

## Creation of a monitoring system for bees

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Nowadays all of us know, that bees are very important for the human life on Earth. For this reason, it is necessary to use the newest technology and help bees to live here. However, we will not present any revolutionary technical innovation in this article (like a Harvard engineers in 2013, which created the RoboBee), but we will focus on development of a bee monitoring system, which can be used by some beekeepers in their bee farms. Every automatic monitoring system for bee hives brings several significant benefits in the same time. It can significantly facilitate bee life in beehives – the beekeepers don't need to active checking bees by opening a roof on the beehives when they use the monitoring system. As a result, bees will be calmer and beekeepers have more free time. Beekeepers can anytime check current measured interior/exterior values of beehives in their mobile phones, laptops or some different „smart” devices (devices which can be connect to the internet - Internet of Things). Nowadays some companies have created beehive monitoring systems, but most of them are expensive for a regular beekeeper. All of those monitoring systems are different – each of them is able to provide only some functions for beekeepers (it can alert a person to an unauthorized visit to the bee farm, etc.).

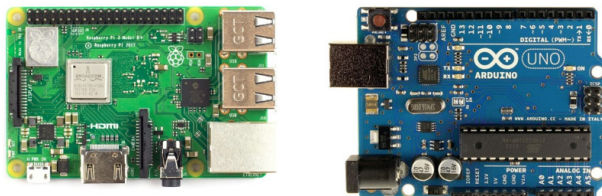
### Comparison of the most used monitoring systems in Slovakia

In the table below are displayed the most commonly used monitoring systems in Slovakia. We can see our own monitoring system in the last column which is named "Our Project". Our monitoring system is cheaper than other monitoring systems and contains all of the most used functions such as other monitoring systems. This is the reason, why a lot of beekeepers make their own monitoring system (like Our Project).

System / parameter	Chytré včely	OSBeeHives	Bee Hive Monitoring	Our Project
Exterior temperature	✓ YES	✓ YES	✓ YES	✓ YES
Interior temperature	✓ YES	✓ YES	✓ YES	✓ YES
Atmospheric pressure	✓ YES	✓ YES	✓ YES	✓ YES
Exterior humidity	✓ YES	✓ YES	✓ YES	✓ YES
Interior humidity	✗ NO	✓ YES	✓ YES	✓ YES
Weight of hives	✓ YES	✗ NO	✓ YES	✓ YES
Solar system	✓ YES	✓ YES	✓ YES	✓ YES
Alert notifications to SMS	✗ NO	✓ YES	✓ YES	✓ YES
Identify a queen bee	✗ NO	✓ YES	✓ YES	✓ YES
Price	250€	240€	577€	150€

### Sensors and devices of our monitoring system

To make a functional monitoring system for the five beehives is needed: 1x Raspberry Pi 3 type B+; 1x Arduino Uno; 5x sensor DHT22 (as many units as we need to according to number of beehives, to monitor temperature and humidity), 5x set of scales for weight measuring (Load cell) with transducer HX711.



Temperature and humidity sensors used are type DHT22. This sensor is different than his predecessor (DHT11) for its parameters – temperature range is -40 - 125 °C (with tolerance  $\pm 0.5$  °C) and humidity range is 0 – 100% (with tolerance  $\pm 2 - 5\%$ ). There was designed a set of 4 weight sensors for each beehive (one under each beehive corner), while each measuring unit can be loaded with maximum weight 50 kg. When there are used four units under one beehive, monitoring system is able to measure the total weight up to 200kg.

Every sensor of designed monitoring system is not very expensive. For this reason, you can install a lot of sensors for your project/monitoring system. In practice this means, that we can buy, for example, GPS modul (its price on internet shop is 4€) and add it to our monitoring system as well. Monitoring system will display current location of beehives, generated from coordinates of a GPS module. Today there is a wide range of sensors for monitoring system available on the market , e.g. PIR sensor for detection of human motion (if PIR sensor is active, monitoring system can send message to our device in real time via internet connection / or GSM modul). Another very useful sensor for monitoring system is IR sensor. This sensor is cheap and really important for monitoring beehives because it can detect fire at the beehive farm and monitoring system sends notification/message to the beekeeper, so he can call firefighter units. This sensor with its low price (0,50€) can save many bee families.



### Received email from monitoring system

If monitoring system sends notification through e-mail account to the user devices, this is how email should look like:

1. first row – sender email address
2. second row – specific beehive
3. third row – predefined text with variable values (variable values are actual values of the monitoring system)

E-mail can be sent through SMTP. Temperature is also displayed in the table graph for easy check of max./min. values during a certain period. The function is working also for sending notifications of the humidity monitoring. In the last column is a date and recommended values, which should be achieved in beehives.



### Graphic displayed monitoring system

The main goal of the monitoring system design is to process information from the exterior/interior sensors and subsequently display them in graphs and tables on the web server, which is created by RPi. In the figure below is showed card "Včelnica Štiavnik" where are displayed all actual values from five beehives. For each beehive is created column, where are located values (actual temperature, humidity and weight), which belongs to the specific beehive. In the first row are values of the interior temperature. Here can be three colors - green color (temperature is good), orange color (temperature is higher than it should be) and red color (temperature is high). In the second row are interior humidity and the third row showing weight from the load cell.



### Conclusion

In this paper we had a close look about creating your own monitoring system. This monitoring system can be configured by user according to his requirements. Monitoring system can save many bee families so it's quite important to present this system for beekeepers. Every beekeeper can create his own monitoring system according to the instructions. For its low price, everyone can use this device.