# INDIAN INSTITUTE OF INFORMATION TECHNOLOGY ALLAHABAD



A PROJECT REPORT ON

# SATELLITE IMAGE PROCESSING

# To Track Deforestation

# (SAID)

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**1. INTRODUCTION**

**1.1** **Introduction**

The use of remote sensing is becoming increasingly frequent in environmental studies. In the 1970s and 1980s satellite images were mostly used in simple interpretations or as a map background. In the past three decades satellite imagery has been used successfully for weather, geographical and geological applications.

Deforestation is one of the major contributors to global warming and climate change. **Global warming** is caused by an elevation in the green house gases that halo our planet. The effect of global warming is further exacerbated by deforestation because the removal of densely forested areas decreases the number of the CO2 consuming vegetation. Indirectly, deforestation disrupts the delicate balance between the carbon dioxide produced and consumed.

**1.2** **Motivation**

Deforestation has been defined as a ‘measurable sustained decrease in crown cover’ below a 10–30% threshold.

According to the World Resources Institute, more than 80 percent of the Earth’s natural forests already have been destroyed. Disregard or ignorance of intrinsic value, lack of ascribed value, lax forest management and deficient environmental laws are some of the factors that allow deforestation to occur on a large scale. Quantifying the damage and its possible consequences is an important task.

Satellite and airborne imagery alone can offer an efficient contribution to natural resource management.

**1.3 Goal**

Our deforestation tracking system should provide a solution to the Deforestation problem which is the seventh Millennium Development Goal of UN; our system shall deliver essential information to people in forest conservation of each country through satellite image comparisons.

**1.4 Project Scope**

The software will be a fully compact tool kit to forest conservation departments of each country.

It will facilitates its uses to track deforestation through satellite image processing and also the software will be equipped with tools to analyze data and provide critical information needed to combat deforestation. Our software will also be capable of delivering future deforestation probabilities based on previous deforestation patterns.

**2. SURVEY**

**2.1 Papers and Research**

Deforestation is typically assessed by quantifying the amount of area deforested, measured at the present time. From an environmental point of view, quantifying the damage and its possible consequences is a more important task, while conservation efforts are more focused on forested land protection and development of land-use alternatives to avoid continued deforestation.

Many Researches are ongoing to track the deforestation pattern and amount for analysis. Some of the related works are:

**2.1.1 Brazil**

Brazil has two systems for tracking deforestation: PRODES (Program to Calculate Deforestation in the Amazon) and DETER (Real-time Detection of Deforestation)

PRODES, which has a sensitivity of 6.5 hectares, provides Brazil’s annual deforestation estimates (measured each August) while DETER, which has a coarser resolution of 25 ha, is a year-round alert system that updates IBAMA, Brazil’s environmental protection agency, every two weeks.

**2.1.2 LANDSAT**

The Landsat Pathfinder project is demonstrating the use of Landsat data for global change research and monitoring the world's forest resources.

One of the five Pathfinder projects initiated by the U.S. National Aeronautics and Space Administration (NASA), Landsat Pathfinder is a first step toward establishing a global monitoring system using high-resolution satellite imagery. The imagery will be stored, managed and analyzed with a GIS.

**2.1.3 GOOGLE**

Google.org, Google's philanthropic arm, has announced a cloud-based method for analyzing deforestation around the world, in a much more up-to-date manner than previously.

Google has now cooperated with some researchers to produce an algorithm that will scan consecutive images of forests in order to detect areas that are being cut.

But this is still in the testing phase.

**3. PROPOSAL**

**3.1 Technical Details**

Two of the most important tools when working on this project work were the Interface which was Matlab and the images we required of a particular area over a time period.

**3.1.1 Satellite Images**

Satellite images of different spatial resolutions are commercially available. Images with high resolution data with ground pixel sizes of less than 5m provide detail information about the Earth’s surface and small objects, such as buildings, streets, and trees can be displayed in great details.

There are three types of remote sensing data:

* Optical
* Radar
* Aerial Photography

**Optical**

It can be of coarse(1km resolution), medium(30m resolution), high(4m resolution) resolution.

Optical Images have their own benefits like:-

* They are best for quick assessment.
* We have globally pre-processed landsat available.
* Its possible to track degradation.

Optical Images have their limitations as well like:-

* Smaller area is covered per image
* Cloud coverage is a problem
* It is Expensive to cover a whole region

The cost can vary fromFree to Moderate

**Radar**  
They are of 30m resolution.

Radar Images have their own benefits like:-

* Penetrates through cloud cover
* Existing data may be able to enhance other data options.

Radar Images have their limitations as well like:-

* Requires high level of expertise
* May not work well in mountainous region.

The cost can vary fromFree to Expensive

**Aerial Photography**

Resolution of 10cm to 1m.

Aerial Photography have their own benefits like:-

* Good for validation of forest Change and degradation.

Aerial Photography have their own benefits like:-

* Usually not large areas covered.
* Requires time and expertise.

They are ofModerate Cost

**3.1.2 MATLAB**

MATLAB (MATrix LABoratory) integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. MATLAB features a family of application-specific solutions called toolboxes.

Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, image processing and many others.

Image processing tool box has extensive functions for many operations for image restoration, enhancement and information extraction.

**3.2 Existing Algorithms**

To detect a change in forest cover (deforestation or forest degradation) with existing data, images are needed for two or more time periods. By overlaying the images and determining the differences between them, the change between the two dates can be determined.

This multi-temporal data set can then be classified to show loss of forest, degradation of forest and other changes.

The two major approaches used to assess deforestation over large scales are ‘wall-to-wall’ and sampling methods.

In wall-to-wall methods, images covering an entire country or region are analyzed. Sampling approaches use systematic sampling where a regularly spaced grid to identify plot locations across an entire region or random sampling stratified by topography, soil type, broad forest type, or degree of disturbance (hot spots) Wall-to-wall mapping has primarily been used for sub-national or national-level assessments while sampling approaches have primarily been used for continental

or global scale assessments.

* 1. **Our Approach**

We have used two techniques to track the amount of vegetation in the image. The two approaches are RGB and HSV . The **RGB color model** is an additive color model in which red, green, and blue light is added together in various ways to reproduce a broad array of colors. HSV stands for *hue*, *saturation*, and *value*, and is also often called **HSB** (*B* for *brightness*). The Algorithm through RGB is a standard algorithm used in detecting colors. HSV has been used by us to detect color with various different shades and thus helping us to detect more different shades of the green color. Thus providing wide range of detection.

* + 1. **RGB Approach**

We will try to detect the change in the vegetation of a particular zone shown in the images over a time period. We will use the color property i.e. green color for vegetation detection. The algorithm that we propose for the detection of green area is composed of two parts. In the first part, the **light green shades** of the image are detected. In the second part, the **dark green shades** are detected.

**Detection of Light Green**

The RGB value of light green has green component greater than blue and red components. Color of a pixel in original image, Image1, whose green component is greater than blue and red components, is copied to a new image, Image2.

In this way, only light green pixels will be copied to Image2. Pixels that do not satisfy the above property are not copied from Image1 to Image2 and their positions in Image2 are made black.

Pseudo Code:-

[row column page] = size(Image1)

for i = row

for j = column

if (Image1 (i, j, 2) > Image1(i, j, 1) & Image1(i, j, 2) > Image1(i, j, 3))

Image2 (I, j, 1) = Image1 (I, j, 1);

Image2 (I, j, 2) = Image1 (I, j, 2);

Image2 (I, j, 3) = Image1 (I, j, 3);

else

Image2 (I, j, 1) = 0;

Image2 (I, j, 2) = 0;

Image2 (I, j, 3) = 0;

end

end

end

**Detection of Dark Green**

The RGB value of dark green has red component of less value than both the green and blue components. Also, the green component is approximately 20 units less than the blue component.

To identify the dark green pixels, the green component is increased by 20 and the light green algorithm is applied.

Pseudo code:-

[row column page] = size(Image1)

for i = row

for j = column

Green = Image1 (i, j, 2) + 20;

if (Green > Image1(i, j, 1) & Green > Image1(i, j, 3))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

else

Image2 (i, j, 1) = 0;

Image2 (i, j, 2) = 0;

Image2 (i, j, 3) = 0;

end

end

end

In the above algorithm some shades of grey may also get detected so it may create error in the output.

So we create an algorithm for prevention of detection for shades of grey.

**Prevention of detection for shades of grey.**

Intensities of R, G, and B components of green color are approximately less than 100. On the other hand, intensities of R, G, and B components of grey shades that satisfy also the conditions of light and dark green are greater than 150. Therefore pixels with R,G and B components greater than 150 are not considered

Pseudo Code:-

[row column page] = size(Image2)

for i = row

for j = column

if Image2 (i, j, 1) > 150

if Image2 (i, j, 2) > 150

if Image2 (i, j, 3) > 150

Image2 (i, j, 1) = 0.0;

Image2 (i, j, 2) = 0.0;

Image2 (i, j, 3) = 0.0;

end

end

end

end

end

* + 1. **HSV** **VALUE APPROACH**

HSV stands for *hue*, *saturation*, and *value*, and is also often called **HSB** (*B* for *brightness*). HSV is cylindrical geometries, with hue, their angular dimension, starting at the red primary at 0°, passing through the green primary at 120° and the blue primary at 240°, and then wrapping back to red at 360°. The resulting mixtures in RGB color space can reproduce a wide variety of colors.

In an attempt to accommodate more traditional and intuitive color mixing models, computer graphics pioneers at PARC and NYIT developed the HSV model in the mid-1970s .

Function available to use in MATLAB library,

hsvImage = rgb2hsv(Image1);

We have used the above function to convert the RGB image to HSV image. converts a red-green-blue (RGB) to hue-saturation-value (HSV) colormap. Image1 is an *m*-by-3 matrix, where *m* is the number of colors in the colormap. Its columns are intensities of red, green, and blue, respectively. The columns of hsvImage represent hue, saturation, and value.

We have taken total of 13 shades for Green Values to increase the accuracy in result.

The shades of this green color are based on the most occurring HSV pixel values found in most of the satellite images.

Pseudo code:-

for i = 1:row

for j = 1:column

if( (hsvImage (i, j, 1) > .20 && hsvImage(i, j,1) <.50) && (hsvImage(i, j,2) > .25 && hsvImage(i, j,2) < .60) && (hsvImage (i, j, 3) > .15 && hsvImage (i, j, 3) < .45))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .35 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .25 && hsvImage(i, j,2) < .50) && (hsvImage (i, j, 3) > .30 && hsvImage (i, j, 3) < .60))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .15 && hsvImage(i, j,1) < .55) && (hsvImage(i, j,2) > .05 && hsvImage(i, j,2) < .50) && (hsvImage (i, j, 3) > .30 && hsvImage (i, j, 3) < .75))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

elseif( (hsvImage (i, j, 1) > .35 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .25 && hsvImage(i, j,2) < .50) && (hsvImage (i, j, 3) > .20 && hsvImage (i, j, 3) < .75))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .35 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .10 && hsvImage(i, j,2) < .40) && (hsvImage (i, j, 3) > .40 && hsvImage (i, j, 3) < .80))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .45 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .40 && hsvImage(i, j,2) < .60) && (hsvImage (i, j, 3) > .50 && hsvImage (i, j, 3) < .70))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .40 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .40 && hsvImage(i, j,2) < .60) && (hsvImage (i, j, 3) > .20 && hsvImage (i, j, 3) < .50))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .40 && hsvImage(i, j,1) <.65) && (hsvImage(i, j,2) > .15 && hsvImage(i, j,2) < .40) && (hsvImage (i, j, 3) > .20 && hsvImage (i, j, 3) < .50))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .10 && hsvImage(i, j,1) <.35) && (hsvImage(i, j,2) > .05 && hsvImage(i, j,2) < .25) && (hsvImage (i, j, 3) > .20 && hsvImage (i, j, 3) < .40))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .60 && hsvImage(i, j,1) <.80) && (hsvImage(i, j,2) > .10 && hsvImage(i, j,2) < .45) && (hsvImage (i, j, 3) > .20 && hsvImage (i, j, 3) < .40))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .20 && hsvImage(i, j,1) <.40) && (hsvImage(i, j,2) > .50 && hsvImage(i, j,2) < .88) && (hsvImage (i, j, 3) > .30 && hsvImage (i, j, 3) < .70))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .20 && hsvImage(i, j,1) <.40) && (hsvImage(i, j,2) > .40 && hsvImage(i, j,2) < .75) && (hsvImage (i, j, 3) > .60 && hsvImage (i, j, 3) < .99))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .20 && hsvImage(i, j,1) <.40) && (hsvImage(i, j,2) > .25 && hsvImage(i, j,2) < .70) && (hsvImage (i, j, 3) > .90 && hsvImage (i, j, 3) < 1.25))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

Else if( (hsvImage (i, j, 1) > .30 && hsvImage(i, j,1) <.60) && (hsvImage(i, j,2) > .50 && hsvImage(i, j,2) < .85) && (hsvImage (i, j, 3) > .15 && hsvImage (i, j, 3) < .40))

Image2 (i, j, 1) = Image1 (i, j, 1);

Image2 (i, j, 2) = Image1 (i, j, 2);

Image2 (i, j, 3) = Image1 (i, j, 3);

else

Image2 (i, j, 1) = 0;

Image2 (i, j, 2) = 0;

Image2 (i, j, 3) = 0;

end

end

end

**4. SYSTEM FEATURES**

**4.1 GUI**

The GUI starts with a welcome screen showing the choices provided by us based on the type of approaches user wants.

As per the choice of the user, the interface opens, the format for the interfaces are similar. On the interface various options are provided. Shown below is the RGB interface uploading an image.

After uploading the image the algorithm works on the interface provides us with the intended output. Shown below is the output for HSV implementation and RGB implementation of Rondonia for the year 2008

After the processing user can analyze the amount of deforestation shown in the image as

black spots. Various analysis tools in form of plots are also provided with the image. Below are the group and future plots.

Various other plots are also provided like an individual pie chart, showing the amount of deforestation and forestation, and a scatter plot to show the variance of the color attributes in the processed image.

As our software is having a purpose of awareness in society we have given a suggestion option where you can know “What should you do” with analyzing the condition of deforestation. There will be a message window which will suggest you to help to save trees according to according to “eight basic rules to preventing deforestation” given by **Reducing Emissions from Deforestation and Forest Degradation** (**REDD**).

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**SUGGESTIONS**

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| **TEACHER’S NAME** | **SUGGESTION** |
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