Abstract

„Bee colony monitoring using IoT devices to detect bee life – threatening situations”

Bees are undoubtedly one of the most important creatures in the world – their contribution for the environment and food production is very important. Unfortunately, all over the world the decrease in bee populations has been noticed since 2007. Among many possible reasons *varroosis* – an illness caused by *Varroa Destructor Mite* is mentioned. It affects bees health condition, makes them weaker and leads to shortening of bees' lives. When early detected, it can be eliminated from a bee colony and preserve multiple bee families from disease and death. The dissertation describes an IoT device based on NVidia Jetson Nano computer that is capable of detecting bees' objects in the film frames gathered from camera (which is a part of the device) and analyzing these objects in terms of presence of Varroa Destructor Mite on bee body in real time. The processes of bee and Varroa Destructor Mite detection are performed on-edge with the use of convolutional neural networks models based on Single Shot Detector method. The implementation of adaptive algorithm that computes the region (density window) of analyzed frame with the biggest density of bees was prepared. Based on that region the further processes (bee and Varroa Destructor detections) are performed. This approach leads to faster processing and enables the analysis of more film frames. Once Varroa Destructor is detected on the bee body, such information is send do Amazon AWS cloud, where the services responsible for sending e-mail notification to beekeeper are activated.

The dissertation describes (in the order listed in the table of contents): basic information about beekeeping, depopulation of bee colonies, Varroa Destructor Mite and varroosis; the technical background for the dissertation; the *state – of – the -art* analysis; the architecture of implemented IoT system that enables detection of life – threatening situations within bee colony, the algorithms and convolutional neural networks models used for the system; the obtained results regarding the quality of both detection processes (measured in metrics such as precision, accuracy, sensitivity etc.), an analysis of the output of an adaptive algorithm that calculates the bee density window; the time performance of all operations performed on edge device. Finally, the comparison of the proposed device and other systems described in related works was made.