Preface

One of the greatest inventions of all times is *camera*, a device for capturing images of the world. Computer vision emerged as the scientific field of understanding the images that cameras produce. Another influential invention of modern technology is *positioning systems*, instruments (namely GPS) for identifying one's location. Even though these two devices are often viewed as belonging to completely different realms, their products (images and locations) have a close relationship. For instance, by just looking at an image, one can sometimes guess its location, e.g., when a rain forest is in view or looking at Eiffel Tower. The opposite is also often true: knowing the location of an image can provide a rich context and significantly assist the process of understanding the visual content. The goal of this book is to explore this bidirectional relationship between images and locations.

In this book, we provide a comprehensive map of the state of the art in large scale visual geo-localization and discuss the emerging trends in this area. Visual geo-localization is defined as the problem of identifying the location of the camera that captured an image and/or the content of the image. Geo-localization finds numerous applications in organizing photo collections, law enforcement, or statistical analysis of commercial market trends.

The book is divided into four main parts: Data-Driven Geo-localization, Semantic Geo-localization, Geometric Matching based Geo-localization, and Real-World Applications. The first part (Data-Driven Geo-localization) discusses recent methods that exploit internet-scale image databases for devising geographically rich features and geo-localizing query images at a city, country, or global scale. The second part (Semantic Geo-localization) presents geo-localization techniques that are built upon high-level and semantic cues. The third part (Geometric Matching based Geo-localization) focuses on the methods that perform localization by geometrically aligning the query image against a 3D model (namely digital elevation model or structure-from-motion reconstructed cities).

In the fourth part of the book (Real-World Applications), methods that use the geo-location of the image, whether extracted automatically or acquired from a GPS-chip, for understanding the image content are presented. Such frameworks are

of great importance as cell phones and cameras are now being equipped with built-in localization devices. Therefore, it is of particular interest to develop techniques that accomplish image analysis *assisted by geo-location*. We also discuss several approaches for geo-localization under more practical settings, e.g., when the supervision of an expert in the form of a user-in-the-loop system is available.

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