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Image Processing for Machine Vision Applications

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Declaration

I hereby declare that, the contents and organization of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

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Image Processing for Machine Vision Applications

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Images are a vital part of our everyday life and Image Processing is the heart of all the modern technologies, including machine vision, artificial intelligence, robotics, deep learning. It would not be wrong to say that image processing is one of the many reasons for achieving success in any industrial domain, whether it be medical, food, textile, or any other automation industry. It is next to impossible to work in these domains without having sufficient knowledge and skills about image processing techniques.

In this thesis document you will find the significance of image processing used in three diverse projects. Each one of the projects is described as a separate chapter in this document.

The first project is focused on reducing the power consumption in OLED-based devices. Actually there are two main goals of this project, first one, as the name suggests, is to minimize the power consumed by an OLED device to display images, and the second goal is to simultaneously enhance the color contrasts in images. OLED display panels have become increasingly popular in recent years, thanks to their numerous advantages over the traditional LCD displays. Power consumption in OLED displays depends on the contents where as the backlight is responsible for power consumption in LCD displays. This image-dependent or content-dependent power consumption model of OLED displays have encouraged numerous researchers to create possibilities for reducing the power consumption in OLED-based devices. One such possibility has been explored in this Ph.D. research work.

Another industrial application has been presented in the second part of the thesis document. It is a part of the "Food Digital Monitoring" project, funded by Regione Piemonte. The major aim of this project is to identify the healthy and contaminated hazelnuts by using fluorescence and spectral imaging techniques. Two types of contamination are discussed in this work, one, caused by bacterial and fungal infections, called "rotten hazelnuts" and the other caused by insect bites, known as "pest-infected hazelnuts". The idea is to illuminate the hazelnut samples under UV (ultraviolet) light using an axial illuminator setup. When the hazelnuts are illuminated with the UV light, its molecules get excited and as a result, they emit fluorescent light.

The amount of fluorescence depends on the quality of hazelnuts. The emitted light is captured in the form of images and then by applying some simple yet powerful image processing techniques, the healthy, rotten and pest-infected hazelnuts are classified into their respective classes.

The last part of the thesis is concerned with measuring the quality of built-in smartphone cameras. With the advancement in smartphone technology, the use of social networking applications have also raised significantly, and the increase in the social media has contributed towards the production of graphical contents in the form of images and videos. The core component for generating this type of data is camera. The latest phones are introducing more advanced features for their built-in cameras. The manufacturers are making efforts to enhance the quality of the smartphone cameras. If we see the technical specifications manual provided by the manufacturers, we will find a great deal of technical parameters under the camera section, for example, image resolution, sensor size, aperture size, focal length, zooming factor, pixel size, etc. Although these are the perfect quantities to define the quality of camera but they are irrelevant for a non-technical person who wants to compare the quality of different mobile phone cameras but is unaware of the technical aspects of photography. It is proposed that along with the technical specifications, the manufacturers should include one additional parameter to represent the quality of their phone camera with a numerical value. As a part of this project, we have developed a mobile application to compute the quality of smartphone cameras numerically by means of Modulation Transfer Function (MTF).

Overall, this research work has provided a great opportunity to me to enhance my knowledge and skills in the area of image processing by working in different application domains. Working on different projects have enabled me to explore different dimensions to further research topics and areas.