Algorithms for identification of imaging sensors

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ABSTRACT

This dissertation deals with the identification of imaging sensors based on the analysis of materials derived from them, i.e. images (photos). The considered devices are digital cameras (single lens reflex, mirrorless cameras, compact cameras, as well as mobile devices such as smartphones or tablets) and flatbed scanners.

Identification of digital cameras based on photographs is considered in two aspects: *individual source camera identification* (ISCI) and *source camera model identification* (SCMI). Identification in the ISCI aspect distinguishes all considered cameras, including individual copies of the same model (e.g. Canon EOS RP (0), Canon EOS RP (1), Canon EOS RP (2), ...). Source camera model identification distinguishes a specific digital camera model from other models, but does not distinguish a specific camera copy among other copies of the same model (e.g. Canon EOS RP, Nikon Z7, Sony A1).

The analysis of the literature revealed that the main emphasis is placed on the effective identification of imaging sensors with the highest possible probability. However, there is a small number of works whose attention (apart from the efficiency of classification) is also focused on the speed of operation of the proposed algorithms. Thus, it is a motivation to conduct research in this direction.

In this dissertation, algorithms for identification of imaging sensors were proposed. Their aim is to achieve identification efficiency at a comparable level as in the case of algorithms from the literature, but in a noticeably shorter time. A number of identification algorithms have been proposed that were tested in the ISCI aspect. Their analysis have shown that it is possible to achieve a similar (or slightly lower) identification efficiency in comparison to algorithms from the literature, simultaneously getting shorter image processing time. A number of classification experiments involving approximately 14 000 images from more than 100 devices were conducted and confirmed the effectiveness of the proposed methods. The learning time of the algorithms was analyzed, and the obtained results clearly confirmed the advantage of the proposed algorithms over methods from the

literature. An extensive statistical analysis of the obtained results was carried out, which also confirmed the effectiveness of the proposed methods.

An additional contribution of the dissertation is the proposal of an image set called IMAGINE, used to test identification algorithms. In contrary to the existing Dresden Image Database, the proposed set includes images from a range of modern imaging devices equipped with CMOS (Complementary Metal-Oxide-Semiconductor) sensors. In addition, the dissertation also presents experiments of the robustness of identification algorithms based on the analysis of photos subjected to noise operations.

Keywords: digital camera, imaging sensor, fingerprint, security, digital forensics, device identification