Title : Rehabilitation and Protection of Coastal Areas

Team Members/Collaborators

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Summary:

This project is proposed with the idea to analyse the difference between the past and present land near coastal areas and provide solutions based on the analysis.

Project Summary

Overview:

1. Gather SAR images with respect to coastal areas with an interval span of 3 years for the same region for past 3 decades.
2. Gather factors to detect mangroves in a SAR Image.
3. Gather factors to detect the urban development in a SAR Image.
4. Segment the images to clean and extract only areas related to mangroves and urban development around such regions.
5. Map the factors in step 2 with the cleaned images in step 4 to create an outline on the images wrt to mangroves.
6. Map the factors in step 3 with the cleaned images in step 4 to create an outline on the images wrt to urban development.
7. Generate difference images between current and historical remote sensed image and color code the difference images with respect to change in water and land coverage.
8. Provide a report on various changes in the coastal area cover.
9. Analyze the alternate factors that leads to the same issues that would result with unavailability of mangroves like climate change, etc

Benefits of Mangroves:

Like coral reefs, mangrove forests are extremely productive ecosystems that provide numerous good and services both to the marine environment and people.

The goods and services include:

- **Fisheries:** Mangrove forests are home to a large variety of fish, crab, shrimp, and mollusk species. These fisheries form an essential source of food for thousands of coastal communities around the world. The forests also serve as nurseries for many fish species, including coral reef fish. A study on the Mesoamerican reef, for example, showed that there are as many as 25 times more fish of some species on reefs close to mangrove areas than in areas where mangroves have been cut down. This makes mangrove forests vitally important to coral reef and commercial fisheries as well.
- **Coastal protection:** The dense root systems of mangrove forests trap sediments flowing down rivers and off the land. This helps stabilize the coastline and prevents erosion from waves and storms. In areas where mangroves have been cleared, coastal damage from hurricanes and typhoons is much more severe. By filtering out sediments, the forests also protect coral reefs and seagrass meadows from being smothered in sediment.
- **Tourism:** Given the diversity of life inhabiting mangrove systems, and their proximity in many cases to other tourist attractions such as coral reefs and sandy beaches, it is perhaps surprising that only a few countries have started to tap into the tourism potential of their mangrove forests.

What challenge are you addressing? What is your proposed solution?

Challenges:

1)Mangrove destruction

- Mangroves are salt-tolerant plants, a common natural feature along the Mumbai coast.
- Apart from playing a role in stabilising coastlines, mangrove trees act as carbon sinks, capturing CO2 from the atmosphere and storing them in the vegetation. This process is called carbon sequestration, and helps control global warming by reducing CO2 levels in the atmosphere.
- Mangrove ecosystem establishes and grows at the interface of soil and water bodies like sea, creeks, estuaries, bays and lagoons. They are commonly found in area between the high tide and the low tide.
- In Maharashtra, mangroves cover almost 222 sq km of coastline covering 53 creeks and seashore.
- Close to 150 hectares of mangrove forests have already been sanctioned to be lost for various development projects in Mumbai, including the proposed Navi Mumbai International airport and the civic body's Coastal Road Project.

2)Land encroachment

Mumbai has witnessed 96 cases of mangrove destruction - 86 cases on private land under the revenue department and ten cases on government land under the forest department between January and August. Violators have gone undetected as only one arrest so far and no convictions were made in the cases yet.

Solution:

The proposed solution uses image change detection process.Image change detection is a process to analyse multi-temporal images of the same scene for identifying the changes that have occurred.We propose a novel difference image analysis approach based on deep neural networks for image change detection problems.The deep neural network learning algorithm for classification includes unsupervised feature learning and supervised fine-tuning.Since a deep neural network can learn complicated functions that can represent high level abstractions,it can obtain satisfactory results.Theoretical analysis and experiment results on real datasets show that the proposed method outperforms some other methods.

How does your project build on existing research?

A literature survey was conducted for each and every functionality that is needed for the project. Several recent work on each aspect of the project done by different researchers is taken into consideration to build a stable model. Following are the papers referred and the outcomes derived from each, that can be used as a part of the proposed solution:

1. **Automatic Extraction Of Mangrove Vegetation from satellite data[1]**
   - In this paper a focus is given to recognize and extract the mangroves vegetation based on the false color composite of satellite images of LISS- III using color and texture elements and True color composite of Landsat 8 using the pixels values.
   - Mangroves have dark red velvety tone and smooth texture. Various methods to recognize mangroves have been implemented and their time complexity and accuracy are studied.
   - The methods implemented in this study using LISS- III data are K-means clustering, Gabor filtering, Otsu's threshold method and Texture and color segmentation. SVM classification and Color based pixel classification are implemented using the Landsat 8 images.

2. **Building change detection using multi-sensor and multi-view angle imagery[2]**
   - This method integrates the sensor model parameters into the co-registration process to relate corresponding pixels. From the corresponding pixels, corresponding segments (patches) are generated. Later on, the brightness values of the matching pixels/segments are compared in order to detect changes. Here, a Multivariate Alteration Detection (MAD) transform is used for identifying the changed segments.
   - The proposed method provides the opportunity to utilize various images as bitemporal sets for change detection.

3. **Monitoring land use changes associated with urbanization: An object based image analysis approach [4]**
   - The paper focuses on determining the land use and land cover changes due to urbanisation.
   - An object based detection technique is used on Satellite images further GIS based change detection.

4. **Automated Building Extraction from High-Resolution Satellite Imagery in Urban Areas Using Structural, Contextual, and Spectral Information[5]**
   - In this paper, IKONOS satellite imagery is used to test our integrated building-extraction strategy.
   - In this paper, an automated building-extraction strategy for high-resolution satellite imagery is proposed that utilizes structural, contextual, and spectral information.

5. **Thresholding and Fuzzy Rule-Based Classification Approaches in Handling Mangrove Forest Mixed Pixel Problems Associated with in QuickBird Remote Sensing Image Analysis[6]**
   - This paper focuses on Clustering and Thresholding the image.
   - Thresholding is used to separate image into equally exclusive and unique areas.
   - The final output would gives us separation of Open Land areas, water areas, mangrove cover.
6. **VERY HIGH RESOLUTION SATELLITE IMAGES FILTERING**[7]
   - The paper presents an approach to filter the images in order to remove any kind of noise from the image.
   - It uses three non linear filters viz. anisotropic diffusion, bilateral filter and mean-shifter filter.
   - Further it shows the effect of above filtering techniques on colored images and VHR satellite images.

7. **WATER BODIES IDENTIFICATION FROM MULTISPECTRAL IMAGES USING GABOR FILTER, FCM AND CANNY EDGE DETECTION METHODS** [8]
   - This paper focuses on marking the edges of a water body after performing a series of steps.At first the feature extraction on satellite images is performed using gabor filter.
   - Next the land cover and land use classification is done using FCM. Lastly water body segmentation is done using canny edge detection and thus a water body is identified.

Methodology: -

Step 1: Data gathering

The images have been collected from Google Earth Pro and Bhuvan-Indian Geo-Platform.

Step 2: To detect mangrove's cover of a region from satellite images collected

For identification of mangroves, color image segmentation method is used.It divides a colored image into a set of disjoint regions which are homogeneous with respect to some properties consistent with human visual perception, such as colors or textures.

Step 3: To detect the change in mangrove cover of a region

In this step, we use Landsat satellite images of an area and by using remote sensing technology and calculate change in mangrove cover.

(If there is some change in mangrove then step 4 comes into existence)

Step 4: To detect the change in urbanization from satellite images taken at different time.

We can detect the growth in urbanisation using Multi Sensor and Multi View Imagery techniques.

Different algorithms and techniques used to detect the change in mangrove cover are as follow:

1) **K means clustering**-Used to partition a collection of data into small clusters

2) **Fuzzy rule based classification**
   To detect changes in images,the process is done in 2 parts: Clustering, Thresholding (used to separate digital image into equally exclusive and unique areas)The final output would gives us separation of Open land areas ,water areas, mangrove cover. The classification is based on both, pure pixel as well as mixed pixel.

3) **Gabors filtering**- used to filter images so that to have finer distinction between textures in image.

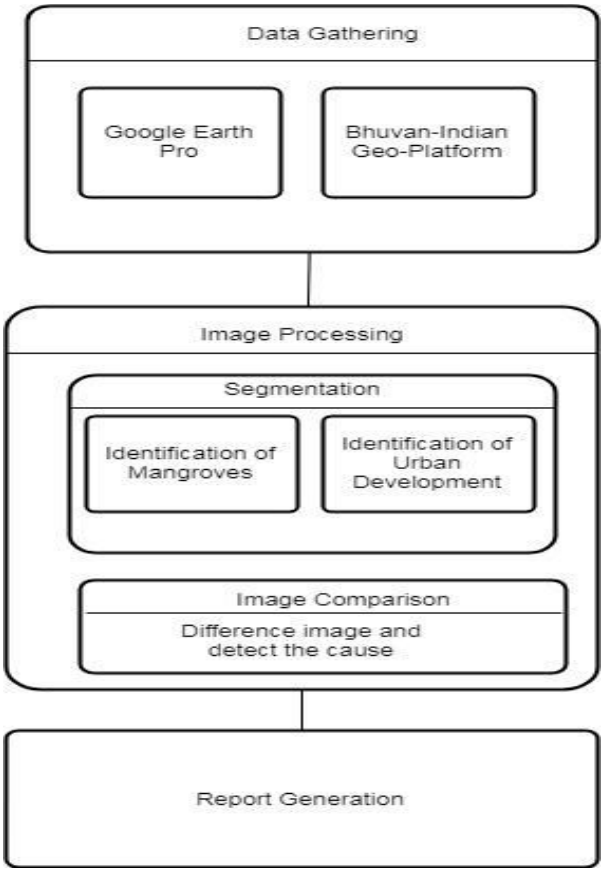
4) **Texture segmentation**- Image segmented using texture features. GCM,GLCM,2D spatial filtering.

5) **Color segmentation**-Noise due to clouds is eliminated using pre processing technique band 9(cirrus).

6) **Pixel thresholding**- specific range (based on svm classifiers result)of Rgb pixel values are mangroves.

7) **Svm classifiers**- Used to classify an image in two classes ie whether mangrove or non mangrove.

BLOCK DIAGRAM:



What datasets will you use for your analyses?

The proposed solution will extract features related to environmental conditions and also about the development in the area. The system will use sources like satellite images and different API's to gather the input dataset needed for processing. Satellite images will help us understand the urbanization, green areas, mangrove cover and water bodies. LandSat images will be used to analyse and extract the features from the images.We have downloaded 7.5 lakh images that only covers the state of Maharashtra(India). This 7.5 lakh Images are only for a specific date and we will be analysing 20 such dates from 1985 to 2018 to understand the changes in the mangrove cover..

The proposed system will then apply Artificial Intelligence and Machine Learning Techniques to derive the catchment areas. The dataset is already ready and the feature extraction is under process. We are testing various algorithms to extract the best possible features.

TECHNICAL COMPONENTS

What Azure and machine learning offerings will you use?

We propose a grant of Azure services to use advance machine learning to accomplish AI image Processing on large scale and for Prediction of Catchment areas. The services we request include Virtual Machines, Storage,Azure SQL Database, App Service, Machine Learning Studio,Azure CosmosDB, Virtual Network, Load Balancer,Network Watcher, Azure Database for MySQL, PowerBI, HDInsight and API Management.

Justify the grant amount your project will need in Azure credit

Service type	Custom name	Region	Description	Estimated Cost
Virtual Machines		West US	1 D2 v3 (2 vCPU(s), 8 GB RAM) x 300 Hours; Windows – (OS Only); Pay as you go; 0 managed OS disks – S4, 100,000 transaction units	$98.70
Storage		East US	Block Blob Storage, General Purpose V2, LRS Redundancy, Hot Access Tier, 1,000 GB Capacity, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 1 Other operations. 1,000 GB Data Retrieval, 1,000 GB Data Write	$21.84
Azure SQL Database		East US	Managed Instance, vCore Purchase Model, General Purpose Tier, Gen 4, 1 8 vCore instance(s) x 300 Hours, 32 GB Storage	$605.24
App Service		West US	Basic Tier; 1 B1 (1 Core(s), 1.75 GB RAM, 10 GB Storage) x 400 Hours; Windows OS	$30.00
Machine		South	Free	$0.00

Learning Studio		Central US		
Azure Cosmos DB		East US	0 GB Storage; Single Region Write, Pay as you go, 4 x 100 RUs x 400 Hours	$12.80
Virtual Network			100 data transfer from East US region to East US region	$2.00
Load Balancer		West US	Basic Load Balancer is free of charge	$0.00
Network Watcher		East US	1 GB Network Logs Collected, 0 Checks for Network Diagnostics, 1 Connections for Monitoring, 1 Connection Metrics, 1 DNS or App Gateway Servers x 0 GB logs ingested, 1 GB logs collected for Traffic Analytics	$5.30
Azure Database for MySQL		East US	General Purpose Tier, 1 Gen 4 (2 vCore) x 300 Hours, 5 GB Storage, 50 GB Additional Backup storage - LRS redundancy	$58.14
Power BI Embedded		East US 2	1 node(s) x 200 Hours, Node type: A1, 1 Virtual Core(s), 3GB RAM, 1-300 Peak renders/hour	$201.62
HDInsight		East US	Hadoop Component: 2 A3 (4 cores, 7 GB RAM) Head nodes x 300 Hours, 1 A3 (4 cores, 7 GB RAM) Region nodes x 300 Hours, 0 D4V2 (8 cores, 28 GB RAM) Edge nodes x 300 Hours	$275.40
Machine Learning Studio		South Central US	Free	$0.00
API Management		East US	Developer tier, 1 units(s), 200 Hours	$13.16
Support			**Support**	$0.00
			Monthly Total	**$1,324.20**
			Annual Total	**$15,890.36**

Approximate timeline for key project milestones:

We expect it will take approximately one year to complete our project milestones

Timeline	Data Platform Milestone	Model Training Result
Jan –Feb 2019	Uploading and labeling two photos	Determine Changes
Feb – April 2019	Batch photo upload and labeling	
April – July 2019	Web UI shows upload/labeling results	Classify mangroves,water bodies
August–December 2019	Data insight and analysis	

Impact

How does your project align with AI for Earth areas of focus?

Permanent destruction of forests or water reserves to make the land available for other uses is increasing rapidly form last several years. Consequences are related to increased loss of biodiversity and land encroachment. Change detection for deforestation and water reserves is the problem of detecting the changes in the earth where people are intentionally trying to destroy the forest and water reserves areas. Images collected from Satellite needs real-time change detection of such activities timely, so that, the deforestation and water reserves can be saved before they get destroyed. It can be significantly advantageous if we can detect the changes from the Satellite images but, it is not feasible to track the changes manually in the Satellite images. There is a need of an automated system which can provide some meaningful information by processing large number of images timely and yet accurate.

How does your project transform the way we address environmental challenges?

We see this opportunity to access Microsoft Azure's resources as a critical step towards helping to conserve biodiversity.. This practice has required that the researchers spend two to three weeks of manual data entry every three months, and their error rate is still high given the time pressure and repetitive nature of the process. Our project seeks to improve this process by working with Azure and collaborators from Microsoft to use advanced machine learning models to improve the quality and efficiency of database analysis.

How will the results of your project be leveraged and beneficial to a community of users?

These results would not only benefit our work, but also the work of thousands of other practitioners and researchers,who find it difficult to analyse the changes in the environment.The application will be open-source.We will disseminate our results close to coastal areas in India and across the larger network, which will in turn help to advance land monitoring and biodiversity conservation science across various Indian states and other places.

References:

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