

# Preface

As the resolution of satellite images increased, more detailed analysis on them became possible. On the other hand, the time required to manually analyze them became prohibitive. Hence, the need for automated systems for such analysis tasks emerged. This book is about such an end-to-end image analysis system to understand land development from satellite images. Our focus is on residential regions. The main building blocks of the proposed system are as follows.

We benefit from vegetation and shadow–water indices in summarizing the multispectral information in the proposed system. Vegetation indices have been used extensively to estimate the vegetation density from satellite and airborne images for many years. We focus on the normalized difference vegetation index (*NDVI*) and introduce a statistical framework to analyze and extend it. Using the established statistical framework, we introduce new a group of shadow–water indices. We use these as the source of multispectral information in land use classification and house and street network detection in residential regions.

Next, we introduce a set of measures based on straight lines to assess land development levels in high resolution satellite images. Urban areas exhibit a preponderance of straight line features. Rural areas produce line structures in more random spatial arrangements. We use this observation to perform an initial triage on the image to restrict the attention of subsequent, more computationally intensive analyses. We then extend our straight line based measures by developing a synergistic approach that combines structural and multispectral information. In particular, the structural features serve as cue regions for multispectral features.

After the initial classification of regions, we introduce computationally more expensive but more precise graph-theoretical measures over panchromatic images to detect residential regions. The graphs are constructed using straight lines as vertices, while graph edges encode their spatial relationships. We introduce a set of measures based on various properties of the graph. These measures are monotonic with increasing structure (organization) in the image. We present a theoretical basis for the measures. In a similar manner, we developed a novel method using feature based grouping to detect residential regions.

Having detected the residential regions, we introduce a novel subsystem to detect houses and street networks in these. This system is composed of four main blocks:

detecting possible house and street pixels by the help of multispectral information; grouping these candidate pixels using a variant of k-means clustering; decomposing the clustering results by a novel balloon algorithm; and finally, representing the balloons in a graph formalism to detect houses and the street network.

We statistically evaluated the performance of the proposed system step by step and obtained very promising results. Especially, the performance in house and street network detection in residential regions is noteworthy. These results indicate the functionality of our satellite image understanding system.

The brief summary above indicates that this book may be useful for both remote sensing and computer vision communities. For the remote sensing community, it proposes a novel end-to-end system to analyze multispectral satellite images. Hence, it may be counted as one of the pioneering works for future automated satellite and aerial image understanding systems. For the computer vision community, the book emphasizes that many new and fruitful research problems are waiting to be solved. For both communities, the book clearly shows that more collaboration between both disciplines is mandatory for developing techniques to improve human life.

Istanbul, Turkey  
Troy, NY, USA

Cem Ünsalan  
Kim L. Boyer



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Unsalan, C.; Boyer, K.L.

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