Chapter 6
Informational Model of Optical Signals and Images in Machine Vision Systems

Oleksandr Ryazantsev
Volodymyr Dahl East Ukrainian National University, Ukraine

Ganna Khoroshun
Volodymyr Dahl East Ukrainian National University, Ukraine

Andrii Riazantsev
Volodymyr Dahl East Ukrainian National University, Ukraine

Tatyana Strelkova
Kharkiv National University of Radio Electronics, Ukraine

ABSTRACT

The rapid development and use of optical systems in measurement, navigation, and space technology to obtain accurate and detailed information about an object of observation is accompanied by the problems of transmitting high quality information through the optical system and processing of the obtained data. Integration of artificial intelligence systems in industry requires the creation and improvement of objective assessment and self-assessment systems. This is especially designed for automated recognition and classification systems. The problem of the object movement registration also contains some peculiarities such as background and main signal separation, noise influence and main objects selecting. Information about data quality is a set of properties that reflects the degree of suitability of specific information. It contains the data about objects and their relationship to achieve the goals of user requirements.

The chapter is focused on a wide class of problems associated with signal propagation through optical systems and material media, including an interaction of a laser radiation with the environment. The employment of Machine Vision Systems (MVSs) (Sinha, 2012; Sergiyenko et al., 2020; Flores-Fuentes et al., 2020) for acquisition, inspection, evaluation, and processing of optical images offers a great solu-

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tion providing the highest accuracy of measurements and reliability of the data obtained. The MVS is a useful tool for independent laboratories and laboratories owned by research institutes and universities. It is considered such topic as the design of optical setup for direct measurements of laser light features and the parameters of micro objects in the reflected light. The software fabrication for micro particles is represented; hardware for optical elements managing is discussed. The implementation of the model of service rendering in using optical laboratory in the conditions of individual needs of the customer is analyzed through the chapter. Also, the ways of the future development of MVSs is considered with application in different areas of science and technology, such as encryption (Alfalou & Brosseau, 2009), holography (Nehmetallah & Banerjee, 2012; Testorf & Lohmann, 2008), identification and tracking (Alfalou & Brosseau, 2010; Alfalou & Brosseau, 2013; Rosen et al., 2009).

The Machine Vision System represents a complete toolbox for solving the automated vision problems and can be considered wider than the automated optical information systems described earlier (Riazantsev et al., 2019). The MVS (Figure 1) contains the optical source which is a laser or an incoherent light source, or represents a combination of several sources; optical elements, including lenses, filters and spatial light modulator for the formation of the required light-field pattern and intensity; a CCD or CMOS camera for acquisition and conversion of optical radiation into electrical signals; a PC for the data visualization; a software for data processing and analyzing; a protocol suite with algorithms what to do for the software and hardware with a final decision of conceptual framework of the system's operation. Actually, the MVS is an adaptive system with feedback due to which the iterative improvement of the signal processing can be realized. The quality of the image experiences the influence of fluctuations, instabilities, and the system aberrations which makes the accuracy of measurements not higher than 10%.

Figure 1. A general structure of the Machine Vision System for optical research realization