Optical high-resolution camera system with computer vision software for recognizing pests, fruits on trees, growth of crops.

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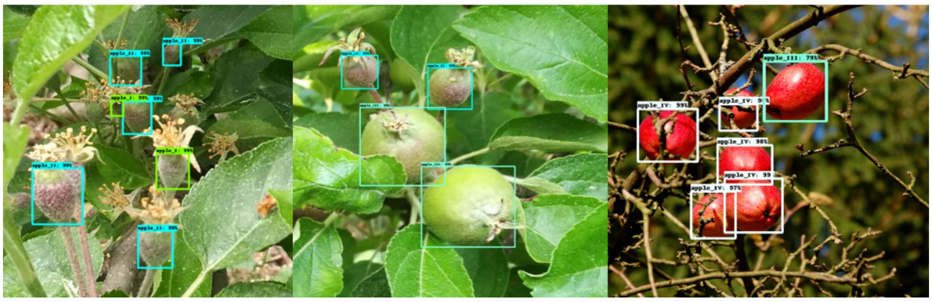
Introduction

Chemical protection agents and fertilizers are indispensable for modern agriculture and necessary for maintaining the current population density. When fertilizers and chemical protection agents are overused, this means more pollution of our nature and subsequently depletion of entire ecosystem. Knowing the field circumstances and pest pressure at every moment, will help to select the optimal moment to spray and fertilize and quantity of chemical protection agents and fertilizer. With the inspiration of helping the farmer to grow his crop in the optimal and most healthy way, Pessl Instruments GmbH, from Weiz, Austria, developed optical high-resolution camera system, together with a computer vision software which is able to recognize pets, fruits on trees and growth of crop from the photo. Pessl Instruments develops decision support system which is consisting from remote monitoring of insect traps and remote monitoring of fields and crops. Optical high-resolution camera system can be installed on the field, to remotely monitor fields and crops, or it can be embedded inside insect trap, to remotely monitor insect pressure at field. Pessl Instruments provides different variations of insect traps, to cover a broad specter of insect species. All of the photos and data from computer vision software is displayed online, on a web portal called ng.fieldclimate.com.

Methods

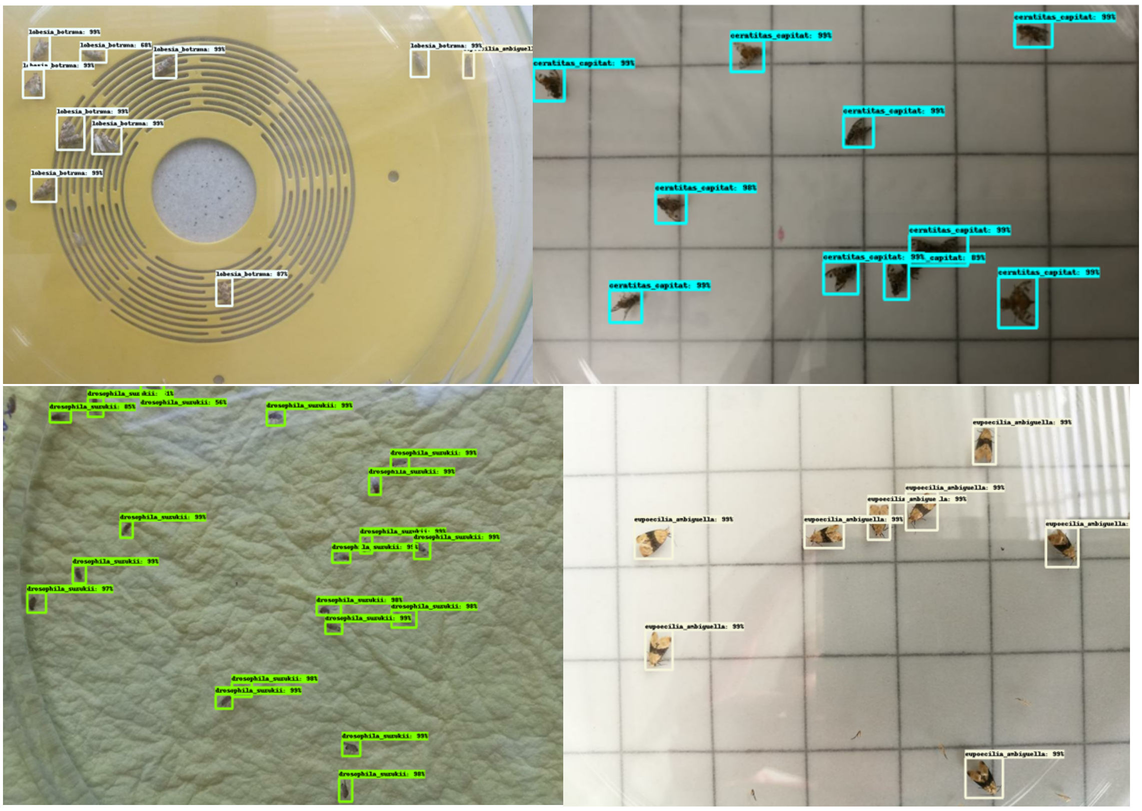
For automatic recognition of objects from the photos, a computer vision software is used, which is based on deep learning methods. A subset of machine learning algorithms is used, which uses deep artificial neural networks as models and does not require future engineering. To successfully train algorithms for fruit recognition, acquisition of 1620 photos of apples in different phenological stages (other crops will follow) was made. In the next step 6899 manual annotations were made and they were divided them in 4 phenological stages.

Figure 1: Apple recognition in four different phenological stages



For pest recognition 2472 photos was acquired from 8 different species (Lobesia Botrana, Ceratitas Capitata, Drosophila Suzukii, Halyomorpha Halys, Diabrotica Vergifera, Helicoverpa Armigera, Eupoecilia Ambiguella, Bactocera Oleae) and 18042 manual annotations (other pests will follow) were made.

Figure 2: Insect recognition in different circumstances, for eight different pest.



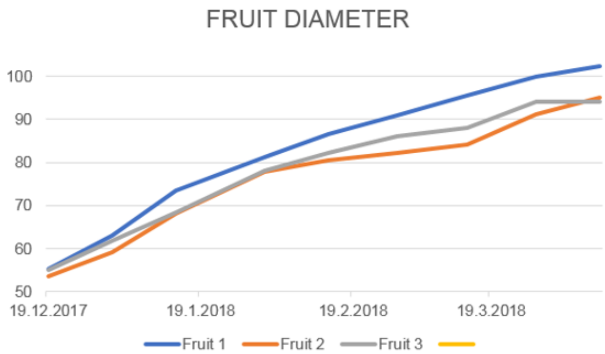
For running the computer vision software, special production server with three GPUs and two CPUs is used. With this configuration a full training process for the automatic recognition algorithm with 200.000 steps takes 2.1 days. Several stations were conducted world widely and trials were made.

OUTLOOK

Device here presented is effective on its own, but it excels when data of pest pressure and growth of crops are brought in correlation with environmental (climatic parameters) and soil data (soil nutrients) and thus allowing better yield prediction, better integrated pest management and lower resource requirements. Along with other recent developments in digital farming and big data processing, the overall picture of optimizing the use of resources, thus producing more with less, will become clearer. In order to achieve these goals, we will develop tools, based on data derived from photos taken with our devices and manipulated with our computer vision software. These tools will be warning application for insect pressure, yield prognosis model for apples and thinning recommendation model for apples (based on measured diameter of apple fruits).

Figure 3: Apple fruit diameter measurements

Figure 4: Apple fruit chart of diameter measurements, showing the growth of fruit



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Photos: own material.

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