Chapter 50
SiRCub, A Novel Approach to Recognize Agricultural Crops Using Supervised Classification

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ABSTRACT

This paper presents a new approach to deal with agricultural crop recognition using SVM (Support Vector Machine), applied to time series of NDVI images. The presented method can be divided into two steps. First, the Timesat software package is used to extract a set of crop features from the NDVI time series. These features serve as descriptors that characterize each NDVI vegetation curve, i.e., the period comprised between sowing and harvesting dates. Then, it is used an SVM to learn the patterns that define each type of crop, and create a crop model that allows classifying new series. The authors present a set of experiments that show the effectiveness of this technique. They evaluated their algorithm with a collection of more than 3000 time series from the Brazilian State of Mato Grosso spanning 4 years (2009-2013). Such time series were annotated in the field by specialists from Embrapa (Brazilian Agricultural Research Corporation). This methodology is generic, and can be adapted to distinct regions and crop profiles.

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INTRODUCTION

Land Use/Land Cover (LULC) maps are necessary in a wide range of applications, from environmental modeling and monitoring to natural resource management and policy development (Wardlow & Egbert, 2008). In particular, they are a major need to assist the research on climate change and global warming (Cihlar, 2000). Remote sensing technology has largely demonstrated its effectiveness in the role of identifying different land cover thematic classes (Lunetta, Johnson, Lyon, & Crotwell, 2004). Specifically, Wardlow, Egbert, and Kastens (2007) showed the capability of the two main MODIS (Moderate-resolution Imaging Spectroradiometer) vegetation indexes –NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index)– to distinguish among different classes. Remote sensing data have progressively improved their resolution and accuracy. In conjunction, new classification methods have appeared, promoting progress in LULC mapping (Defries & Belward, 2000). However, most of the existing LULC mapping proposals have focused on the recognition of natural-related land cover types (e.g., forest, grassland, shrubland), and classify cropland areas in just a single general class (Wardlow & Egbert, 2008). Few automated mapping efforts have attempted to identify different specific crop types (e.g., alfalfa, corn, sorghum, cotton) and associated land management practices (single/double crop, fallow, irrigated/non-irrigated) (Craig, 2001).

In Brazil, monitoring the dynamics of the agricultural lands is a strategic issue for the country, since agribusiness represents approximately 25% of the Brazilian GDP. Furthermore, such dynamics strongly affect issues related to the composition of the national agricultural production, the direct and indirect impacts on the environment, the social and human development, and the formulation and execution of public policies. The cropping season in Brazil presents regional variations due the continental extension of the country and the climate differences. The State of Mato Grosso, focus of our case study, is the most important grain producer in Brazil. Its cropping season may include one or two production cycles, depending on the level of agricultural intensification. The main cultivated crops in this state are soybean, corn, and cotton. Timely information about cropping areas is important for Government and producers, mainly to support agricultural production forecasting systems. Official forecasting statistics combine subjective and objective issues. Examples of the former include interviews with producers, information from agricultural commercialization (e.g., seeds, machinery, pesticides), and field surveys on a sampling basis. Remote sensing and geoprocessing techniques are being used to develop objective methodologies for crop mapping and monitoring.

The classical approach to LULC mapping considered the use of a wide set of methods applied to a single image, exploring the spectral behavior of the land surface. In contrast, the spectro-temporal approach, based on time series of vegetation indices extracted from images, has been pointed out by various specialist groups as the most appropriate to monitor and map agricultural crops (Brown, Kastens, Coutinho, de Castro Victoria, & Bishop, 2013; Jakubauskas, Legates, & Kastens, 2002; Wardlow et al., 2007). This approach explores the high temporal resolution of orbital sensors such as MODIS, aboard the Terra and Aqua satellites, to evaluate the biomass condition of the crops throughout phenological cycles. This kind of temporal analysis does not consider the spectral images independently, but it is used to interpret and characterize the behavior of pixels along a time series, emphasizing spectral variations. Besides minimizing problems such as cloud occurrence or variations of atmospheric nature, it is possible to monitor the dynamics of vegetation in specific temporal scales, and apply this information to