Monitoring the Land Use, Land Cover Changes of Roorkee Region (Uttarakhand, India) Using Machine Learning Techniques

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ABSTRACT

Satellite images play an important role for capturing Earth's surface. Using satellite images land cover monitoring could be done through which the modification or changes on land surface could be identified. Comparison can be made on the basis of past satellite image analysis, which helps to identify the changes that are occurring or have already occurred. Although there exist many techniques for land cover monitoring, proper land cover identification and detection of changes on the land cover is still a challenge. In the recent years, machine learning techniques have been utilized in distinct areas of image analysis and resulted in positive outcomes. Hence, in this paper, four supervised machine learning algorithms (i.e., support vector machine [SVM]), neural network [NN], maximum likelihood [MLC], and parallelepiped [PP] algorithms) have been utilized for land cover identification and detecting the amount of changes that have occurred in the individual land cover classes.

KEYWORDS

Agriculture Monitoring, Maximum Likelihood, Neural Network, Parallelepiped, Radar Images, Satellite Images, Support Vector Machine, Sustainability Development

1. INTRODUCTION

Urbanization is considered as a form of development. It is usually associated and resulted from modernization and industrialization, which is generally done for the benefit of the upliftment of the backward area or for the improvement of a particular region population. Although urbanization is

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regarded as advancement, it has many negative impacts also. Urbanization has led to environmental problems like, lack of fertile land for cultivation, scarcity of water etc. All these effects are not at all good for the upcoming generation as they will not get any type of healthy environment for their living. The increase in population is one of the main reasons of urbanization which results into construction of roads, decrease in the cultivation area and deforestation. In order to identify all these deterioration, the use of satellite images have played an important role. Satellite images have proved beneficial in monitoring the earth surface and in identifying the associated problems.

Satellite image classification has a crucial role in extraction of consecutive useful knowledge required for analysis of Earth's surface. Machine learning has played a major part in the field of satellite image classification and analysis. Since past decades, they have proved beneficial in identifying Earth's surface by their implementation on distinct bands and indices of satellite images. There are various machine learning based classifying techniques present like, Neural Network, Support Vector Machine, Maximum Likelihood, K-mean, Binary Encoding classification, Minimum Distance classification, Parallelepiped classification etc. Each of the machine learning technique has different working principle and significance. These techniques have been usually explored individually for satellite image analysis and have given satisfactory results. The work reporting the comparison and analysis between these techniques for performing land cover assessment and change analysis is still very less communicated.

Hence, the current research work focuses on applying four different machine learning methods: SVM, NN, MLC, and PP for satellite image interpretation. For performing the research, the Roorkee area of Uttarakhand (which comes under Devbhoomi-land of God) has been selected. Since last few decades this area has also observed a great enhance in urbanization. The research work also compares and analyse the result obtained by the application of the distinct learning techniques. The result obtained has been further utilized for identifying the class wise changes by applying the machine learning algorithms on a time series data. Hence, effort has been made to investigate the land use/ cover changes of Roorkee region, area which is in district Haridwar, to identified the rate or manner in which the land has been utilized and the changes that have been happened in the precedent two decades using machine learning techniques on a time series data.

The remaining article is structured as follows: The section 2 provides an overview of relevant work done by the various writers. Section 3 discusses the work's associated theory or methodology, as well as its benefits and drawbacks. Section 4 lists the data and materials that were utilised in this work. Section 5 presents the data preparation, identification of LULC change detection, result and accuracy evaluation, and change analysis with explanations. The work comes to a close with Section 6.

1.1 Contribution

Each of the machine learning technique has its own merits and demerits. These techniques have given their contribution in satellite image analysis in some or the other ways. Hence, for land cover identification and detecting the amount of changes that have occurred in the individual land cover classes, four supervised machine learning algorithms, namely: SVM, NN, MLC, and PP were analysed in this paper. These machine learning algorithms were applied on Landsat data of the Roorkee (Uttarakhand, India) area. The Satellite data from the years 2000 and 2017 were analysed to find changes using four machine learning algorithms on both years.

2. LITERATURE SURVEY

Land cover classification is considered as a significant application of satellite image analysis. Land cover classification implies the distinction of land surface into various classes like urban, water, bare soil, vegetation, etc. The commencement in the area of information technology and new-fangled satellites possessing good resolution (spatial, spectral, temporal and radiometric) leads to the progression and improvement in the land cover classification techniques. Many researchers in India and outside have worked on the identification of land cover using satellite images, such as Pooja *et*

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