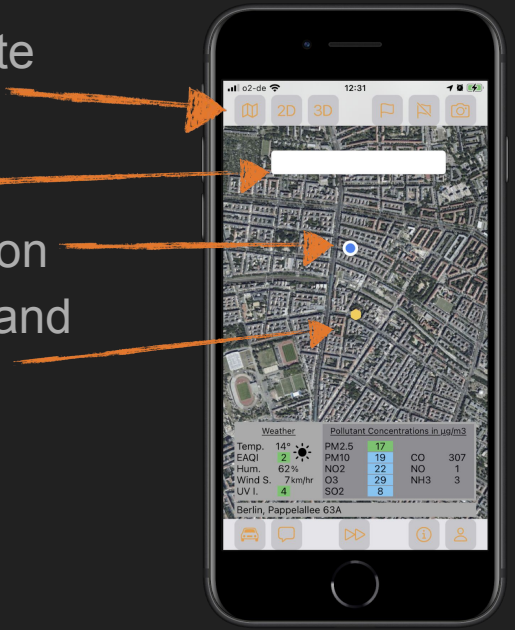
- ...an interactive augmented map that shows key elements
- ...users making inputs for them
- ...a simple and swiftly useable solution

Methods and Tools Overview

- Native iOS app in Swift with IDE Xcode
  - Mobile for GPS location, camera
- Apple’s MapKit for an interactive map
- Pretrained CNN with Core ML Framework for public flower dataset
- Google’s Cloud FIrestore as database for instant access
- Cloud also for storage of authentication of users, annotations and chat messages
- API from openWeather for weather and pollution data
- API from Wikipedia for flower data

The Interactive Map as Mobile App

- With MapKit map view as standard, 2D and 3D satellite images
- Search bar for a search of different locations
- Shows users location and path to a selected destination
- Fixed yellow dot in the middle as a focus for weather and pollution data, annotating this spot, et cetera.

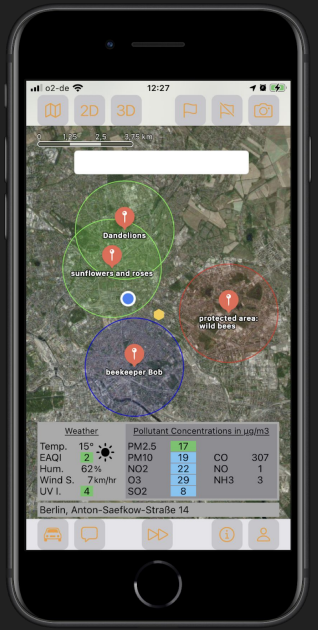


Weather and Air Pollution Data

- Map shows key elements of weather and air quality
- Weather API from openWeather to get data for all coordinates
- Current and forecast weather anad air pollution data
- Air pollution values based on European Air Quality Index

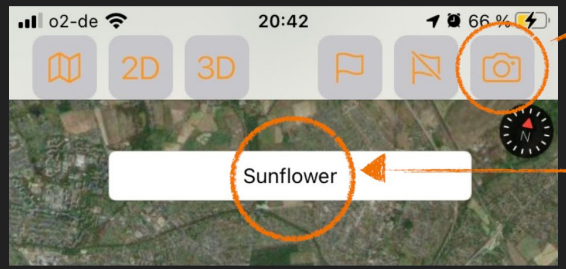
Input from Users

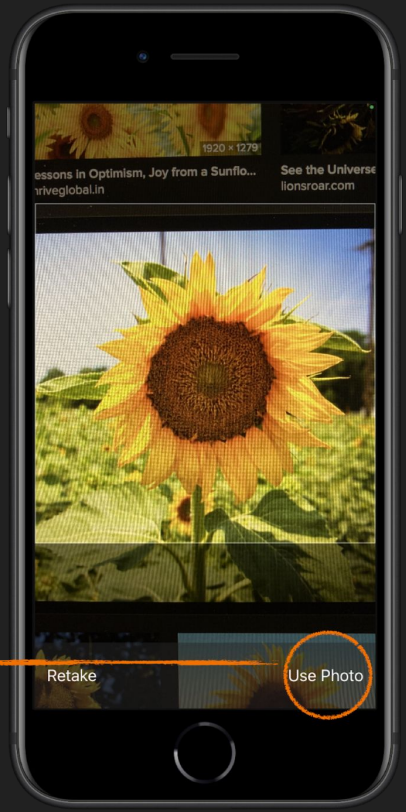
- Users are able to make inputs to help beekeepers with it
  - Interesting plants for beekeepers
  - Where beekeepers are: to prevent too many hives at close location
  - Banned places in order to protect wild bees
  - Where pesticides were sprayed, et cetera.



Flower Detection

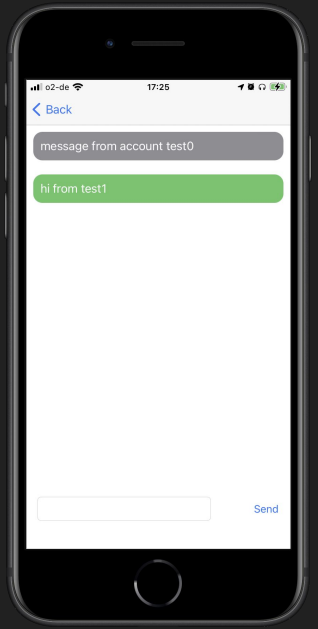
- Oxford's 102 Flower Dataset with
  102 categories each with 40-200 images
- Pretrained convolutional neural network
- Allows taking a picture of any flower and
  It will try to recognise its name





Authentication and Chat

- Users can create a new account with email and password
- Data is stored encrypted on the Firestore Cloud server
- Registered users can chat with other users
- Messages are stored at the cloud

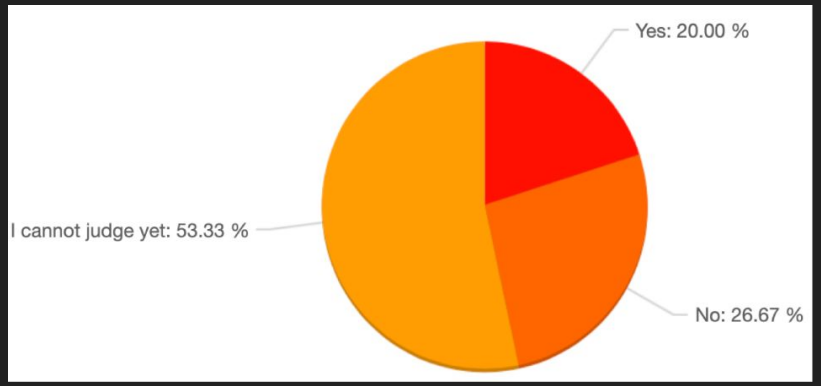


Preliminary User Evaluation of the Prototype

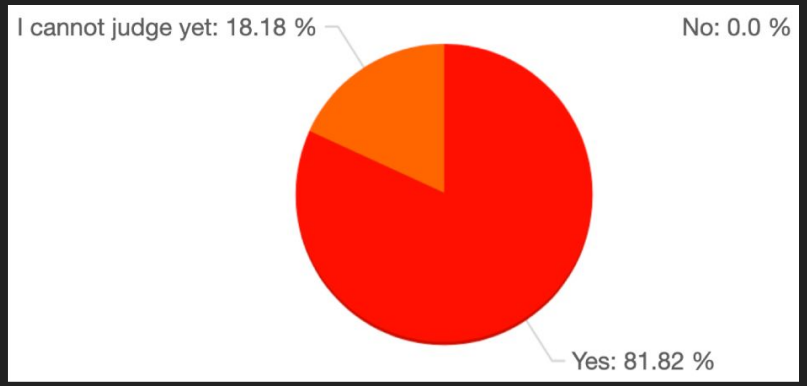
- 6-minute video about the app followed by an online survey
- App rated by 15 beekeepers and 11 non-beekeepers
- Online survey was made via surveyonline.com
- Participants were searched for on imkerforum.de and bienenforum.at
- Each participant was asked 10 questions

One Question for Beekeepers and Non-Beekeepers

Beekeepers asked: Do you feel that you could work more effectively with this app?



Non-Beekeepers asked: Do you feel that you could help beekeepers with this app?



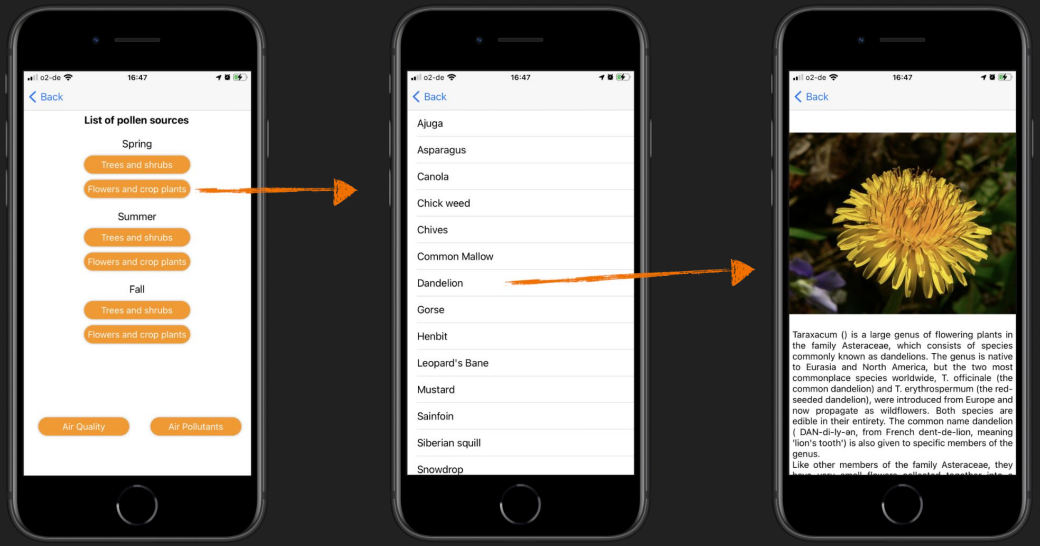
Some Key Facts from the Preliminary User Evaluation

- About the app:
  - “If enough users enter plants the app is useful.”
  - “If you have to move your bees to another location, it is good to be able to keep an eye on the surrounding area.”
  - “It is possible to produce specific types of honey.”

- Functionality wishes:
  - “If users could indicate when they see a plant’s bloom time start, i.e., when it actually becomes available as a food supply.”
  - If the farmers would also use the app and it was indicated by them when and where spraying was taking place (maybe too extensive).”
  - From non-beekeeper: “The function to recognise which plants are most attractive food bees.”

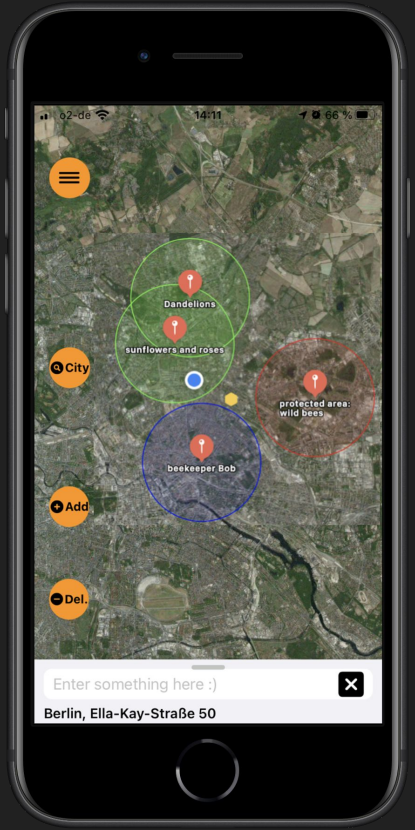
Improvements: New Features

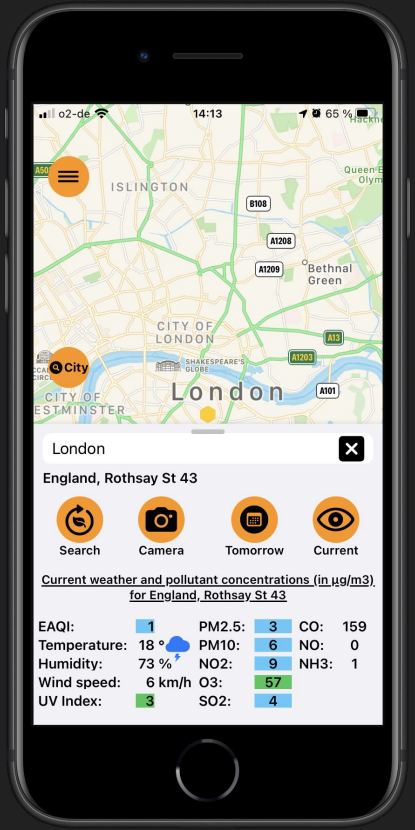
- Wikipedia API for flower data
  - List of pollen sources for pollinators
- Journal for beekeepers
  - One can document what was discover or performed on bees/beehives



Improvements: New Look

- New UI
- Dark Mode
  - Appearance of app can be toggled Between light and dark mode



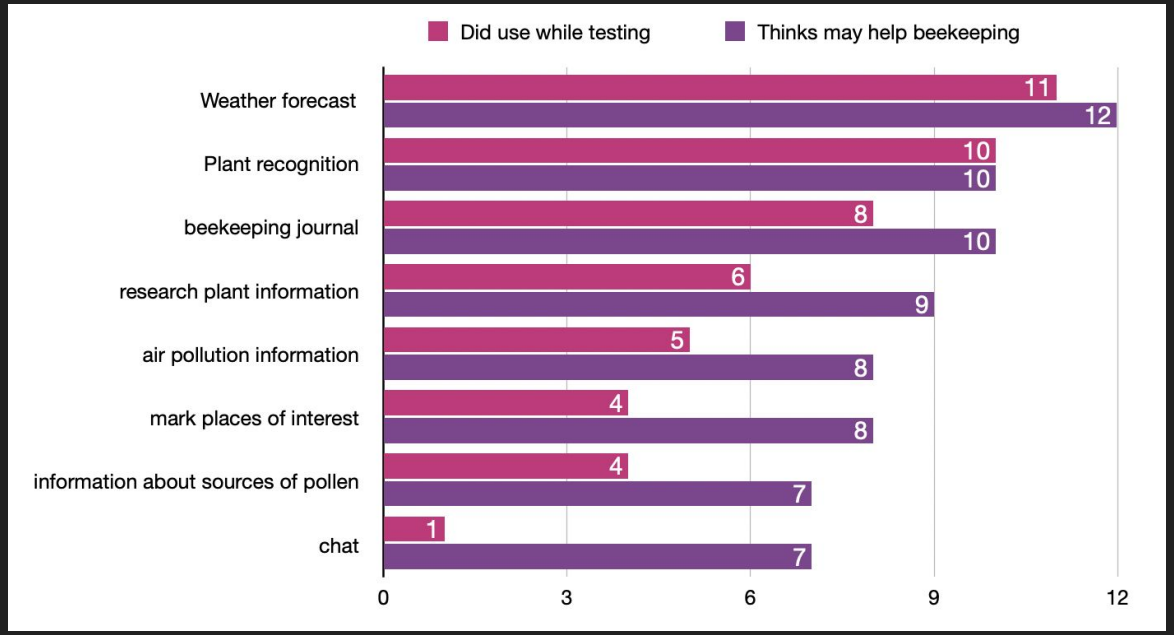


Alpha Test

- Sergey Petrov from Pollenity has run the alpha test
  - Pollenity is a Bulgarian firm established in 2015 doing IoT solutions for beekeepers
- 3-minute explanatory video created for the test by the author
- Team members translated the video live and showed the app to the beekeepers simultaneously in groups of 3-4 people
- They all spent between 3-10 minutes with a phone provided by them
- Overall 22 beekeepers took part in those tests
- Some only made the answers with the crosses set or gave useless answers. In total 14 of them were usable

2 Questions From the Alpha Test

- Which of the following features did you use while testing the app?
- Which of the App's features do you think may contribute to your beekeeping operations?



Summary And Future Work

- “There is much more to be done but good start.”
- Android implementation
- More improvements on features and UI, for example
- More evaluations
- Localisation
- Gamification to motivate and hook users to the app