

Preface

Humans receive the great majority of information about their environment through sight, and at least 50% of the human brain is dedicated to vision. Vision is also a key component for building artificial systems that can perceive and understand their environment. Computer vision is likely to change society in many ways; for example, it will improve the safety and security of people, it will help blind people see, and it will make human-computer interaction more natural. With computer vision it is possible to provide machines with an ability to understand their surroundings, control the quality of products in industrial processes, help diagnose diseases in medicine, recognize humans and their actions, and search for information from databases using image or video content.

Texture is an important characteristic of many types of images. It can be seen in images ranging from multispectral remotely sensed data to microscopic images. A textured area in an image can be characterized by a nonuniform or varying spatial distribution of intensity or color. The variation reflects some changes in the scene being imaged. For example, an image of mountainous terrain appears textured. In outdoor images, trees, bushes, grass, sky, lakes, roads, buildings etc. appear as different types of texture. The specific structure of the texture depends on the surface topography and albedo, the illumination of the surface, and the position and frequency response of the viewer. An X-ray of diseased tissue may appear textured due to the different absorption coefficients of healthy and diseased cells within the tissue.

Texture can play a key role in a wide variety of applications of computer vision. The traditional areas of application considered for texture analysis include biomedical image analysis, industrial inspection, analysis of satellite or aerial imagery, document image analysis, and texture synthesis for computer graphics or animation.

Texture analysis has been a topic of intensive research since the 1960s, and a wide variety of techniques for discriminating textures have been proposed. Most of the proposed methods have not been, however, capable to perform well enough for real-world textures and are computationally too complex to meet the real-time requirements of many applications. In recent years, very discriminative and computationally efficient local texture descriptors have been developed, such as local binary

patterns (LBP), which has led to a significant progress in applying texture methods to various computer vision problems. The focus of the research has broadened from 2D textures to 3D textures and spatiotemporal (dynamic) textures.

With this progress the emerging application areas of texture analysis will also cover such modern fields as face analysis and biometrics, object recognition, motion analysis, recognition of actions, content-based retrieval from image or video databases, and visual speech recognition. This book provides an excellent overview how texture methods can be used for solving these kinds of problems, as well as more traditional applications. Especially the use of LBP in biomedical applications and biometric recognition systems has grown rapidly in recent years.

The local binary pattern (LBP) is a simple yet very efficient operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. The LBP method can be seen as a unifying approach to the traditionally divergent statistical and structural models of texture analysis. Perhaps the most important property of the LBP operator in real-world applications is its invariance against monotonic gray level changes caused, for example, by illumination variations. Another equally important is its computational simplicity, which makes it possible to analyze images in challenging real-time settings. LBP is also very flexible: it can be easily adapted to different types of problems and used together with other image descriptors.

The book is divided into five parts. Part I provides an introduction to the book contents and an in-depth description of the local binary pattern operator. A comprehensive survey of different variants of LBP is also presented. Part II deals with the analysis of still images using LBP operators. Applications in texture classification, segmentation, description of interest regions, content-based image retrieval and 3D recognition of textured surfaces are considered. The topic of Part III is motion analysis, with applications in dynamic texture recognition and segmentation, background modeling and detection of moving objects, and recognition of actions. Part IV deals with face analysis. The LBP operators are used for analyzing still images and image sequences. The specific application problem of visual speech recognition is presented in more detail. Finally, Part V provides an introduction to some related work by describing representative examples of using LBP in different applications, such as biometrics, visual inspection and biomedical applications, for example.

We would like to thank all co-authors of our LBP papers for their invaluable contributions to the contents of this book. First of all, special thanks to Timo Ojala and David Harwood who started LBP investigations in our group in fall 1992 during David Harwood's visit from the University of Maryland to Oulu. Since then Timo Ojala made many central contributions to LBP until 2002 when our very frequently cited paper was published in IEEE Transactions on Pattern Analysis and Machine Intelligence. Topi Mäenpää played also a very significant role in many developments of LBP. Other key contributors, in alphabetic order, include Jie Chen, Xiaoyi Feng, Yimo Guo, Chu He, Marko Heikkilä, Vili Kellokumpu, Stan Z. Li, Jiri Matas, Tomi Nurmela, Cordelia Schmid, Matti Taini, Valtteri Takala, and Markus Turtinen. We also thank the anonymous reviewers, whose constructive comments helped us improve the book.

Matlab and C codes of the basic LBP operators and some video demonstrations can be found from an accompanying website at www.cse.oulu.fi/MVG/LBP_Book. For a bibliography of LBP-related research and links to many papers, see www.cse.oulu.fi/MVG/LBP_Bibliography.

Oulu, Finland
Oulu, Finland
Oulu, Finland
Palo Alto, CA

Matti Pietikäinen
Abdenour Hadid
Guoying Zhao
Timo Ahonen



<http://www.springer.com/978-0-85729-747-1>

Computer Vision Using Local Binary Patterns
Pietikäinen, M.; Hadid, A.; Zhao, G.; Ahonen, T.
2011, XVI, 212 p., Hardcover
ISBN: 978-0-85729-747-1