CHAPTER 1

Introduction

The thesis contributes to the subject area of Remote Sensing and Geographic Information System. It is focused on the study and analysis of automated Cloud detection and removal of satellite imagery using the selection of thresholds value for various spectral tests in the perspective of RSGIS.

A significant obstacle of extracting information using satellite imagery is the presence of clouds. Removing these portions of image and then filling in the missing data is an important image editing task. Traditionally the objective is to cut the cloudy portions out from the frame and fill in the gaps with clear patches from similar images taken at different time. [1]

Remote sensing is providing opportunities in various branch of environmental research. The fields of application for multi-spectral remote sensing instruments in Earth observation are monitoring the forests, oceans or urban areas over agricultural applications to the extent of natural resources. A significant prerequisite for analysis of Earth observation data is the information that is free from external influences and disturbances [6, 7]. One possible cause of data loss is cloud cover of satellite imagery. Cloud cover is recognized as a significant loss of data and information quality by many scientific studies [8–12]. The existence of cloud covers the loss of meaningful data and information because they are a considerable source of uncertainty with regard to the application of any algorithm aiming for the retrieval of land surface [2].

All solar radiation used in satellite remote sensing must pass through the earth's atmosphere. During propagation, this radiation interacts with the atmosphere, generating a variety of effects upon the resulting satellite image that must subsequently be accounted for through atmospheric corrections. Some atmospheric effects, such as cloud, block almost all radiations in the visible and infrared spectral regions. Others partly obscure the ground-reflected radiation leaving an underlying ground information component in

contaminated form. ‘Haze’ is an example of this latter effect. Haze is a commonly used term in image analysis, referring to a set of atmospheric effects that reduce image contrast. [3]

There is a very limited research work in the field of cloud detection and cloud removal. It is very difficult to characterize and identify cloud; cloud detection algorithm must classify clouds and other entities that have similar appearance as clouds. The appearances of the entities in satellite imagery of the same cloud may differ from region to region. The clouds and snow are difficult to distinguish in polar region because all the entities are reflective in the visible wavelengths and demonstrate little contrast in the thermal infrared. Due to the typical features of cloud, it is required to analyze the satellite imagery in the perspective of remote sensing data process and an effective method needs to be developed for cloud detection and cloud removal.

1.1 Motivation

Many works related to Cloud detection and cloud removal in satellite imagery have been done in Remote Sensing and Geographic Information System (RSGIS). Several Cloud detection and cloud removal methods are developed by using different algorithms. For instance, Cloud removal from satellite imagery was developed using Auto associative neural network, Stationary wavelet transform method [1].

In the year 1988 Saunders and Kriebel developed a procedure for application to the High resolution picture resolution (HRPT) data. The basic concept of cloud detection was not different from multi-channel sea surface temperature (MCSST) method. Several common problems appear in both the methods such as, both the method use data from channel-3, although these data sometimes were affected due to excessive electronic interference, also a pixels is recognized as cloud free if and only if all the tests reveal the pixel not cloudy. However a number of cloud-free pixels may be sometimes misjudged as cloudy and thus a number of cloud-free pixels are probably lost [4].

In the year 1993 Masahisa Kubota developed a new cloud detection algorithm for nighttime AVHRR/HRPT data and applied to a large number of images from various

locations around Japan. The algorithm is characterized by a recovery function and the use of two-dimensional histogram. The result reveals that the new algorithm appears to be more successful compared to the previous algorithms.[5]

Therefore, there is a vital requirement to develop an automatic Cloud detection and cloud removal on satellite imagery in the perspective of RSGIS. With this motivation, we identify objectives of this thesis.

1.2 Objectives

The main objective of this research work is to solve the problem of missing information caused by cloud cover in satellite images. The primary objective of the thesis can be summarized as follows:

1) To study the different aspects of Remote sensing and geographic information system.
2) To study the different techniques currently used for detection of clouds.
3) To study the different techniques currently used for removal of clouds.
4) To study processes for filling out the missing information using brightness threshold approach.
5) To study some cloud detection and cloud removal approaches based on threshold value and their applications in geo-informatics.
6) To develop an automated cloud detection and removal algorithm that can process for large satellite imagery data.
7) Finally, to develop an automated cloud detection and removal for RSGIS.
8) Evaluate the results of the filling out missing information procedures.

1.3 Methodology

The methodology of this research work is stated as hereunder.

1) *Image selection*: The image of same area in 3 different time periods was selected. This is done in order to have a multi-temporal data set for the study area.

2) *Atmospheric corrections*: It is important to apply the atmospheric corrections to the multi-temporal data set.

3) *Geometric corrections*: It is applied to all the images of the multi-temporal data set, to determine the accuracy of the process. If the level of accuracy is not sufficient enough, it is necessary to select a principal image of the data set, then co-register the other images with respect to the principal image.

4) Pattern recognition approach in order to detect clouds in the satellite imagery.

5) Comparing the results of previous clouds detection and removal approaches with the proposed methods.

6) Performing an image fusion procedure using brightness threshold approach to fill out missing information caused by clouds in the satellite imagery.

7) Application matrix to calculate the accuracy of the clouds detection and removal in the satellite imagery.

1.4 Main Contributions

The main contributions of the thesis are:

1) Study and analysis of Remote Sensing and Geographic Information System in view of satellite imagery.
2) Study and analysis of various cloud detection algorithms and its computational approaches.
3) Study and analysis of various cloud removal algorithms and its computational approaches.
4) Development of an automated cloud detection algorithm using brightness threshold value.
5) Development of an automated cloud removal algorithm using image fusion technique.
6) Development of an automated cloud-free image from a number of clouded images

taken by satellite in different time intervals for the same location.

7) The development of automated cloud-free image to help the researchers working in the area of RSGIS.

1.5 Thesis Outline

Chapter 2: Principles of Remote Sensing: This chapter presents an overview of Remote sensing, its different paradigms. It also presents some applications of Remote Sensing in the field of earth observation.

Chapter 3: A Brief Overview on Geographic Information System: This chapter represents a brief description on operational details such as acquisition, and post processing options of various Ground based, Airborne and Satellite sensor systems. It also represents the systematic design and arrangement of software, people and procedures to manipulate, analyze, model and display the geographically referenced data for understanding, planning management and solving of complex problems in the various domains.

Chapter 4: Limitations of RS Data: This chapter describes the overall limitations of optical Remote Sensing data with special emphasis on cloud cover of satellite imagery.

Chapter 5: Computational Analysis of existing Cloud Detection Techniques: This chapter begins with the previous works related with cloud detection of satellite imagery. It also presents a discussion on some methods of cloud detection. Again this chapter discusses different algorithms of cloud detection and proposed a new cloud detection algorithm. Further, the chapter presents some experimental results.

Chapter 6: Computational Analysis of existing Cloud Removal Techniques: This chapter presents an overview of cloud removal. It then presents the existing cloud removal approaches and proposes a cloud removal algorithm. Further it presents some experimental results.

Chapter 7: Automated Cloud Detection and Removal of Satellite Imagery: This chapter presents the proposed cloud detection and removal algorithm. Further it presents some experimental results and comparison with the existing approaches.

Chapter 8: Result, Conclusion, Limitations and Future Scope: Finally, this chapter presents the conclusion. Summary of the works and contributions are outlined along with a discussion on scope for future research work in the field of RSGIS.