

Monitoring Of Infrastructure Corridors Using Deep Learning

Case Study:

Encroachment Detection In Oil And Gas Pipeline Buffer Zone

Reedhi Shukla ,
[reedhi_shukla@nrsc.gov.in,](mailto:reedhi_shukla@nrsc.gov.in)
[NRSC,ISRO](#)
9014403055

Background

- GAIL India Ltd. Maintains 15000 Km Pipe line infrastructure for Gas Transportation.
- Regular Surveillance of entire Pipeline is mandatory for checking any physical disturbances over pipeline Right of Usage (ROU) at 30m.
- Till now manual marking of exception was done

Existing Surveillance Method

- **Visual inspection by Helicopters-Monthly:** *Very time consuming, costly and not very effective as it requires, human-eye based navigation.*
- **Inspection by Walkers -Six months :** *involves risk of life in case of any natural disasters like landslides or floods.*

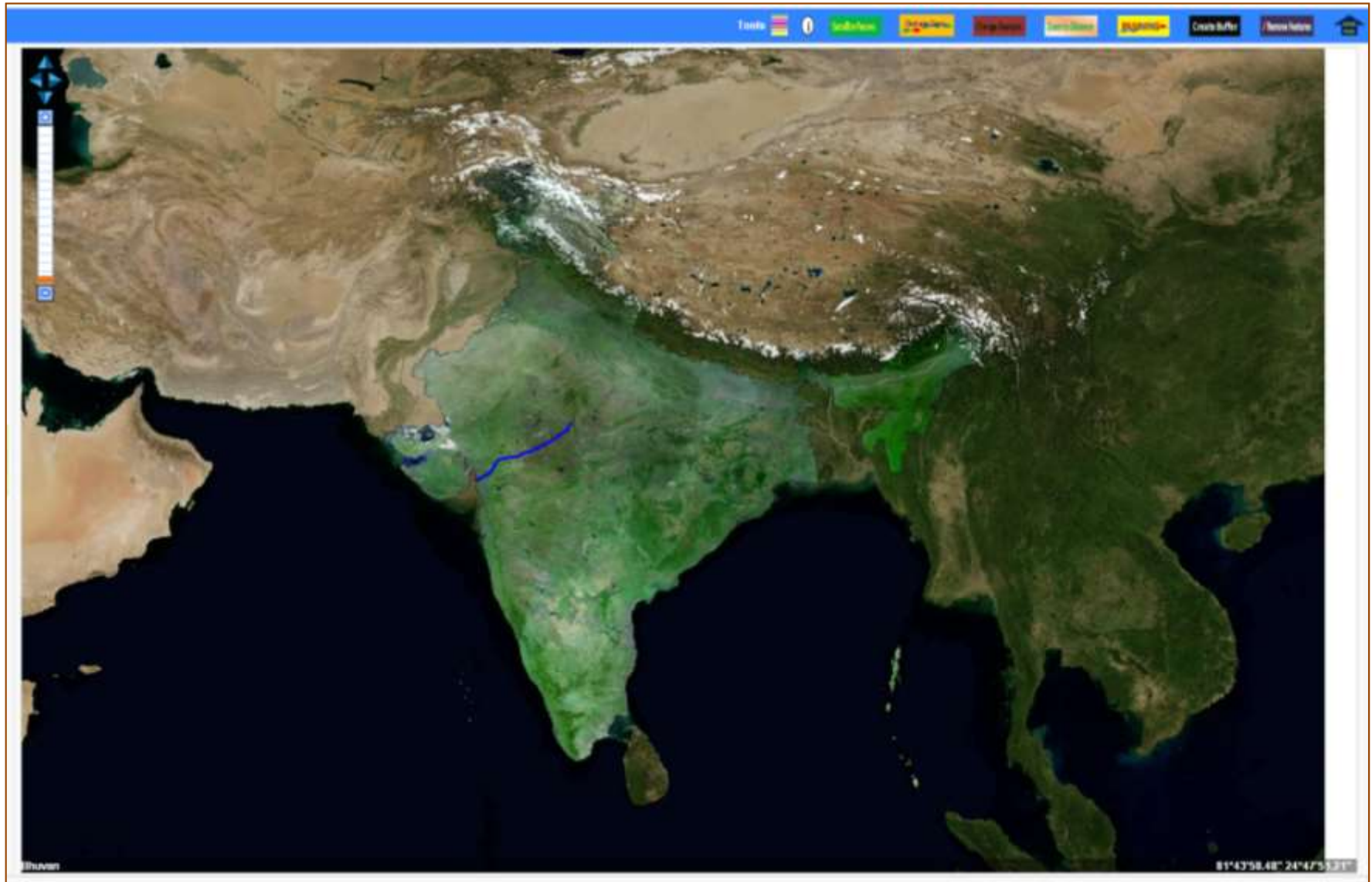
Need for study

- Automatic detection of urban features like building plays an important role not only in infrastructural monitoring but also in urban planning
- The recent research in deep learning in branch of computer science has given the way to develop the algorithms which can help in automatic detection of building in satellite data.

Objective

- Develop deep-learning methodology to detect building within a given area without much manual efforts.
- Create output image in tiff format having rectangular window over the for detecting features, which are converted to a shape file to be used in GIS environment

PipeLine Visualization



ROU Visualization



Change Analysis

File Edit View History Bookmarks Tools Help
Pioneer Broadband Service :: X ISRO's Geoportal | Gateway... X
bhuvan-noeds.nrsc.gov.in/projects/bhuvangal_ver45/gai.php#

GAIL: GAS PIPELINE SURVEILLANCE INFORMATION SYSTEM Ministry Of Petroleum and Natural Gas National Remote Sensing Centre
Overview of Application
Go to Bhuvan

January-2015

Welcome | [Logout](#) | Tool For Viewing Satellite Passes Covering the area you click is activated | The distance of point for zooming is 500m | Tools | [View Legends](#) | [Zoom To Distance](#) | [Satellite Passes](#) | [Zoom To Change](#) | [Change Analysis](#) | [Auto Panning](#) | [Create Buffer](#) | [Remove Features](#)

Pipeline Layers

- Bhuvan Satellite Imagery Service [Zoom](#)
- Gail_Pipelines_India [Zoom](#)
- GAIL_PIPELINE [Zoom](#)
- Gail_km_point_dvpl [Zoom](#)
- Change_Apr15_May15_50m [Zoom](#)
- Change_Apr15_May15_1km [Zoom](#)

Hide Buffer Layers

- Buffer_1km [Zoom](#)
- Buffer_50m [Zoom](#)
- Buffer_50m [Zoom](#)

Select year for Pipeline Information:
Select month for Pipeline Information:

[Show Field Data Viewer](#)

Satpasses Coverage in Clicked Area On Map

<input type="checkbox"/>	hrs_05301182_18Mar2015	zoom
<input type="checkbox"/>	hrs_05291182_18Feb2015	zoom
<input type="checkbox"/>	hrs_05291182_13Feb2015	zoom
<input checked="" type="checkbox"/>	hrs_05291182_11Jan2015	zoom

Bhuvan
72°49'51.01" 21°47'48.82"

Windows Taskbar: To Me - ha... Feero :: 12/... Pending... PM New Tab... ISRO's Geo... Lync Excel Presentatio... reedhigal... 3:39 PM 12/12/2015

11/7/2023

Change Analysis

bhuvan-staging.nrsc.gov.in/apo_team/bhuvangal_ver24/gal.php#

Ministry Of Petroleum and Natural Gas
National Remote Sensing Centre

Welcome. Next Logout Change area is more than 100 square metre Change Analysis is between Hrs_05291162_11Jan2015 and Hrs_05301162_16Mar2015

Tools Satellite View Change Area Create Buffer Remove Layers

Police Layers

- Bhuvan Satellite Imagery Service **Zoom To Layer**
- Gal_Pipeline_India **Zoom To Layer**
- GAL_PIPELINE **Zoom To Layer**
- Gal_km_point_step **Zoom To Layer**
- Satellite_HRS_Coverage **Zoom To Layer**

Hide Buffer Layers

- Buffer_30m **Zoom To Layer**
- Buffer_50m **Zoom To Layer**
- Buffer_30m **Zoom To Layer**

Select year for Pipeline Information: 2015
Select month for Pipeline Information: January

Show Field Data Viewer

GAL Satellite data GAL Base data
 GAL Satellite Data

Hide Tool for Visual Interpretation and marking

Create buffer for marking discrepancies within the buffer


Stop marking discrepancies Start marking discrepancies

Hide Report Viewing Options

Date Month

From Date: 2015-01-01
To Date: 2015-03-31

View report Remove report SAVE AS EXCEL



72°49'42.84" 21°47'13.30"

Report Visualization(pre target identified on the application)

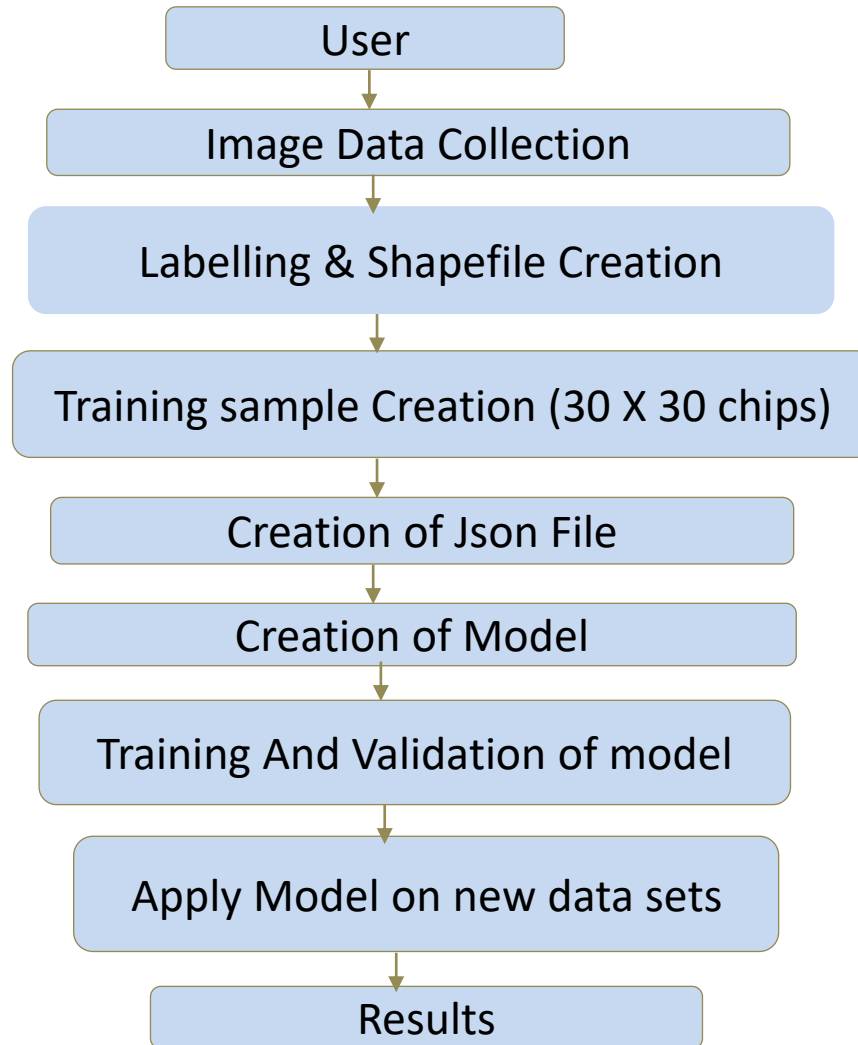
Encroachment (pre target) in ROU. Reporting

Date	Status	Description	Length	Offset	Latitude	Longitude	Action	Created By	Creation Date	Zoom
2015-01-08	DVPL	Human Road	284.283 Km	0.01 Km	24.80489326207	74.882467227117	Pending	HRSC	20150108-12:03:00	Zoom
2015-01-10	DVPL	Wali	802.335 Km	0.02 Km	24.80489326207	74.882467227117	Pending	HRSC	20150110-11:56:30	Zoom
2015-01-10	DVPL	Expansion of Soil Out the boundary	817.803 Km	0.02 Km	24.807398197481	77.148014898667	Pending	HRSC	20150110-11:56:30	Zoom
2015-01-10	DVPL	Wall in ROU LHS	383.177 Km	0.01 Km	24.39079487154	77.065825162037	Pending	HRSC	20150110-12:03:00	Zoom



Deep Learning based Solution for Encroachment monitoring

Deep Learning based Solution for Encroachment monitoring



Training Sample preparation

- The satellite data is visualized in Quantum gis and features are marked
- If feature is building the attribute value is 1 and if feature is non building the status is 0 as shown.
- The shape file is taken as input for the preparation sample chips of 30x30
- The chips are used as input for the preparation of JSON file.
- JSON file is prepared having values corresponding to data, labels, locations and scene_id.



1_4_1_2_2_74.380310079_22.7899426013

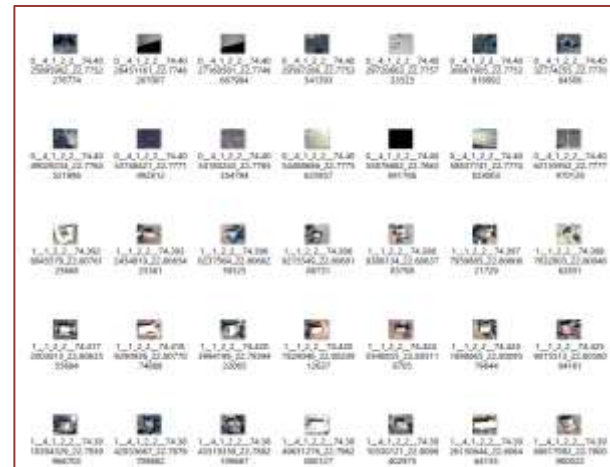


0_4_1_2_2_74.398448368_22.7926289727

- The total of 224 sample :47 are positive and 177 are negative samples

Data Preprocessing

- The JSON file prepared is taken as input for the training of the model.
- The tensor flow libraries for the reading of JSON file and training of neural networks and building detection in very high resolution satellite data.
- The pre-processing of data is required in order to train the neural network.
- To improve the performance of the neural network the new training data set is artificially calculated using existing training data sets using random flip right and left and random rotation.



Model Training and Validation On Data

- The model parameters :
- Epoch: 70
- Loss: 0.01767
- Acc: 0.95
- Iter: 160/160

Technologies Used: Open source

- Anaconda
- Python
- Tensor flow with Keras framework

- The methodology is being used on satellite imagery having 1 m of spatial resolution. The accuracy of the 75% is achieved using the above methodology.

Results



11/7/2023

Reedhi Shukla ,
reedhi_shukla@npsc.gov.in.NRSC,I

Advantages and Limitations

- The model is applied only on 4 band multispectral satellite data and samples are also collected from the same data.
- The same model, may not work for the panchromatic high resolution imagery.
- The advantage of the above methodology is that same can be applied on different satellite data only by changing the samples used for the training of the models.

Results: 85% of accuracy has been achieved

Advantages and Limitations

- The model is applied only on 4 band multispectral satellite data and samples are also collected from the same data.
- The same model, may not work for the panchromatic high resolution imagery.
- The advantage of the above methodology is that same can be applied on different satellite data only by changing the samples used for the training of the models.

Results: 85% of accuracy has been achieved

Conclusion

- Improvement in algorithms by increasing the number of training samples to enhance the accuracy of the building detection
- The model can be used for urban for planning by finding out the new building in a given area
- Model can also be used for infrastructural monitoring like finding exception with pipeline ROU
- The scope of the model is not limited to the detection of buildings only the model can be trained for detection of different objects like trees etc for

Advancement in work (Building footprint detection and Extraction)

- The work is further extended for detection and extraction of building footprints in VHRS .
- Unet with Resnet encoder is used for the same
- Model is trained for 60 epochs with batch size 16
- For preliminary study 10k samples are used
- The model is tested over parts of Hyderabad, Meriyalguda,Indore ,Kanchipuram(drone)

Input Image



Output :Building Extracted



VHRS 0.5m Spatial Resolution Building Footprint Extraction In Dense Urban Area



Vertical Change identification



Building Footprint extraction In Drone Data

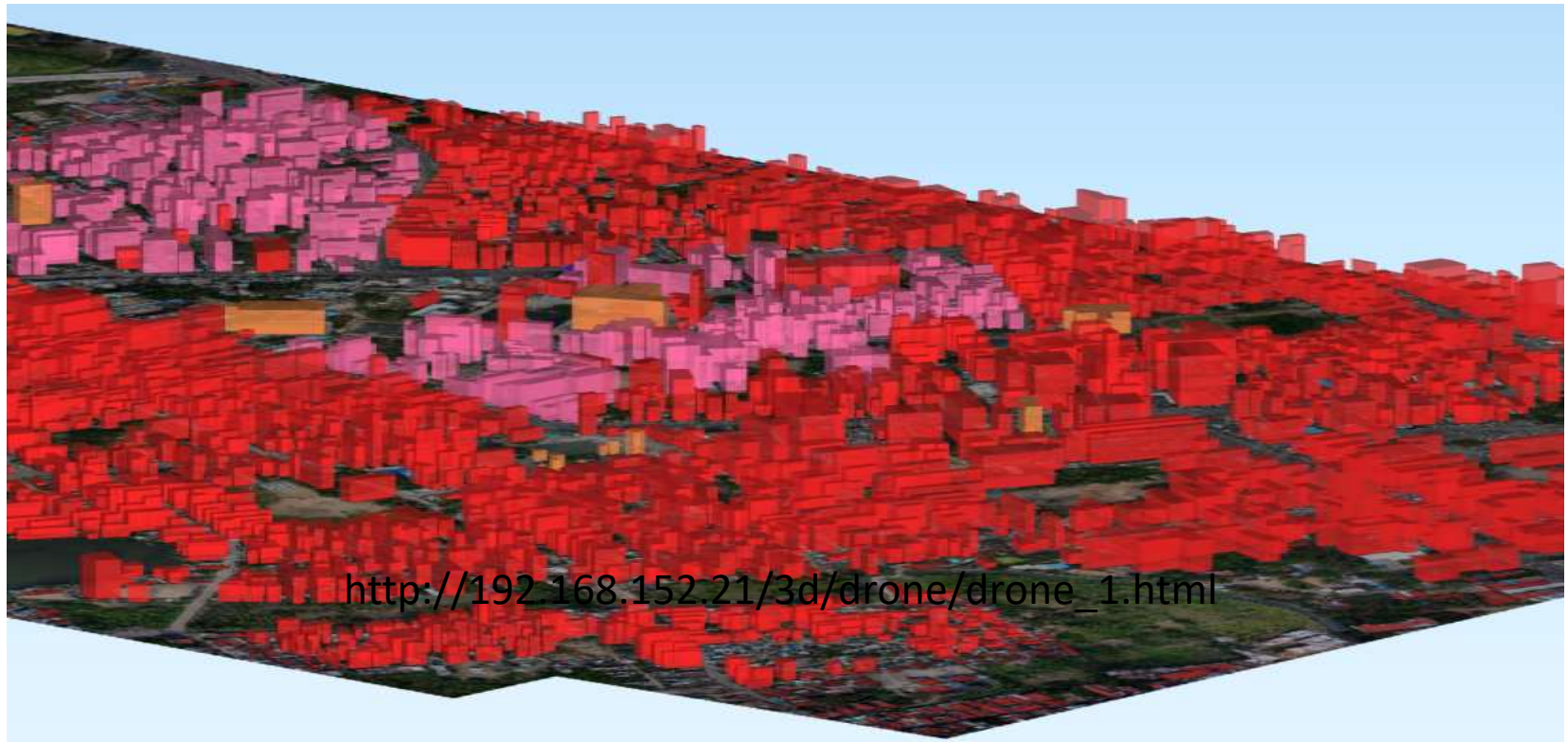
Input Image



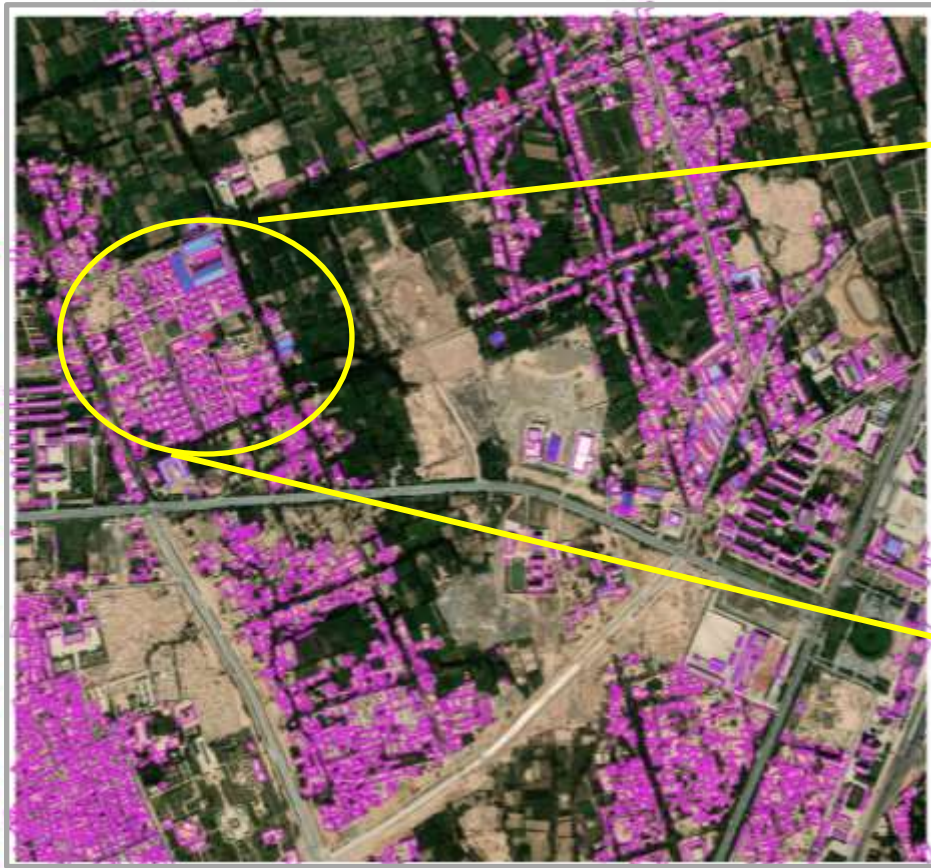
Output :Building Extracted



Output :Building Extracted



http://192.168.152.21/3d/drone/drone_1.html



11/7/2023

Reedhi Shukla ,
reedhi_shukla@npsc.gov.in.NRSC,ISRO

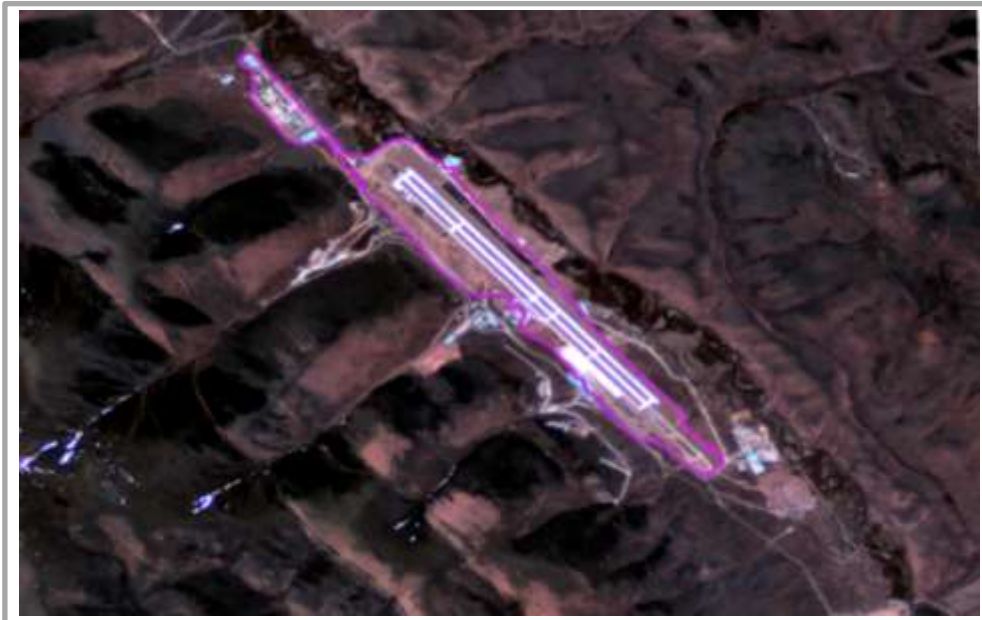


Input

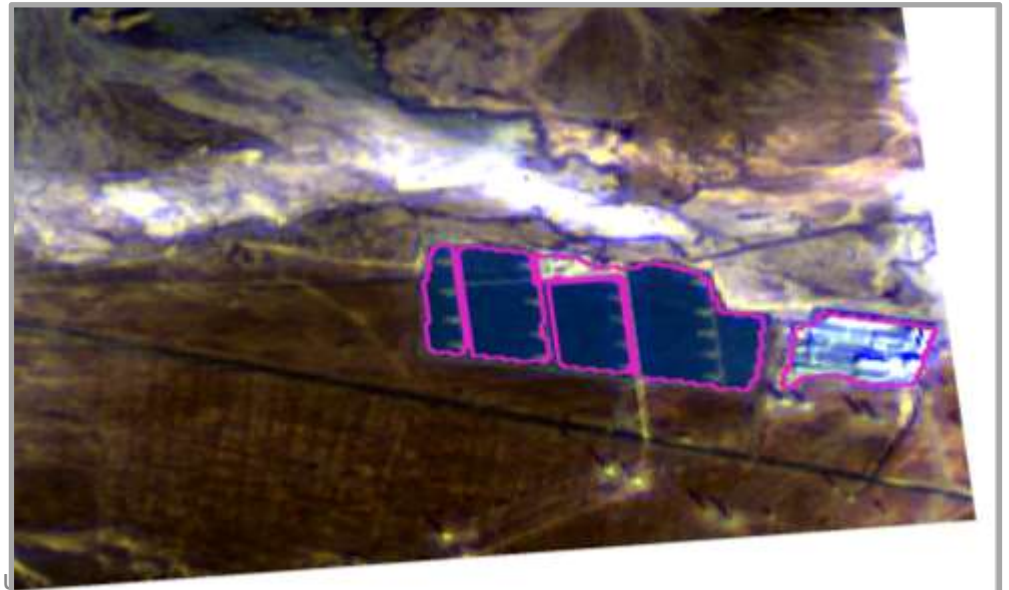


Detected Tree with Yellow Borders

Air Stripe Detection



Solar Farm Detection



Thank you
Reedhi Shukla
Reedhi_shukla@nrsc.gov.in