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*Universitatea de Științe Agricole și Medicină Veterinară Cluj-Napoca*

**Calea Mănăstur, nr.3, 400372 Cluj-Napoca**

Tel. 0264-596384

Fax. 0264-593792

E-mail: eap@usamvcluj.ro

## **Geometric contrast feature for automatic visual counting of honeybee brood capped cells**

Pedro João Rodrigues, Cátia Neves and M. Alice Pinto

School of Technology and Management, Polytechnic Institute of Bragança, Campus de Santa Apolónia, Apartado 1172, 5301-855 Bragança, Portugal

**E-mail:** pjsr@ipb.pt

Assessment of honey bee colony strength by measuring adults or broodis often required for ecological studies. The brood has typically been estimated through a subjective mode (Lieberfeldermethod), although it can also be objectively determined by counting (manually or automatically) the brood cells (capped or uncapped) from digital images. The manual counting of capped cells is highly prone to errors and a time-consuming and tedious task. An automatic way to accomplish that task allows reducing those drawbacks. The main challenge for developing an automatic method is, however, the presence of intraclass color variation; it is not possible to make a reliable detection based just on the pixel color presented by the capped cells. While several researchers are using the Hough transform to solve that problem, at certain light, noise, and surface conditions the automatic detection fails. After carefully observing capped cell regions of several combs, we identified a set of geometrical relations that could be used to build a consistent contrast feature. That feature is the key to detect the capped cells with a high accuracy in our work. A functional optimizer is performing a searching on the image looking for the locations that maximize the contrast on that feature. Our experimental results are showing a good detection rate (over 96%), despite the wide intraclass color variation.

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