

Chapter XXXV

Use of Remotely Sensed Imagery in Cyber Warfare and Cyber Counterterrorism

Gang Gong

Sam Houston State University, USA

Mark R. Leipnik

Sam Houston State University, USA

ABSTRACT

Remote sensing refers to the acquisition of information at a distance. More specifically, it has come to mean using aerial photographs or sensors on satellites to gather data about features on the surface of the earth. In this article, remote sensing and related concepts are defined and the methods used in gathering and processing remotely sensed imagery are discussed. The evolution of remote sensing, generic applications and major sources of remotely sensed imagery and programs used in processing and analyzing remotely sensed imagery are presented. Then the application of remote sensing in warfare and counterterrorism is discussed in general terms with a number of specific examples of successes and failures in this particular area. Next, the potential for misuse of the increasing amount of high resolution imagery available over the Internet is discussed along with prudent countermeasures to potential abuses of this data. Finally, future trends with respect to this rapidly evolving technology are included.

INTRODUCTION: DEFINITION AND HISTORY

Numerous definitions of remote sensing have been proposed. For example: “Remote sensing is the acquiring of data about an object without touching it” (Fussell et al., 1986), and “Remote sensing is the collection and interpretation of information about

an object without being in physical contact with the object” (Weissel, 1990). Other definitions are more focused and precise:

Remote sensing is the non-contact recording of information from the ultraviolet, visible, infrared, and microwave regions of the electromagnetic spectrum by means of instruments such as cameras, scanners, lasers,

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linear arrays, and/or area arrays locates on platforms such as aircraft or spacecraft, and the analysis of acquired information by means of visual and digital image processing. (Jensen, 2000, p. 4)

Remote sensing is formally defined by the American Society for Photogrammetry and Remote Sensing (ASPRS) as: “The measurement or acquisition of information of some property of an object or phenomenon, by a recording device that is not in physical or intimate contact with the object or phenomenon under study” (Colwell, 1983, p. 23). Then in 1988, ASPRS adopted a combined definition of photogrammetry and remote sensing:

Photogrammetry and remote sensing are the art, science, and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from non-contact sensor systems. (Colwell, 1997, pp. 33-48)

The history of remote sensing has extended back to the early days of photography, but the field received a major impetus during both world wars, when very extensive use was made of aerial photography taken from aircraft for reconnaissance. The science of aerial photography interpretation developed to systematize the detection of features from high-altitude aerial photography. Remote sensing received another boost during the Cold War, as instruments were developed to obtain digital high resolution images from satellites flying above the earth’s atmosphere (Goodchild, Pratt, & Watts, 2000). It was then that the term *remote sensing* was coined by the Office of Naval Research, Geography Branch (Pruitt, 1979). Instruments other than cameras (e.g., scanners, radiometers), are now often deployed and imagery has expanded into the regions of the electromagnetic spectrum beyond the visible and near-infrared regions (e.g., thermal infrared, microwave). In the 1990s the field was further fuelled by launch of a series of satellite-borne remote sensing systems by NASA, the Earth Observing System (EOS),

the French SPOT series of satellites and of commercial high resolution earth-orbiting systems like IKONOS and QUICKBIRD (www.earth.nasa.gov).

STRUCTURE OF REMOTE SENSING

Modern remote sensing uses digital instruments attached to satellites or aircraft. Passive remote sensing systems record electromagnetic energy that is reflected from the surface of the earth, while active systems generate their own electromagnetic energy and measure the proportion reflected. Light Detection and Ranging (LIDAR) is one widely used active remote sensing system, it uses lasers to measure distances to reflecting surfaces, usually the ground. The radiation detected in a small area known as the instantaneous field of view (IFOV) is integrated, and recorded. A complete image is assembled as a two-dimensional array of pixels. Scientists have made significant advances in digital image processing of remotely sensed data for scientific visualization and hypothesis testing (Jensen, 2000). The major digital image processing techniques include image enhancement and correction, image classification, pattern recognition, and hyperspectral data analysis.

GENERIC APPLICATIONS OF REMOTE SENSING

There are two broad types of applications; some systems are designed to provide data that can be treated as measurements of some variable which is then analyzed such as the “Ozone Hole” over Antarctica. More often, systems are used primarily for mapping, in which case the image is used to identify and locate various types of features on the earth’s surface, such as vegetation, crops, roads, buildings, or geological features (Goodchild, Pratt, & Watts, 2000). Remote sensing systems are widely used today in many areas including intelligence gathering, weather forecasting, crop yield estimation, land use and land cover change detection, hazard monitoring, and occasionally, for

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