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Addressing Modern Challenges for Bees through a Novel Mobile App

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Agenda

- HIVEOPOLIS
- Motivation
- The New App
- Preliminary User Evaluation
- Further Work on the App
- First Hands-on Test
- Summary

HIVEOPOLIS

- The European project aims to augment honeybee colonies with sensors and actuators
- To help monitor colony health and encourage bees to forage in specific locations or keep them from flying to undesirable places.
- Research is being conducted on a whole ecosystem of augmented beehives, community, and infrastructure connecting everything

- We developed a mobile application to support the interaction of the hive with the surrounding ecosystem

Motivation

- Bees are increasingly exposed to unfavorable environmental influences caused by humans: Pesticides, parasites, climate change, lack of flowers, air pollution
- Domesticated honeybees can also be a dangerous foraging competitor for wild bee species

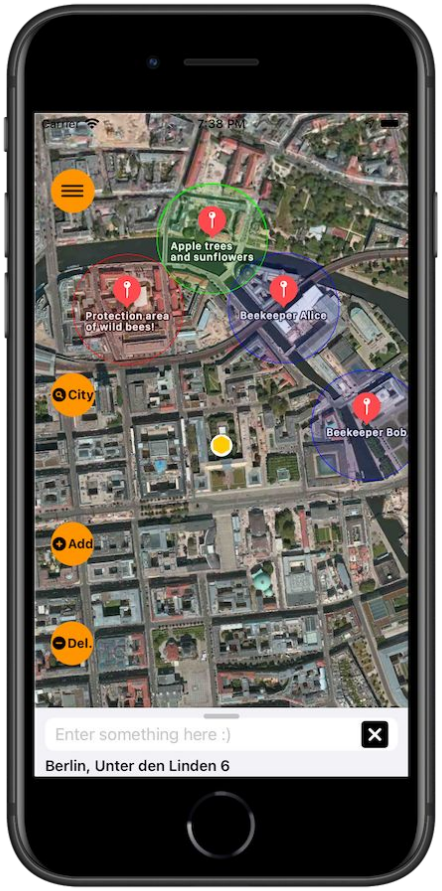
- Beekeepers should monitor these challenges with…
  - …an interactive augmented map that shows key elements
  - …users making inputs for them
  - …a simple and swiftly useable solution

Few Scenarios and the Advantages

- Data collection for apiarists and scientists
- People (environmentalist, amateur beekeeper) who want to learn about bees, beekeeping, nature protection, get the information through the app and can participate directly
- Connecting communities, establishing contacts on a social level between beekeepers and non-beekeepers.
- Nature conservation and bee protection through more conscious beekeeping

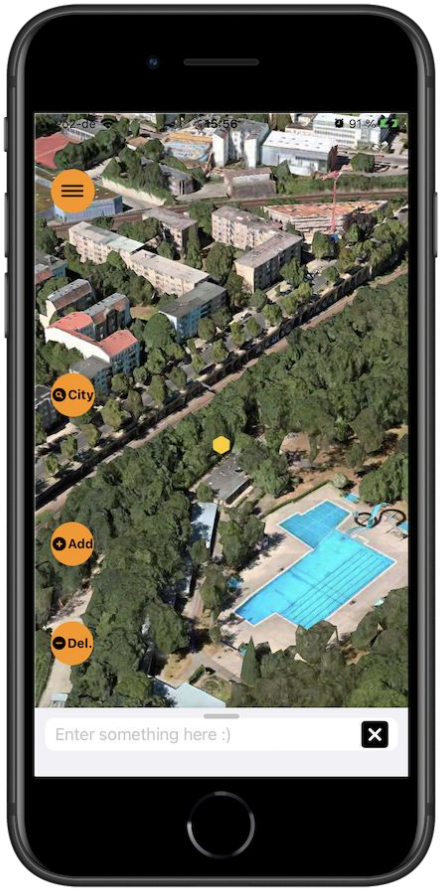
User Inputs

- Environmentalists can make the following contributions to support beekeepers and bees
  - 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.



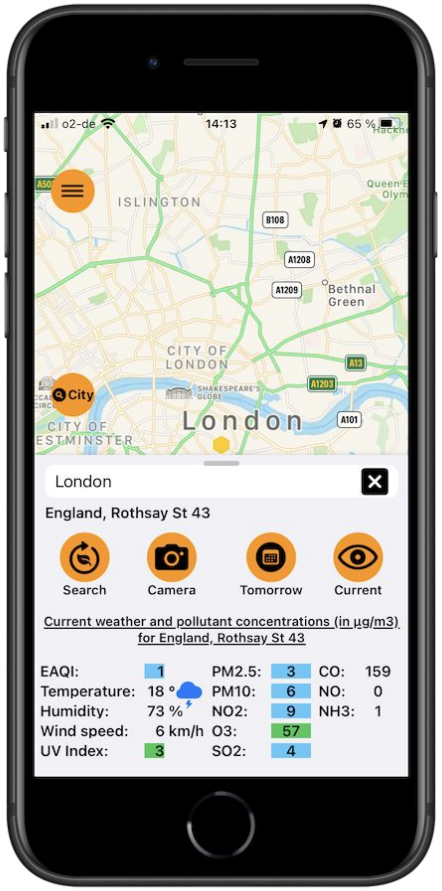
The Interactive Map as Mobile App

- 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.
- Filter through various annotations



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 and air pollution data
- Air pollution values based on regions Air Quality Index

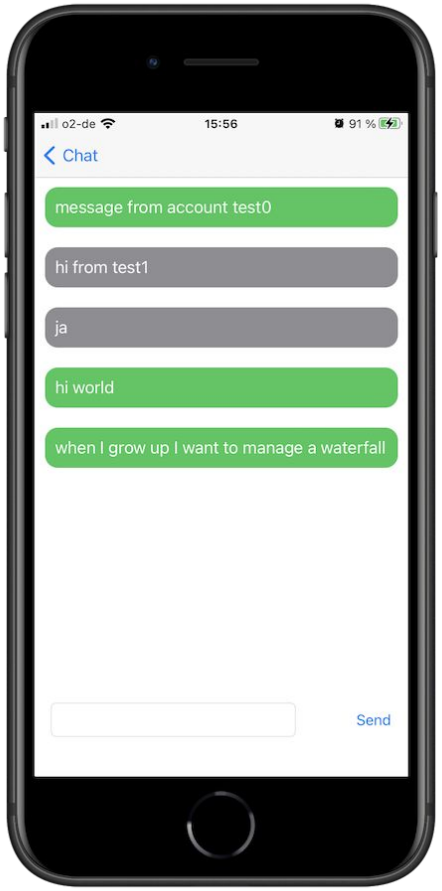


Flower Recognition

- 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 Firestore Cloud servers
- Registered users can chat with other users



Methods and Tools Overview

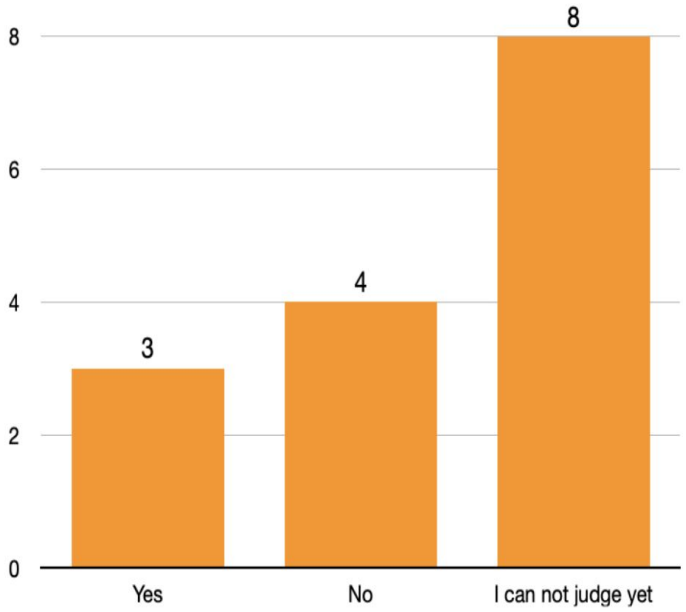
- Native iOS app in Swift with IDE Xcode
- Mobile for GPS location, camera
- Apple’s MapKit for an interactive map
- Pretrained CNN with Core ML Framework for public flower dataset
- Google’s Cloud FIrestore as database for instant access
- Cloud also for storage of authentication of users, annotations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

Preliminary User Evaluation

- 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

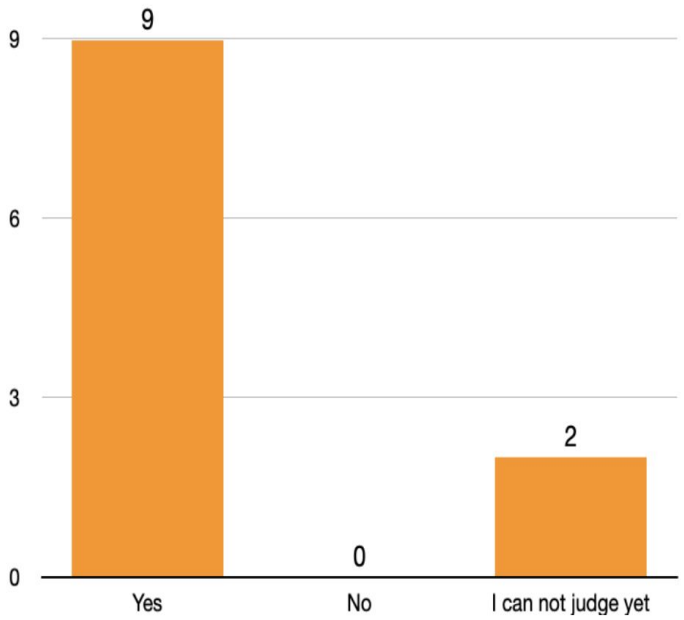
One Question for Beekeepers

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



One for Non-Beekeepers

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



Some Key Facts from the Preliminary Evaluation

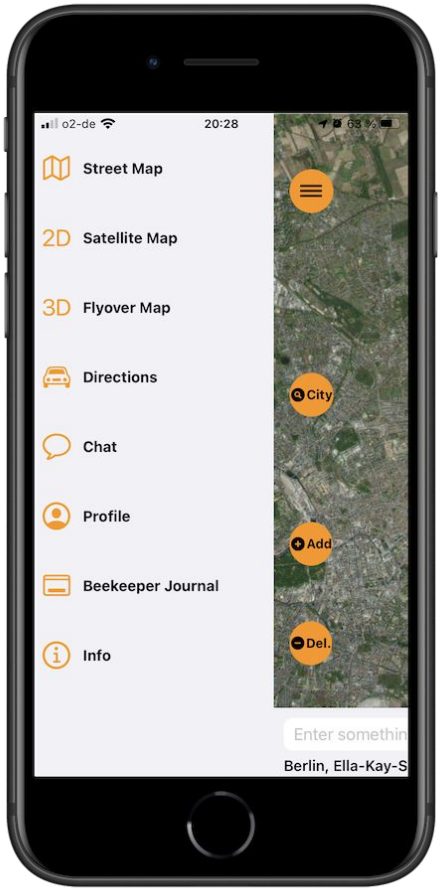
- About the app:
  - “If enough users enter plants the app is useful.”
  - “If you have to move your bees to another location, it is good to be able to keep an eye on the surrounding area.”
  - “It is possible to produce specific types of honey.”

More Key Facts from the Preliminary Evaluation

- 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 for bees”

Further Work After First Evaluation

- New user interface with switchable dark mode
- List of pollen sources for pollinators through Wikipedia
- Journal for beekeepers for documentation of discoveries or performances on bees and beehives

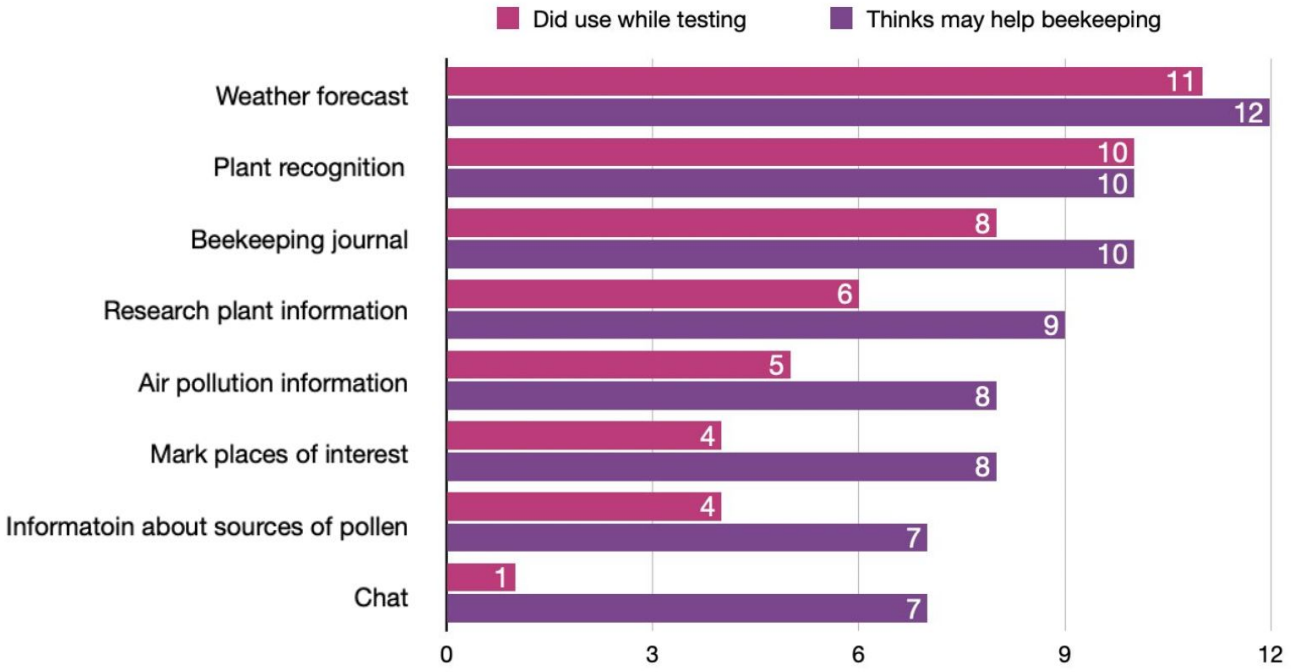


First Hands-on Test

- Pollenity, a Bulgarian firm for IoT solutions for beekeepers, has run the first hands-on test
- 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
- A total of 14 responses could be evaluated
- Each participant was asked 10 questions

Two Questions from the First Hands-on 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
- HIVEOPOLIS-connection
- Improvements on features and user interfaces
- Gamification to motivate and hook non-beekeepers to the app
- Much more tests with beekeepers and non-beekeepers