Extended Abstract: A Novel Mobile App for the Next Generation of Beekeepers

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Abstract

In this extended abstract, the authors report the ongoing work on a new mobile app for beekeepers. It is very important for beekeepers - especially for those who are in search of new locations for their beehives - to know the current situation in the immediate vicinity. This work presents a mobile application suitable for beekeepers to view weather and air quality data and, in particular, what people in the nearby area have annotated.

Keywords

Beekeeping, Mobile App, Prototype, HIVEOPOLIS

1. Introduction

Beekeepers pollinate many crop plants with their bees. Most important crops depend to some degree of pollination from the most important species for crop pollination: the western honey bee. Honey production is also an important source of income in many rural communities [1]. Often forgotten are the wild bees, who are responsible for pollinating garden plants and wildflowers. Honey bees are linked to the spread of diseases to wild pollinators via shared flowers. They can also out-compete with native pollinators for resources and food [2]. Other modern challenges for bees are pesticides, parasites, climate change and a lack of flowers [3]. According to the World Health Organization, an estimated seven million people die each year from air pollution [4]. Since bees rely on their sense of smell to identify different flowers, air pollution is affecting them too. Air pollution masks the scent molecules from plants. This makes bees forage longer leading them to become ineffective pollinators because of the decreased reproductive output and the amount of pollen flow in flowering plants [5]. Another study observed a reduction in pollinator survival as well as significant molecular and physiological changes [6]. In order to fight these challenges, the authors created a prototype in the form of a mobile app. Beekeepers should monitor climate and air conditions to keep bees and themselves healthy. Managed honey bee hives should not be placed in protected areas, where a risk would exist of wild bees being driven away or attacked. More plants are required to address the plant shortage and help wild insects. The map-based app uses current technologies, with which non-beekeepers can help beekeepers by marking spots on the map. The whole utilization

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process is simplified for all users with features such as identifying plant species via photos and showing which plants are suitable for bees.

The development of a new app is part of the HIVEOPOLIS project [7, 8]. HIVEOPOLIS intends to provide honeybee colonies with technology (internet, databases, satellite data and robots) that would otherwise be unavailable to them.

2. Methodology

The goals of developing the app consists of three main components:

1. An interactive augmented map shows key elements of weather and air quality for beekeepers.
2. Users must be able to make inputs and help beekeepers with it.
3. It should be simple and swiftly to use.

The application was developed as a native iOS app in the programming language Swift with the integrated development environment Xcode. One reason mobile app development was preferred is access to the camera for various functions, such as photographing plants for plant identification. Furthermore, GPS data is required in case a user of the app wants to get directions to the next destination of his hives. Apple's MapKit was used natively for the app's interactive map. This allows users to see the map as a satellite view in 2D or 3D. OpenWeather provides with its API the current and forecast weather as well as air pollution data for all coordinates. The air pollution values are currently based on the European Air Quality Index. A pretrained convolutional neural network was used for the flower recognition function: Oxford's 102 Flower Dataset with 102 categories, each 40 - 200 images, allows to take a picture of any flower and it tries to recognise the flower's name [9]. Users can have their own account with email and password, which are stored and encrypted on Google's Firestore servers. The cloud database is instantly accessible, which means saved data is instantly available for other users. For example, registered users are able to send chat messages and save annotations. An API from Wikipedia was used to retrieve flower data, allowing users to look up information about any flower.

3. Results and Discussion

A preliminary user evaluation had been created as an online survey. A total of 26 people participated in it, 15 were beekeepers and 11 were non-beekeepers. They assisted in revising the design and generated ideas for new functionalities. After this evaluation an alpha test was made. Sergey Petrov from the company Pollenity asked 22 Bulgarian beekeepers to test the app on an iPhone and give feedback. Each member of the group spent between 1 and 10 minutes testing the app. The methodology of the test included a short verbal presentation and a video tutorial on how to use the app. In the following pictures, you can see the app. Figure 1 depicts an impression of the app. (Left) shows markers on the map that have theoretically been set by users. Potential beekeeping locations are depicted here, along with plants of interest to bees. For example, a beekeeper can see where other beekeepers are in the vicinity, if they have marked a chosen location as already been occupied by the beekeeper, and where beekeepers should pay

attention to the protection of wild bees. (Right) shows the current weather with temperature, humidity, air speed, UV index, as well as the current air quality values.

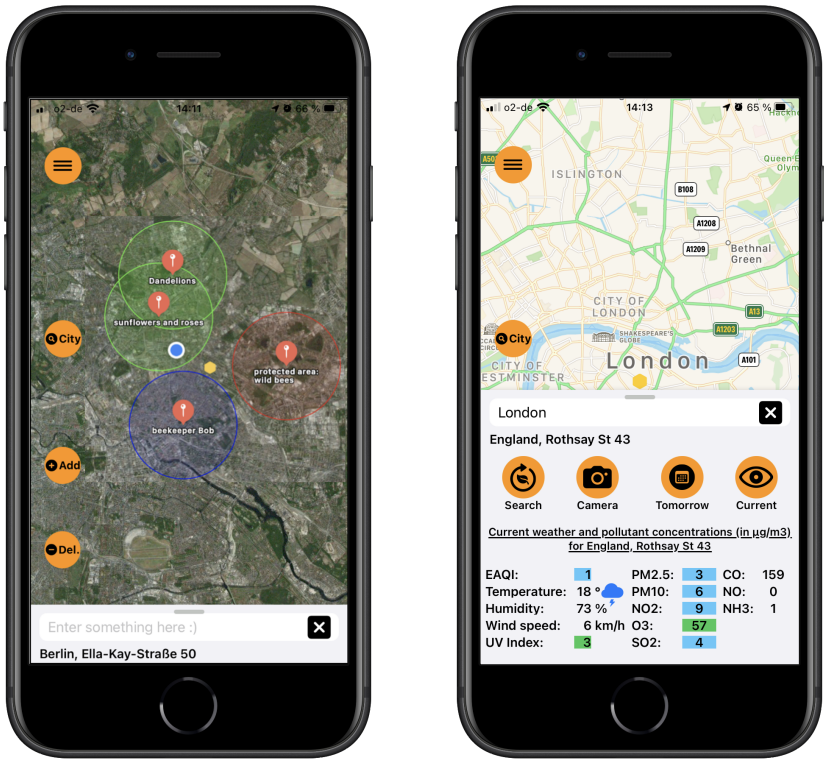

Figure 1: View of the application. Left: overview with annotations. Buttons: hamburger menu with more functions; set focus to a specific city; adding and deleting annotations. Right: Slide up menu with current weather and pollution data. Buttons here are the search button for displaying information of a specific plant; camera for shooting pictures; tomorrow for future weather and air quality; current for weather and air quality at the moment.

4. Conclusion

The preliminary user evaluation and the alpha test confirmed that such an app could be of interest to beekeepers and environmentalists. The next steps would be to define some corrections to the design and then test it again as a beta version to get further constructive feedback. Further evaluation is needed to collect more meaningful reactions and constructive criticism from beekeepers to be able to improve the app. Current ideas for improvements are: The most important point is the implementation of Android. Another important point is localization, so that the app works all over the world without language barriers. The authors are also considering how gamification can be integrated to motivate users and bind them to the app. Furthermore, there are still a lot of functions that could be implemented. For example, the

flowering times of the respective plants, so that beekeepers know when the flowers are usable for them. And uploadable images so that users can see more of what the location looks like. After some testing and improvements, the app could be made available to the public.

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References

[1] Ashley N. Mortensen at el. European honey bee apis mellifera linnaeus and subspecies (insecta: Hymenoptera: Apidae). UF/IFAS Extension, EENY568, August 2013

[2] Jonas Geldmann and Juan P. González-Varo. Conserving honey bees does not help wildlife. Science, 359(6374):392–393, January 2018

[3] Dave Goulson at el. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. Science, 347(6229), March 2015

[4] Air pollution in the Western Pacific https://www.who.int/westernpacific/health-topics/air-pollution Last access 1 July 2021

[5] Quinn S. McFrederick et al. Air pollution modifies floral scent trails. Atmospheric Environment, 42(10):2336–2348, March 2008

[6] Geetha G. Thimmegowda et al. A field-based quantitative analysis of sublethal effects of air pollution on pollinators. Proceedings of the National Academy of Sciences, 117(34), August 2020

[7] Futuristic Beehives For A Smart Metropolis https://cordis.europa.eu/project/id/824069 Last access 1 July 2021

[8] Asya Ilgün et al. Bio-Hybrid Systems for Ecosystem Level Effects in Proceedings of the Artificial Life Conference 2021 (ALIFE 2021) (to appear)

[9] Nilsback, M-E. and Zisserman, A. Automated flower classification over a large number of classes Proceedings of the Indian Conference on Computer Vision, Graphics and Image Processing (2008) https://www.robots.ox.ac.uk/~vgg/data/flowers/102/