Good

1 Introduction

Bees are one of the most important insect species. Worldwide, there are around 25,000 different types of bee species. Honey bees are remarkable sentinels of the environment; a single colony can thoroughly sample areas of up to 10 km^2[1]. As known, pollination is essential for plant reproduction, and it depends on bees and other species. Pollination is the transfer of pollen from the male part of the flower, to the female part. Thus, taking care of bees is an important task for their proliferation and crop betterment. Nonetheless, late climate changes have affected the bee population. Furthermore, there is a consensus of opinion within the scientific community that more field data are required to help understand the continuing decline in honey bee health.

Nowadays, bees are dying at a worrying pace. The increasing mortality rate of the species is due to several reasons:

- Wrong use of chemical pesticides
- Bad distribution of hives in different growing areas
- Poor coordination between the cultivation
- Bee pollination cycles and bad environmental conditions.

Studies proved that if hives do not have the right environmental conditions, i.e. temperature, then bees tend to abandon them or bees die. Also, honeybees do not benefit from being disturbed by frequent examinations. Their normal activities are disturbed and occasionally the colonies become weaker potentially biasing results. System described here was developed precisely with the aim to minimise the disruption to honey bee colonies while allowing automation of vital parameter collection, such as bee activity, hive weight, temperature humidity, air pressure, carbon dioxide content, light luminous level, orientation of the beehive, and the location of the bee hive [2]. Advances in technology which have rendered remote data acquisition and automation a reality, coupled with the steep decline in honey bee welfare as well as a significant rise in public's awareness of honey bee importance in the ecosystem, resulted in the evolution of remote beehive monitoring. The contribution of this work is to show a proof-of-concept of the design and development of the automated beehive.

2 Persona Scenarios

As we have two different products we focus on (the physical, digital beehive for the beekeepers and the smartphone application for gardeners) we have to divide our persona there as well.

The Personas who are buying and using our digital beehive look like this:

2.1. Persona Jasper K.

- Age: 34
- Gender: Male
- Job: Engineer at BMW
- Family: Wife + 2 kids
- Hobbies: Green Thumb/ Gardener, Hiking in the mountains, Flying with drones
- Living: Suburb of Munich, House with garden

nice story, but please focus more on technical details -> which sensors? -> which data is collected? -> how can this data be accessed?

Scenario: Jasper wants to spent more time with his family and therefore thinks of becoming a beekeeper. As the topic “bees” is in the news very often he often has conversations about that with his colleagues in the BMW office. Unfortunately Jasper neither had contact to bees nor to beekeepers ever before and he has no idea where to start his journey of becoming a successful beekeeper. Furthermore his job is very demanding and he does not have a lot of time to get into the topic by visiting beekeeping classes or reading books and articles about it. One evening, while browsing in you tube for bee-videos he stumbles over a guy talking about “Plan bee-project” which should help people to get started and then work with the bees. He downloads the app and instantly gets information about advantages and disadvantages of different bee-housing types, gets an overview of where to receive bees and furthermore what tasks the beekeeper has in every week of the year. In the App he gets an offer for a “digital beehive” that helps him keeping bees by providing him with all the necessary recommendations he needs by collecting various data out of his own beehive. He decides to start beekeeping with that digital beehive and orders it via the app. After receiving the digital beehive the app tells him, how to place the beehive in the correct way (the beehive should point to south-east in Germany) and afterwards where to find bees within his neighbourhood. Successfully he moves bees

into his digital beehive and he can't wait to watch his bees fly and produce honey within the beehive. Therefore he opens the app and watches the live stream. Every day he is able to see the progress they do inside of the beehive the weight increases and he can visit his –beehive without having to worry about being stung because the app tells him the bees are calm based on internal frequency analysis. He can't wait to show the progress to his friends and colleagues in the office.

2.2 Persona Frank M.

- Age: 55
- Gender: Male
- Job: Farmer, Part time beekeeper
- Family: Wife + 3 kids
- Hobbies: Spending time with the bees, hiking
- Living: Lives on a farm in the countryside

Scenario: Frank is a cosy person, likes to spent time on his fields on the farm and enjoys living outside of the cities. Frank is passionate about keeping bees but often he is too busy checking the beehives and carrying for them. Furthermore his beehives are separated within an area of more than 15 kilometres and checking all of his hives just takes a lot of time where he often needs another person helping him. A friend tells him about Planbee-project's digital beehive-stands in order to save time checking the bees and monitor them remotely via app. Frank decides to order his first digital beehive-stand. The setup is easy he just puts his current beehive on top of the digital – beehive stand and the App guides him through the next steps (create an account, name your beehive) and directly thereafter provides the real time information about weight, temperature, humidity and much more from his own personal beehive. Frank loves the idea because he is now able to check for his bees without even leaving his house! Whenever it is necessary for him to check for the bees or when there is the perfect moment to harvest the honey the App instantly tells him via push notification.

only this part is relevant.

focus more on technical details
→ how does the user is using your app
e.g. how does they log in? → which data are necessary?

please look again at the template

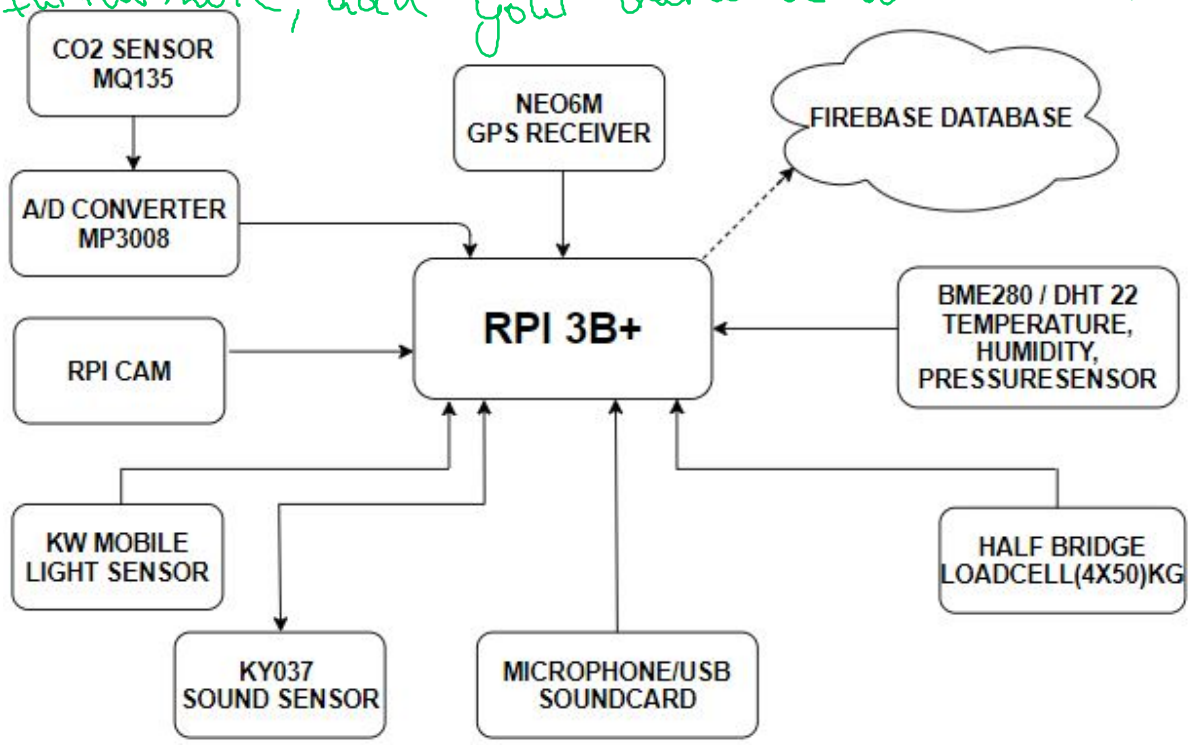
here a mock up of the user interface is needed
mock up the app and if you have an interface
for the hive mock this too Cool picture is not enough!

2.3 Mock Up :

3 System Architecture

The following pictures illustrates the vision Planbee-project has with his digital beehive and all the features they want to generate with the sensors:

- also add the architecture for the app
- furthermore, add your database architecture / JSON format



Good !

Sensor to functionality mapping -

Required Data out of the beehive	**Required Sensor**	**Why do we need the sensor?**
Temperature (Outside/Inside)	GY BME280 or DHT22	Outside: Temperature has a huge impact on the behaviour of bees (if they fly or not, if they collect honey or water or rather stay inside) Inside: The Queen Bee has to be kept on a certain temperature to stay alive
Humidity (Outside/Inside)	GY BME280 or DHT22	Outside: Same as temperature Inside: Humidity might cause mould inside the beehive and increase conditions for diseases
Air Pressure (Outside)	GY BME280	Same as Temperature
Frequency of Bee Buzzing	Microphone	Frequency of bee buzzing give insight of the mood the bees have (aggressive, calm also)
Volume of Bee Buzzing	Microphone	Same as Frequency
Weight of Beehive	Load Cells	For the beekeeper the weight of the beehive is the most important data to have because it tells if the bees have enough honey / food for winter or if the bees collected enough honey so he can harvest it

Pictures / Video inside Beehive	Rpi NV Cam	For the beekeeper and the bee-parental ships having real-time inside life streams would be really cool to have and see. By pictures we can see the speed bees build their combs and collect honey, the live stream is just a nice feature that every beekeeper will enjoy
GPS	Neo 6M	In order to offer bee-parental ships to our customers we want to offer a map where customers can see where the beehives are placed
Beehive was opened	KW Mobile Light Sensor	Opening the beehive means stress for the bees
CO2 (Outside)	MQ135	CO2 Emission have certain impact on behaviour of bee-breeding and Varroa-mite population

4. State of the art

good use of references !

4.1 Platforms/Systems –

The earlier systems for bee monitoring employed microcontrollers with few sensors and used primitive database systems. In 1914, Gates published data on the temperature of a beehive manually collected every hour for several days in 1907 [15].

The advancement in the sensor technology and electronic data-acquisition systems has allowed the improvement of measurement processes. In this way, different types of monitoring methods have been used, from simple observation of the data in the hive [17] to systems that are able to analyse those data [18].

The improvement of the performance and size of the microcontrollers has allowed the development of low-cost beehive-monitoring systems based on Arduino®, Make®, Sparkfun®, and Adafruit®. → add a link to these

reference for Arduino information would be nice

Arduino is an open-source and prototype platform based on hardware and software which is easy to use. But it doesn't have in-built WiFi and Bluetooth modules and it has low processing speed. Earlier system stored the temperature and relative humidity data in a microSD memory card by means of an Excel database. The beekeeper needed to go to the beehive colony and download the content of the SD memory card for each hive to his/her laptop to be able to process those data later on. But, current technologies have overcome the drawbacks. Wireless technologies are employed in recent times. Zigbee network, GSM technology were used to transmit data over a network to facilitate IOT systems realization. But, they are not reliable in our use case due to short range and low bandwidth [3]. I think there is also an university that does something with bees. → Ask your team! otherwise good!

4.2 Technology/ Frameworks –

→ this chapter needs more references

For this project we will be using different sensors which will all be controlled by Raspberry Pi.

reference where this data is from

Raspberry Pi is a single board computer which can be used as personal computer by connecting keyboard, mouse and display. Mostly it is used for real time Image/Video Processing and Robotics applications. Even though it is slower than laptop or desktop, it is still a computer which can provide all the expected features or abilities, at a low power consumption. It has Debian based Raspbian Operating system, which is officially free to use. Raspbian have GUI which includes tools for Browsing, Python programming, office, etc. Raspberry Pi is more than computer as it provides access to the on-chip hardware i.e. GPIOs for developing an application. We can connect devices like LED, sensors, etc. to GPIOs and can control them. The CPU speed of Raspberry Pi varies from 700 MHz to 1.2 GHz. It has on-board SDRAM that ranges from 256 MB to 1 GB and also provides on-chip SPI, I2C, I2S and UART modules.

Raspberry Pi has inbuilt Wi-Fi and Bluetooth connectivity. And Raspberry-pi has more GPIO pins. In Raspberry pi we can directly code and run that code in real time. Raspberry pi can run a operating system (Linux). The speed of Raspberry pi is 1.2 Ghz. Raspberry Pi has media ports such as HDMi, USB, Audio and Camera ports.

only link at first time you mention it

So data are received from sensors then the data are transferred to the database. There are many databases but for this project we would be using Firebase database. In raspberry pi we would be using Python programming. Basically we would be using Python programming 3x for our project. We are basically importing python libraries .Mainly the libraries that we are using are Adafruit and other predefined libraries for the sensors.

link to the database (there should be a homepage)

The Firebase Realtime Database is a cloud-hosted database. The data read from the sensor is stored as JSON format then these database will be synchronized in real-time to every connected client in the system. The apps that are built are cross-platform apps they will be using Android, IOS, and JavaScript SDKs, all of the clients will be sharing one Realtime Database instance and automatically receive updates with the newest data. The Firebase database is easy to use and while storing our sensor sensed data we don't need to make tables, it will easily save the data in the form of nodes. The firebase database also doesn't have many clutters.

please reference your source

Likely in our project we will be using Python programming language, as Raspberry pi works on python programming. Python is a high level language, interpreted, general purpose language. There are many inbuilt libraries which can be easily imported and can be used. Also it is more compatible with Raspberry Pi as it has Linux operating system and the sensor codes can be run without dumping.

5 Time Table

→ please provide a table when you want to implement what

References

[1] Hazards of pesticides to bees - 12th International Symposium of the ICP-PR Bee Protection Group, Ghent (Belgium), September 15-17, 2014

[2] E. López-Tagle, E. Siqueiros and H. Ponce, "Design of an automated hive for bee proliferation and crop betterment," 2017 14th International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE), Mexico City, 2017, pp. 1-5.

[3] Gil-Lebrero, Sergio & Quiles Latorre, Francisco & Ortiz, Manuel & Sánche Ruiz, Víctor & Gamiz, Victoria & Luna-Rodriguez, Juan-Jesus. (2017). Honey Bee Colonies Remote Monitoring System. Sensors. 17. 55. 10.3390/s17010055.

[4] https://www.electronicwings.com/raspberry-pi/raspberry-pi-introduction

Please write your name on the chapter you wrote.
You need to hand in at least 10 pages!