Automatic Water, Land and Vegetation Boundary Detection using Machine Learning on Satellite Image

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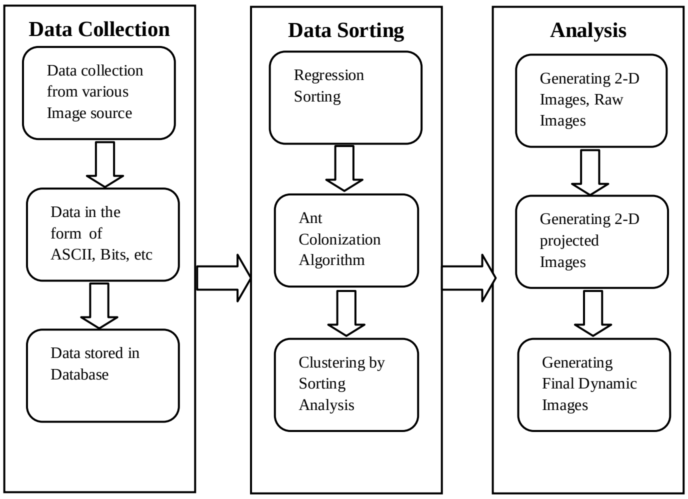
Abstract - *Satellite Image are made using remote sensing technique. This images or we can say data, are solvable through big data analysis. This huge data of satellite if processed live, it can have a huge application in Human Civilization and also in Technological development. We have the analysis of real time satellite images and we wear able to distinguish between Water, Land and Vegetation boundary using machine learning. This is very intense problem statement, in the mean of any natural calamity the only thing which can track down the whole natural disaster is satellite image, but it is important to set back the proper boundary for every geological features. This technique which we have developed will be having a great application, in disaster management, flood relief, to know extend of deforestation, forest fire etc.*

Keywords: Data Collection, Data Sorting, Remote Sensing, Analysis.

INTRODUCTION

The earth is a complex system with a huge variety of geophysical processes many of which are interrelated. We want to understand these processes and monitor their evolution over time both at small scales and global scales. And remote sensing from earth orbiting satellites is one of the only ways we can do that effectively repetitively and consistently for long periods of time. You can see here a wide range of earth system properties that can be accessed by remote sensing and this is only a small number of the true range of parameters that we can observe. Most earth observation satellites are in what's called a low earth orbit this means they orbit generally speaking north to south or south to north approximately while the earth turns below them and the image of a swath of variable width below the spacecraft with their imaging instruments. So you can see here the NASA Terra satellite which is imaging a swath of around two-and-a-half thousand kilometers below the satellite as it's rotating around the earth. Earth is rotating below it and it allows it to cover almost the entire planet every day with imagery by measuring wide swath imagery. Such as this you can image the earth every day if you want more spatial detail you can go to higher spatial resolution imagery but generally that means a narrower swath width and a longer time between imaging instances, so close to the earth here you can see two low-earth orbiting satellites approximately orbiting north to south or south to much further away from the earth. We can see what's called a geostationary satellite that's actually positioned about 36,000km away from the earth and that's just far enough so it rotates at the same angular rotates at the same angular rotation rate as the earth itself and it's called a geostationary satellite because compared to the earth itself it appears to be stationary in this case we're looking at the orbit of meteor sat and it appears to hang directly over Africa and is able to image Africa and Europe every 15 minutes because of this the disadvantage is you can't see the entire earth with one geostationary satellite so in fact that are positioned in a ring around the earth with multiple satellites in order to provide a global picture so with any satellites orbit the velocity of the satellite is governed by the balance between the centripetal for and the gravitational for and in the case of geostationary satellites my position the satellite about 36 thousand kilometers away from Earth the velocity of the satellite is such that it takes one day to go round it's all bit and that's the same time as that orbit takes to make one revolution on its axis and so the satellite appears to hang over the same position above the earth continuously low-earth orbiting satellites are usually placed in something called a Sun synchronous orbit which means they pass over the earth at the same local solar time each day which allows easy comparison between images taken on different dates if the illumination conditions were changing markedly it would be difficult to tell whether change you see in the imagery are due to change on the land surface or changes in the illumination conditions but using this Sun synchronous orbit we can much more easily identify changes in the Earth's environment electromagnetic radiation comes an enormously wide range of wavelengths which is the distance between the wave crests if you think of light as a wave the visible part of the spectrum is actually only a tiny range of wavelengths compared to the overall electromagnetic spectrum the sun is a very hot object almost 6,000 Kelvin and that means it emits preferentially short wavelength electromagnetic radiation and we use that with our eyes to see that's the visible part of electromagnetic spectrum the earth being much cooler than the Sun maybe about 300 Kelvin on average doesn't emit visible light instead at much longer wavelengths peaking around ten or eleven microns maybe 20 times the wavelength of visible light we need to design special sensors to measure these thermal infrared wavelengths which we can't see with our eyes but the advantage of those sensors is that we can use them to tell properties of the earth that we can't assess with visible light alone for example the temperature of the oceans or cloud tops the Earth's surface itself .

1. BLOCK DIAGRAM



2.1 LITERATURE REVIEW

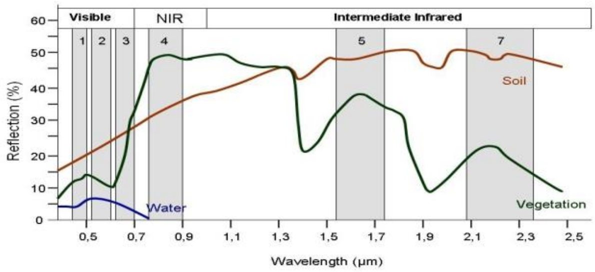
We receive 8 bit data from satellite using remote sensing, data from earth observatory like data of sun, moon, cloud, stars, etc. For example considering a cloud in rainy season, the observatories send a signal through remote sensing, then this signal is reflected back and we receive the image of the cloud along with the properties of the particular cloud.. Now these properties we have to study, using these properties we develop image and each image will have different bandwidth. Each bandwidth here give us some property like with what velocity that cloud reached here, what is the saturation level of the cloud, with how much saturation it will have rainfall, if it gives rains then how much rain it will give, etc. we can predict all this. We have the vast future application of this we can do rainbow prediction, rainfall prediction etc. We are talking about raw images collected from the satellites during remote sensing technique Remote sensing is based on the measurement of reflected or emitted radiation from different bodies. Objects having different surface features reflect or absorb the sun's radiation in different ways. The reflectance properties of an object depend on the particular material and its physical and chemical state (e.g. moisture), the surface roughness as well as the geometric circumstances (e.g. incidence angle of the sunlight).

Remote sensing is a science of acquiring information of the earth surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information."

Raw image

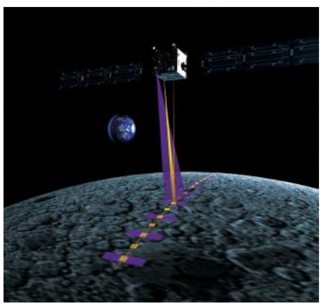
We are talking about raw images collected from the satellites during remote sensing technique. Remote sensing is based on the measurement of reflected or emitted radiation from different bodies. Objects having different surface features reflect or absorb the sun's radiation in different ways. The reflectance properties of an object depend on the particular material and its physical and chemical state (e.g. moisture), the surface roughness as well as the geometric circumstances (e.g. incidence angle of the sunlight). The most important surface features are colour, structure and surface texture.

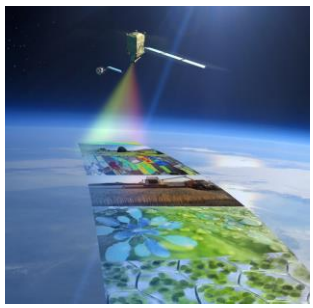
These differences make it possible to identify different earth surface features or materials by analysing their spectral reflectance patterns or spectral signatures. These signatures can be visualised in so called spectral reflectance curves as a function of wavelengths.



The figure shows typical spectral reflectance curves of three basic types of Earth features: green vegetation, dry bare soil and clear water.

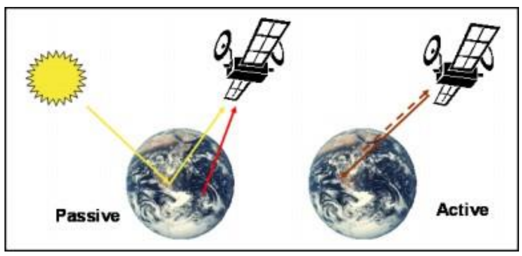
How satellite collects data



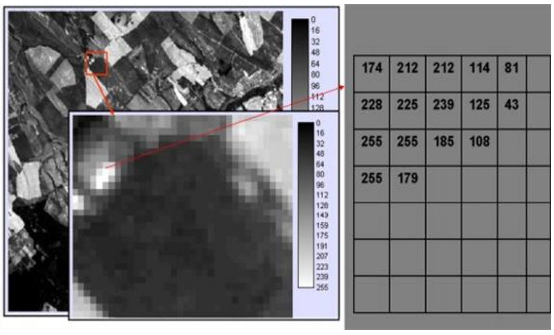


Imaging systems (sensors)

Remote sensing systems which measure energy that is naturally available are called passive sensors. The sensor records energy that is reflected such as visible wavelenghts from the sun or emitted (thermal infrared) from the source. Passive sensors can only be used to detect energy when the naturally occurring energy is available. Active sensors rely on their own sources of radiation for illuminating objects.



The sensor emits radiation which is directed toward the target to be investigated. The reflected energy from that target is detected and measured by the sensor. Electromagnetic energy may be detected either photographically or electronically and the images produced may be analog or digital. Aerial photographs are examples of analog images while satellite images acquired using electronic sensors are examples of digital images. A digital image comprises of a two dimensional array of individual picture elements (pixels) arranged in columns and rows. Each pixel represents an area on the Earth's surface.



Digital image, you can see pictures elements (pixels). Every pixel has an intensity value and a location address in the two dimensional image (columns and rows). A pixel has an intensity value and a location address in the two dimensional image. The intensity value represents the measured physical quantity such as the solar radiance in a given wavelength band reflected from the ground, emitted infrared radiation or backscattered radar intensity. This value is normally the average value for the whole ground area covered by the pixel. The intensity of a pixel is recorded as a digital number and stored with a finite number of bits (binary digits).

2.2 Software

MATLAB

MATLAB is a multi–paradigm numerical computing environment. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces.

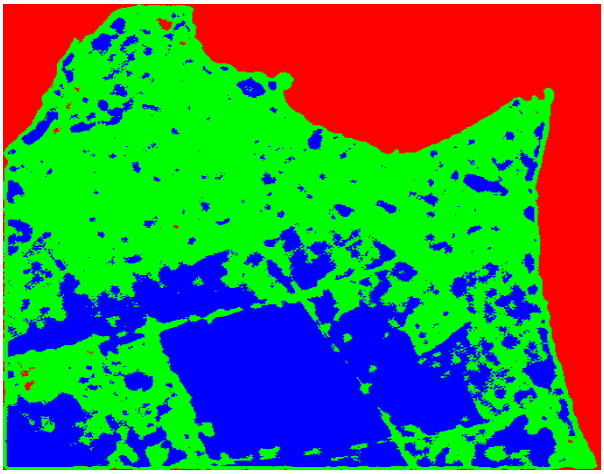
TOOL USED

- Simulink
- Filter Design HDL
- Filter Design
- Wavelet
- Image Processing Tools
- Signal Processing Tool Box
- Neural Network Tool Box

3. RESULTS

3.1 Input

3.2 Output



3.3 Discussion

The satellite data which we have collected is in the ASCII format, the data after proper sorting is used for analysis. We have initially worked upon the test image, where we have taken arbitrary digital data and then we have used it to test with the Ant Colonization algorithm. The data storage we have handled very efficiently using matlab workspace. We were able to handle more than 1 lakh cross 1 lakh matrices of digital data using just simple sorting algorithm. We have developed the matlab code, and the code can handle bit file of pixel, to analysis the boundary between any image contrasts we deal with in any frequency spectrum. Ant Colonization algorithm is been divided in matlab into three parts, First we have modeled the cluster part, where the search algorithm works with fine efficiency. Second we have integrated the small cluster part and divided the segment into red, blue and green defining a particular boundary. Third part deploying that boundary data on the real raw data of the image, to give the exact 2-D image with boundary borders integrated with the real live image. This projected image on the raw image we call as dynamic raw image. The data we can handle per second can range from 12MB to 80MB, which can cover the long range satellite data (after filtering) upto 1000 Sq Km. This optimization can help in bringing a high level performance in image categorizations and its processing.

We have applied this algorithm on real live example of Chandipur basin in Odisha. It's one of the unique beach, and its study is widely done. We have characterized the data into two frequency spectrum, and tried to analysis two properties out of this two frequency bands. First we have properly defined the geological boundary, for land-water; water-greenery and land-greenery. Second we were able to analysis the precipitation pattern of water from land and sea, and also we have detected some sign of ground water intrusion in sea, this result can help us in adding the plus point towards scarcity of water in Odisha. The results are conclusive and are highly showing convergence with 95.5% efficiency.

4. CONCLUSIONS

The conclusion is to fragment the Geology of the area. We want water different, we want mountain different we want vegetation different; we want sea different we want land different. We want to analyse this. This can be only done with the help of electromagnetic spectrum and this electromagnetic spectrum is the one who studies is called the remote sensing. What we do is we are studying this frequency and wavelength. The particular wave that reflects from any surface it is nothing but the collection of the data in mesh grid system and saves it and then we apply some pre-processing techniques and do sorting clustering. After clustering we use some algorithms, using the algorithm our clustering looks more highlighted and clear and we can know exactly where the boundary is present. We can actually say where we have land, sea, vegetation, etc.

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