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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 typicallybeen estimatedthrough 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 cellsis highlyprone 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 intraclasscolor 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 certainlight, 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 couldbe used to build a consistent contrast feature. That feature is the key to detect the capped cells with a high accuracy in our work. Afunctional optimizer is performing a searching on the imagelooking for the locations that maximize the contrast on that feature. Ourexperimental results are showing a good detection rate (over 96%), despite thewide intraclasscolor variation.