Newsletter

November 2015

Abstract

After summarising some short news relating our project, we give an detailed insight on the techical aspects of the eHive project. Besides the project's software for the micro controller and the diagram, we discuss the self developed ciruit board. We conclude this newsletter by giving an outlook on the schedule until Spring 2016 and some new developments that are in our pipeline now.

Dear readers,

Our last newsletter reached you more than three month ago. This is why we want to inform you in detail about what happened until now and what is planned for the near future. Since summer many changes and developments occurred to the BeeBIT project: New partners and sponsors have been found, technical difficulties resolved. Simultaneously, BeeBIT was registered as a non-profit association and is now called »BeeBIT e.V.« (the addendum »e.V.« is the German abbreviation for registered association).

Short remarks

Formation of BeeBIT e.V.

By establishing the association we hope to simplify and merge the structure of our project, so that working with us together trustfully on a regional as well as on an international level becomes more easier and concrete – both for our partner schools as well as for external institutions, companies and educational facilities. The association's scope of duties herein will be of an organizational character, particularly with regard to communication, project organization and public relations.

Meeting with Project Partners

From the 1st November to the 4th November, the project partners from all over Europe came to Würzburg for a meeting with the BeeBIT team. We mainly discussed the status and further planning of the entire BeeBIT project. They also recieved an introduction to the BeeBIT webpage (www.beebit.de) and translated the diagram (www.beebit.de/diagram) in their mother tongues, so we got six available languages by now (German, English, Italian, Swedish, Slovenian and Croatian, more to follow).

Awards

In the course of the so called »Land der Ideen« contest, our project was decorated with a prize. The contest was founded by the past German government and is yearly assigned to innovative and creative ideas from around the country. On October 21st the award was submitted at Friedrich-Koenig-Gymnasium in the context of a colloquium of natural sciences. On November 11th Christoph Bauer (FKG) and Arnold Weibel (DHG) represented BeeBIT e.V. at the awardee meeting in Berlin.

BeeBIT on German TV

On the 2nd November, the German TV broadcaster of the federal country Bavaria, the Bayerische Rundfunk, came to us to shoot a short report about our project. They interviewed our software engineer, David Schneller, a member of our association board, Christoph Bauer, and a student of the FKG grammar school. The report can be found here (it is only available in German, sorry!): https://beebit.de/br15tv.php

MINT-EC congress

On the 13th and 14th of November the German headmaster congress for participating MINT-EC (Excellence schools in STEM subjects) schools took place at the Friedrich-Koenig-Gymnasium. Martin Otersen (DHG) and Christoph Bauer (FKG) held a workshop about the BeeBIT project and informed about the eHive, especially about how to get involved in the project. Both options, purchasing an eHive or alternatively securing access to the collected data and provided materials by acquiring membership in our network were mentioned and explained.

Cooperation

Thanks to Schneider Electric, a global player in matters of electronic components with around 170.000 employees worldwide, BeeBIT e.V. can benefit of the support from a gifted and well-versed partner. Schneider Electric is involved in producing the eHive's new, improved and finally working circuit board. This board is planned to be finished at the beginning of January, which means we are able to ship the missing modules until the end of January to our European partners. In February all delivered eHives should be able to connect to the network and provide real-time data. At the moment this is our very first priority. Besides that, Schneider Electric also offered us support on developing and producing better technical solutions for the eHive. Consequently, in the background we are beginning to work on enlarging the network and think about how to benefit from the offered possibilities.

Furthermore, we initiated a partnership with the LMU Munich, who will take over the duties of the University of Würzburg. This includes the creation of teaching materials and the scientific monitoring of didactics-related tasks. There will also be possibilities for final theses using our data. We would like to thank Dr. Monika Aufleger from the Institute of Biology Education.

We also want to thank the Umweltstation Würzburg, the conversation agency of Würzburg. Since the very beginning of our project, they supported us with knowhow and tools regarding beekeeping. Besides, two of our eHives are located on their site.

School seminar

The BeeBIT project emerged from a so called »Projekt-Seminar« at the Deutschhaus-Gymnasium more than two years ago. This autumn another seminar started which is thematically related. Its purpose is to support and enlarge our team. Until next spring their most talented programmers are working on a multilingual administration system for education materials. Additionally, the group produces a corporate video about the project featuring a 3d-model of the eHive and its important parts.

Technical developments

The software system

Basically, BeeBIT establishes a network of several clients, one per bee box, which collect sensor data and send it to a central server. The central server stores the data in a database which is connected to the internet to enable a wide range of applications, cf. Fig.1.

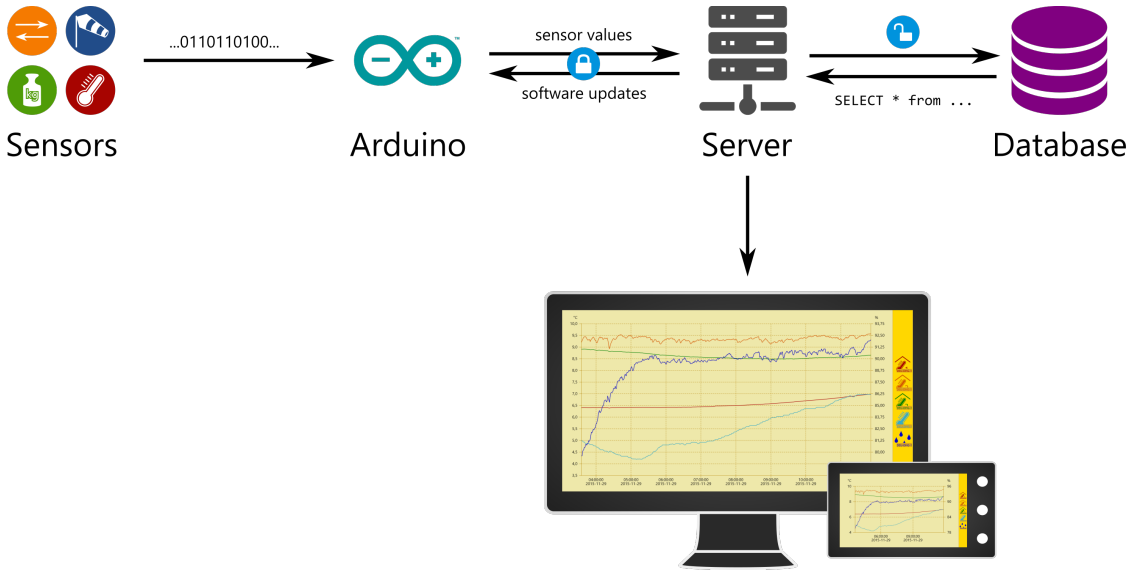

Fig.1: The flow of data from the sensors inside an eHive to your screen.

As for the clients, we use an Arduino Due to collect the data. In the aftermath, we partially regret our decision to have chosen such a device; on the one hand, it simplifies access to some obvious Features, but sometimes Blocks or at least hinders the use of some more complex and subtle functions of the microprocessor. For example, as we wanted to query the temperature sensor of the microcontroller, we had to access the specific component directly, because the Arduino abstraction did not implement such a feature. And of course, our implementation is not compatible with Arduino's one. So, for small projects, the Arduino might have been the perfect choice, but in our case, it made things harder.

In the recent time, we have implemented some revolutionary Features on the Arduino you might also be interested in (I'll describe them here in a *hopefully* high level form. If you are interested in a more technical explanation, you can contact us directly, or wait until we post a documentation on our webpage www.beebit.de which will hopefully happen really soon):

Encryption using the mbedTLS library

Well, this is one of the more obvious ones. It is easy to implement a library, right? But we developed our own way of encryption: Each, server and the clients, got their own keys and they basically generate temporary keys to communicate with each other. We can easily authenticate and authorize our clients at the server, and the encryption has shown to only lead to small performance issues about every 30 minutes when client and server exchange new keys to communicate with each other.

GSM on the Arduino Due (i.e. cellular communication)

As you might know, the Arduino GSM library does only work for AVR-based chips which the Arduino Due is not. So we had to develop an own version of it (it only Features internet, no SMS or call functionality is planned to be implemented, as we don't really need it; we wanted to develop a library from scratch, because the Arduino GSM library felt a bit too bulky, we thought), we are currently tweaking it a bit.

Firmware-Over-The-Air functionality

This was maybe the biggest challenge in developing the software: How to update the software of the Arduino without plugging it to a computer, so we can automatically distribute updates? Well,

we did it! We just write the data from some position in our flash storage to the position where the program is executed, and we do this all from RAM. Then we just reset the microcontroller. It sounds really easy when described in such a high level way, but there is hardly any resources on this topic (specifically when you try to update an Arduino...) except from the datasheet and some additional notes by the manufacturer.

The best part about it: The update is independent from the type of internet connection (GSM or Ethernet) and is also encrypted to secure the network even further. The code used for the update might also work on other Atmel-ARM-SoCs, at least on those that include the RSTC and EFC controllers.

Data visualisation: diagram

But we not only made some progress with client software (by the way, we are currently recording data experimentally, using the GSM library and the encryption and successfully sent some updates). We also tweaked the server software and the database and added a live diagram which is still in an early stage of development. With it, you will are able to display the data in a way which not only computer scientists can understand. It is developed as a responsive website, so it is fully functional on most devices, from smartphone to desktop. You can view up to eight different sensors at once and scroll through all our test data. As mentioned previously, we already translated it into six languages, more to follow. Pretty cool, isn't it? You will even be able to see when new data comes in approximately every ten minutes! By the way, you can find it here: www.beebit.de/diagram. Have fun! If you have any suggestions for improvements or found a bug, please contact us.

The hardware system

After we revised the circuit diagram and the layout of the PCB, two prototypes were produced in September, cf. Fig.2. The boards were ordered by an external company and manually assembled by us with nearly 90 parts and over 400 soldering joints. The SMD parts were reflow soldered. First, the solder paste was dabbed on the pads of the board and then it was populated. After all, the whole PCB with the components sticking on it was heated till the solder paste melted. The through-hole components were soldered with a soldering iron, what needs to be done in this way later as well, because in the regular soldering process, the wave soldering, too much solder would be deposited at the pins, which must fit into the Arduino. The SMD parts will be assembled later by a pick-and-place machine.

One of the two prototypes is in use at the Umweltstation Würzburg right now.

The future timeline of the BeeBIT project

As mentioned previously, we agreed on a partnership with Schneider Electric. They will manufacture a small range of our circuit boards which will be completed early January. We expect to activate the existing eHives until the end of February.

In the meantime, we will add some improvements to our live diagram, create a detailed documentation of all parts of the project in a Wiki style and start the development of the Teaching Resource Management System (TRMS).

Furthermore, we will try to fix the existing circuit boards for the Entrance/Departure Sensor by optimizing its software. If these attempts remain unsuccessful, we will try to develop an entirely new sensor.

From spring 2015, we will try to enlarge our network. We are currently designing a second version of the eHive, which mainly relies on the technologies of the first version, but it will e.g. include a weather barrier and thus avoiding technical difficulties.

But of course, we want to enlarge the possibilities of the eHive and design more and more complex sensors. Those will be included in the so-called rHive (Research Hive), which will be finished not earlier than the end of 2017. We already drafted concepts for the following sensors:

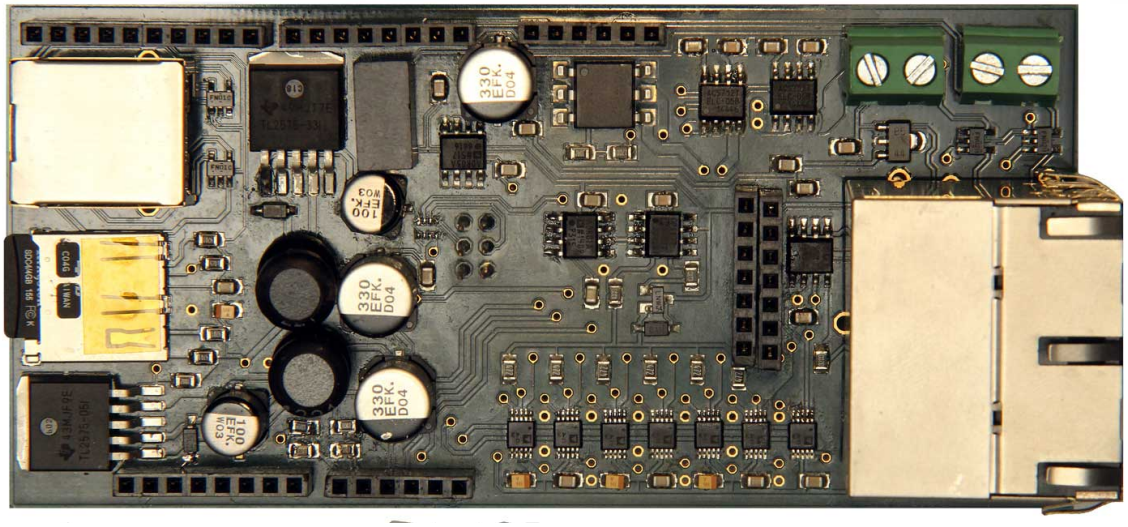

Fig.2: The test circuit board, entirely soldered off hand.

- Automatic varroa mite counter
- Hive microphone
- Detection of the weight of single combs
- Infrared camera in the entrance of the hive
- Three-dimensional temperature probing (currently, all our temperature sensors are aligned in a row)
- Detection of CO2 and respirable dust concentrations
- Development of a custom weather station

By developing these sensors, we want to increase the toolset for the BeeBIT project and bee research in general. Besides, we want to make the rHive expandable and also add an interface for third party sensors. We also want to include the already developed display unit.

This is the end of our newsletter. Please have a look at our website, www.beebit.de, and the bulletin board, where new entries are always welcome. Of course, you can always contact us directly via beebit[at]beebit.de.

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