UNCONVENTIONAL INDUSTRIAL MEASUREMENT APPLICATIONS WITH IMAGE PROCESSING

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Abstract

Image analysis for unconventional applications in the industrial and non-industrial fields is currently a plausible alternative to conventional measurement techniques that can often be too expensive, time-consuming or even need highly qualified staff. The use of machine vision systems for extracting measurements from images is well known and has deep roots and numerous applications. It is fundamental for many industrial and scientific purposes, including objects localisation and tracking, human-machine interaction, quality control and more. Thanks to the progress of computer and electronic technologies, sensors, and research in computer vision, image processing and acquisition systems, it is now possible to make the most of devices with reduced dimensions and costs to analyse the quality of products, processes, or processes tools. The advent of Industry 4.0 and IoT paradigms have further encouraged the development and use of machine vision-based technologies for both direct applications of vision systems and indirect applications.

Vision Systems play an increasingly important and central role in industry and more; they supplant the human being and support him in carrying out repetitive activities or those activities for which the request for attention or sensitivity on the part of man is not always and constantly assured. The vision systems have undergone a remarkable evolution thanks not only to the technological increase, research and the decrease of the components' cost, both sensors and elaboration systems but above all, thanks to the continuous request of better performances in the existing applications or innovative uses. Today there are more and more examples of the use of vision systems for applications for which there are no instruments able to extract the desired information, or the use of such instruments would be too expensive or difficult to apply. It is possible to find examples of this kind of use everywhere: face recognition in crime prevention and security or contexts related to shopping or tourism. The present work mainly addresses the last type of applications where vision systems are an alternative and sometimes unconventional way to fulfil a specific objective. Starting from the first chapter with a round-up of applications of machine vision systems in industry and technology, both in terms of software and hardware, which allows the use of images as a raw source of information, three different application cases will be presented.

The first application case presented is related to an industrial application in which image processing allows to identify the state of wear of a traditional drilling tool but that in some industrial realities, such as aeronautics, becomes a crucial point for maintaining the quality of production. The literature reports examples of this type of analysis applied to small diameter tools, PCB drilling, or tools of considerable size for machine tools and heavy machining. In both contexts, the classical solutions often require complex alignment systems, both motorised and non-motorised, or high-cost lighting techniques based on polarised light. The proposed solution solves these two problems with a low cost and easy to use the system while managing to guarantee acceptable results. Another alternative use

of artificial vision techniques can be seen in analysing drinking water leaks, a vital problem already dealt with in different ways and presented in the second chapter. The application of a device capable of taking images to the dial of a standard analogue water meter makes this device designed and used by water companies a valuable tool in detecting water leaks at the level of domestic users. The results obtained using the correlation technique on consecutive images allow discriminating the presence of water leaks from the ordinary conditions of use of the system for domestic applications. In this case, image processing, assisted by the availability of low-cost and high-performance acquisition and processing devices, generates a valuable and unconventional tool for a widespread problem. The last application case presented in the fourth chapter is the use of image analysis to determine the colour and the pH value of beer for the growing microbrewery industry where the cost of the equipment has a heavy impact, and the use of low-cost instrumentation but still able to ensure high-performance performance is essential. In this context, image analysis can be applied on pH test strips or reduced to analysing a specific spectrum of visible light captured through a photodiode and using signal analysis. The two applications show two different uses and methods of colour analysis in the beverage and food industry.