Mini Project

Project Progress Review #3

Project Title : Forest Canopy Density Detection Using Python
Project ID :22
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Outline

- Abstract and Scope of the Project
- Design
- Methodology
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Abstract and Scope

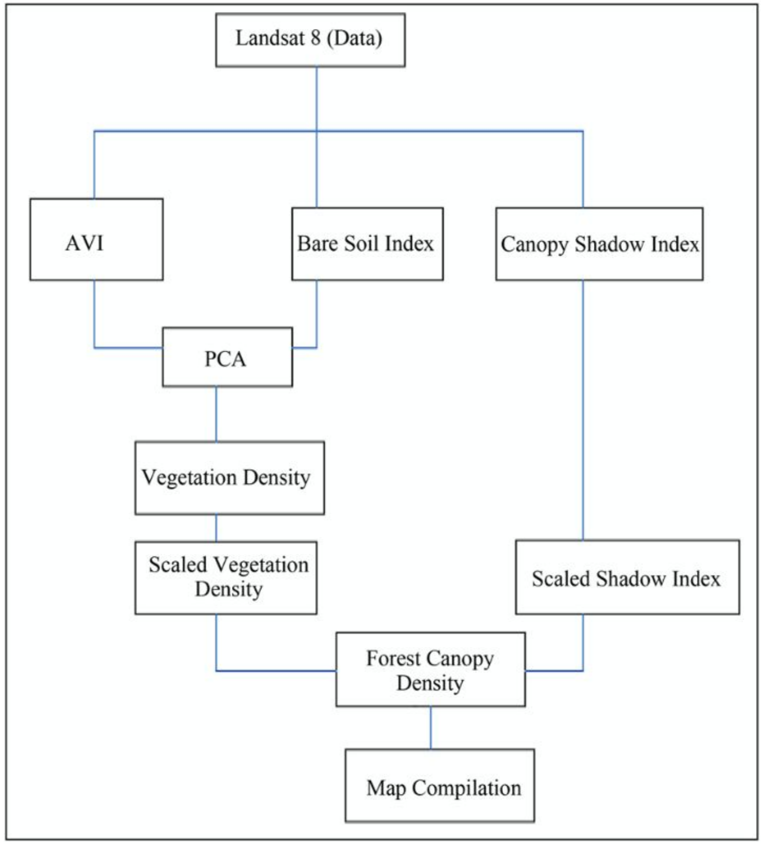
- Provide a basic introduction of the project and also an overview of scope it entails.

Forest canopy density is one of the most useful parameters to consider in the planning and implementation of rehabilitation program.Many bands are required for computation of Forest Canopy Density. Each band correspond to an image.Current technology has certain limitations is capturing Forest Canopy Density.Firstly these images from satellite are downloaded to ground stations . This itself takes lots of time and there is a lot of data as well because satellite image transfers undergoes data loss . Secondly this process is done under human influence therefore results obtained are subjected to Bias

Our project is to find a solution to this problem.Our project is a python script that can be run on satellites . Images captured by satellite will be processed by our python file then the required canopy density map will be produced. Instead of sending many images to ground station only one resultant map will be sent.

Project Design

All modules complete design.



Methodology

There are a total of 5 modules -

In first module we fetch Landsat image collection and required feature collection. We input the region of interest from the user. We develop some predefined functions for image computations for example mean, standard deviation. Then we filter the image collection to get the the most optimal image.

Module-wise implementation details that include,

MODULE 1:

```
Landsat=ee.ImageCollection("LANDSAT/LC08/C02/T1")
states = ee.FeatureCollection("FAO/GAUL_SIMPLIFIED_500m/2015/level2");
district_name=input('Enter district name?')
district=states.filter(ee.Filter.eq('ADM2_NAME', district_name))
roi=district.geometry()
startdate="2008-01-01"
lastdate= "2020-01-01"
image=Landsat.filterDate(startdate,lastdate)\.filterBounds(roi).median().clip(roi)
```

Here we use geemap library and ee library to extract required image collection and feature collection

Image collection is set of raster images.

Feature collection is set of vector information.

We input the area of interest . In our case we have taken districts as area of interest.

Then we filter the Image collection to get the best possible image for the given area of interest.

Methodology

In second module we filter the required bands and apply normalization to each band. We do this by using the normalization formula .

$$A = \frac{(Y1 - Y2)}{(X1 - X2)} = \frac{(Y1 - Y2)}{(M - 2S) - (M + 2S)}$$

where:

A – linear transformation,

$Y1$ – maximum value of standardized value,

$Y2$ – minimum value of standardized value,

$X1 = M - 2S$,

$X2 = M + 2S$,

M – mean of values,

S – standard deviation.

$$Y = AX + (-AX1 + Y1)$$

where:

Y – normalized data,

X – original value.

MODULE 2:

```
def getmin(image,band_name,scl,mxpxls):
mini=image.select(band_name).reduceRegion(
reducer=ee.Reducer.min(),
geometry=image.geometry(),
scale=scl,
maxPixels=mxpxls).getInfo().get(band_name)
return mini
```

```
def getmax(image,band_name,scl,mxpxls):
maxi=image.select(band_name).reduceRegion(
reducer=ee.Reducer.max(),
geometry=image.geometry(),
scale=scl,
maxPixels=mxpxls).getInfo().get(band_name)
return maxi
```

We code some predefined functions for image computations for example mean, standard deviation. Then we filter the image collection to get the the most optimal image.We apply normalization to band B2 ,B3 ,B4, B5,B7.

In third module we do band computation on normalized primary bands to generate required secondary bands which will required in further computation. The formulas were mentioned in the research paper. Then we visualize the these bands.

Advanced vegetation index (AVI): $AVI = [(B5 + 1)(65536 - B4)(B5 - B4)]^{1/3}$

Bare Soil Index(BI): $BI = BIO * 100 + 100$

$BIO = [(B6 + B4) - (B5 + B2)/(B6 + B4) + (B5 + B2)]$

Shadow index (SI): $SI = [(65536 - B2) * (65536 - B3) * (65536 - B4)]^{1/3}$

MODULE 3:

```
avi=image.expression('((B5+1)*(65536-B4)*(B5-B4))**(1/3)',{
'B5': image.select('b5norm'),
'B4': image.select('b4norm'),}).rename('AVI')
bi=image.expression('((((B6+B4)-(B5+B2))/((B6+B4)+(B5+B2)))*1000)+1000',{
'B6': image.select('B6'),
'B4': image.select('b4norm'),
'B2': image.select('b2norm'),
'B5':image.select('b5norm')
}).rename('BI')
#Thermal index is integrated in SI
si=image.expression('((65536-B2)*(65536-B3)*(65536-B4))**(1/3)',{
'B3': image.select('b3norm'),
'B2': image.select('b3norm'),
'B4': image.select('b4norm')
}).rename('SI')
image=image.addBands(avi).addBands(bi).addBands(si)
```

We use the normalized data to calculated Advanced Vegetation Index, Bare Soil Index, Thermal Index. Later we visualize these bands , so to visualize these bands we find the minimum and maximum of each band . We do so by using the reducer functions previously defined.

In fourth module we do the prerequisite of Principal Component Analysis.Our images are in earth engine object format . We need to convert these earth engine object int tiff images with compression format 'ZSTD'. In 'ZSTD' format maximum amount of information is retained.We use GDAL library for this conversion.

MODULE 4:

```
out_dir = os.path.join('/', 'content/PCA_image')
filename = os.path.join(out_dir, 'landsat.tif')
geemap.ee_export_image(Aviimage, filename=filename, scale=90, region=roi, file_per_band=True)
out_dir = os.path.join('/', 'content/PCA_image')
filename = os.path.join(out_dir, 'landsat.tif')
geemap.ee_export_image(Siimage, filename=filename, scale=90, region=roi, file_per_band=True)
out_dir = os.path.join('/', 'content/PCA_image')
filename = os.path.join(out_dir, 'landsat.tif')
geemap.ee_export_image(Biimage, filename=filename, scale=90, region=roi, file_per_band=True)
```

We then save the calculated bands into colab directories. We need these images for performing PCA . We use gdal library to convert the images to .tiff format with PACKBITS compression. PACKBITS compression retains the most amount of data .

Methodology

In fifth module we do PCA on our image.We run PCA only on AVI band and BI band.We use whitebox library for PCA computation.First we configure White box module then we run PCA module of Whitebox.
After we have processed the image we use the white box library to produce the Forest Canopy Density map.

MODULE 5:

In final module we will perform PCA on the calculated bands . We will use Whitebox library for this module. After PCA we will get Vegetation Density band and Scaled Shadow index band. These two will be used to develop our Forest Canopy density map.
Essentially we will automating this entire process , that is given raw image and a region of interest we can produce a Forest Canopy Density Map.

Expected result

Summarize the key points.

- We first filter the required region of interest image
- Then we develop some functions which will required for image computation
- After that we normalize our selected primary bands and calculate secondary bands.
- Now we convert these secondary band images into images with particular type of compression
- Lastly we need to perform PCA on secondary images and do final computation to produce Forest Canopy Density Map.

Expected result

Provide a glimpse of Future work.

In the future we can develop a user friendly interface for exchange of user requests and produced inferences.
We can use this Forest Canopy Density map in Forest Monitoring Systems and Deforestation Detection Systems

An interesting use case

In coal mining industry mining companies need to do land refills, called land restoration. The progress is tracked by calculating the FCD(Forest Canopy Density) of that area. In today scenario FCD is calculated under human supervision. Hence it is subjected to human bias. Therefore proper restoration of land is not done. To bypass this problem automation is the key. Hence our script can be used in such scenarios.

References

Provide references pertaining to your project according to IEEE format.

https://www.researchgate.net/publication/339624736_Application_of_Forest_Canopy_Density_FCD_Model_for_the_Hotspot_Monitoring_of_Crown_Fire_in_Tebo_Jambi_Province

This contains the implementation details of Forest Canopy Density.

Thank
You