PS-10: Change Detection using Satellite Imageries

1. General Description

Availability of every day satellite imageries, giving carpet coverage of entire landmass of regions of our interest, has given the capability to continuously monitor any new developments. But it is impossible to handle this much volume of satellite imageries using trained human resource to analyse because of the scale and volume. Hence automation of change detection on such datasets using AI/ML has great operational usage to detect any new man-made developments including roads/tracks and other facilities of interest. AI/ML based change detection models can reduce false alarms in such change detection.

2. Problem Statement

a. Compare two satellite imageries of same sensor, with same location of different time periods.
b. Extract the man-made changes as a change mask in both georeferenced raster format, where pixel value 1 represents change and pixel value 0 represents no change, and vector format.

3. Outcomes

a. Stage-1
   1. Results to be shown as both raster change mask and corresponding vector file, extracted from the satellite imagery pair.
   2. Output file format is explained in evaluation methodology section 8.
b. Stage-2: Stage-2 problem will include change detection and further classification of detected change. However, solutions expected need to be developed for both Electro-Optical imagery pair and SAR imagery pair. Exact details will be updated to Stage-1 selected teams/participants.
c. Stage-3: Stage-3 problem will remain as change detection and classification, however, exact details will be updated to Stage-2 selected teams/participants

4. Datasets

Stage	Type of Dataset	Format	Objects /features to be searched	Remarks
Stage-1	• ResourceSat-2 (LISS-IV sensor) at 5.8m resolution • Sentinel-2 at 10m resolution	Tiff/jp2 file.	Man-made change detection on Electro-optical (EO) imagery.	Data to be downloaded from Bhoonidhi and Copernicus Portal. (*Refer links below the table)
Stage-2	• ResourceSat-2 (LISS-IV sensor) at 5.8m resolution • Sentinel-2 at 10m resolution	Tiff/jp2 file.	Man-made change detection and classification on EO and Synthetic Aperture Radar (SAR) imagery.	Source for downloading 3 m multispectral satellite imagery will be shared

	• Multispectral satellite imagery at 3m resolution • Sentinel-1 (SAR)		Classes may include 1. Kacha Tracks 2. Buildings 3. Roads 4. Land clearing/construction activities 5. Large-scale infra development (e.g., dams, solar, mining, factories, warehouse) 6. New Village Settlements	with Stage-2 participants.
Stage-3	• Internal Data • Both SAR AND EO	Tiff/jp2 file.	Man-made change detection and classification on both EO and SAR imagery	Data Source will be shared with Stage-3 participants

*Data Source for Stage-1
Bhoonidhi Portal: https://bhoonidhi.nrsc.gov.in/bhoonidhi/home.html
Copernicus Portal: https://browser.dataspace.copernicus.eu

5. Dataset Arrangement for Stage-1

a. **Training Dataset:** For development of the solution, Participants are expected to download and use data of the above-mentioned satellite sensors for stage-1.

b. **Mock Dataset:** Mock sets have been identified for the participants to test their solution. Details of the Mock set will be released on T0 + 45 day i.e. 15th Sep 2025. Solutions can be submitted on every Thursday from week commencing 15th Sep 2025. Participants can submit their results generated on Mock Set. The results submitted on this set will not be used by the organiser to short-list the participants for offline evaluation, but is meant for self-assessment and improvement of the developed solutions by the participants. Performance of the solution' results will be ranked and displayed on leader-board by Tuesday of corresponding week commencing 15th Sep 2025. Ranking will be based on the comparison between submitted results and ground truth.

c. **Shortlisting Dataset (Online)**: Details of the shortlisting dataset, containing list of 4 pairs of satellite imageries (02 each from both sensors, LISS-4 & Sentinel-2 hence makes data size approx. 10 GB), will be released on 31st Oct 2025 @ 1200 Hrs for download and inference generation. Participants have to submit the results of their solution on this set for the Stage-1 evaluation till 1600 Hrs of the same day i.e. 31st Oct 2025. They will be shortlisted based on evaluation of their submitted results, against this Shortlisting Dataset only. Hence, it is mandatory for participants to timely submit their results.

d. **Holdout Dataset(Offline):** A holdout dataset will be given to the participants, called for offline evaluation, to show their solution after Stage-1 deadline i.e. post 31st Oct 2025. The offline evaluation timeline will be shared later to the shortlisted participants.

e. **Sample Set:** sample_set.zip. This set contains 02 sample image-pairs with corresponding man-made change mask in raster and vector format, intended to serve as reference.

6. Guidelines for Stage-1 Challenge

i. Participants are expected to develop a solution that will work on different type of terrain features (sample locations provided in the list below). The desired solution should effectively detect man-made changes, in an automated way, for these different terrain conditions.

S.No	Terrain	Latitude (N)	Longitude (E)
1	Snow	34.0531	74.3909
2	Plain	13.3143	77.6157
3	Hill	31.2834	76.7904
4	Desert	26.9027	70.9543
5	Forest	23.7380	84.2129
6	Urban	28.1740	77.6126

ii. Participants are expected to download and use data of the satellite sensors mentioned in datasets section, for development. They are free to supplement it with other data sources.

iii. Participants are expected to develop an AI/ML Model which can identify man-made changes from given image pairs.

iv. Participants are free to use any development framework/ language.

v. When two images are being compared by the model, it should give a mask of man-made changes in georeferenced raster format, where pixel value 1 represents change and pixel value 0 represents no change, along with a corresponding vector file of the results.

vi. The generated output mask should be georeferenced in GeoTIFF format (raster) and shapefile (vector).

vii. Specifications of the satellite imageries used here (Maximum size) are mentioned below for reference.
   a. Sentinel-2: (~11000 x 11000 pixels at 10m resolution)
   b. Resourcesat-2: (~18000 x 17000 pixels at 5.8m resolution)

viii. Evaluation of the solutions will be held in both online and offline mode.

ix. Participants can submit the results generated on Mock Dataset on every Thursday from week commencing 15th Sep 2025. Using a leader-board, Ranking - based on results submitted - of the participants will be shared by Tuesday of corresponding week commencing 15th Sep 2025. This ranking is only for indicating the improvement requirement in the solution for participants only.

x. **Selection of 15-20 participants for offline-evalution in Stage-1:** On 31st Oct 2025, the details of Shortlisting Dataset will be made available on this website. Results generated on the Shortlisting Dataset imageries will be evaluated for final selection of 15-20 participants. The number may vary based on the

overall performance at the discretion of the Jury for this Problem Statement. Along with results, hash value (using md5 algorithm) of the solution needs to be submitted by the participant on 31st Oct 2025. Submissions found Incomplete in any manner will not be considered for further processing. The shortlisted participants will be published alongwith the cutoff score as per the evaluation criteria. Participants individual scores will be shared over the email.

xi. During offline evaluation, the model will be verified using this Hash value, subsequent upon which further evaluation will be carried out. Any kind of unfair means be avoided while developing and generating the solution and results, failing which will leads to cancellation of participation for the grand challenge and organisers can call the next participant from leader-board for evaluation.

7. Sessions with Mentors\Experts

a. For Stage-1, the organisers plan to meet participants via online meet or email to resolve their doubts, if any. This provision will be made active from 15th Aug 2025 and details regarding interaction will be shared on this website. Kindly keep viewing this website regularly for updates on this.

b. There will be sessions with Mentors\Experts in Stage-2 and Stage-3 for the willing selected participants to help them in achieving the best solutions

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8. Evaluation Methodology for Stage-1

A. Online Solution Evaluation during Stage-1

a. General Instructions

1. Participants will be given Mock Dataset details which they will download. They can use this dataset to test their solution performance. Solutions are expected to be submitted on every Thursday from week commencing 15th Sep 2025 and ranking will be shared by Tuesday of corresponding week commencing 15th Sep 2025. A leader board will be displayed for assessment and improvement of solution, based on test dataset. The submitted results against Mock Dataset will not be used for selection of participants by Organiser but to give the assessment of their solution performance.
2. The results submitted against Mock Dataset will be evaluated against the ground truth, withheld by the organizer, to score their performance. Scores/Rankings will be computed based on the evaluation metrics indicated below:

Category	Criteria	Description
Metric Evaluation	Jaccard Index	Score based on official metric on Test Set satellite imagery

3. On 31st October 2025, details of the Shortlisting Dataset (online), listing scene ids, will be made available on website @ 1200 Hrs. Participants need to download the dataset and generate the results (in raster and vector format) which will be submitted on the website, along with their model hash value (using md5 algorithm). The website submission will remain open from 1200 hrs and participants can submit their outputs till 1600 hrs. **So please ensure this submission by 1600h on 31st Oct 2025.**
4. The generated georeferenced change mask in raster (GeoTIFF) and vector (shapefile) format, for each image pair, need to be submitted for evaluation.
5. Based on the performance on Shortlisting Dataset (online), top 15-20 participants will be called for offline evaluation.

b. Input

The solution developed must take following inputs:

1. Image-pairs (Two images of same sensor of same location, with varying time period)

c. Output

The solution developed must:

1. Compare the two images for man-made changes.
2. Output a raster mask in GeoTIFF format where pixel value 1 represents change and pixel value 0 represents no change.
3. Corresponding vector file in shapefile format need to be generated.
4. **Submission of Results:** Participants need to generate and submit the results for all image pairs listed in 'Mock' and 'Shortlisting Dataset'. Name each image-pair change mask output file name as 'Change_Mask_Lat_Long.tif' (Raster File) and 'Change_Mask_Lat_Long.shp' (Vector File) where Lat_Long are given in 'Reference Location' column of the table listing dataset.
5. Keep your results in a Folder and submit it in compressed format as PS10_[DD-MMM-YYYY]_[Startup/Group Name without Space].zip.
6. Results will be evaluated against reference labels of the corresponding dataset with the organizers.
7. Additionally, the hash value of the model needs to be generated using MD5 hashing algorithm in text file and submitted on website on 31st Oct 2025 along with the results of Shortlisting Dataset (online). The hash value of the model must be submitted along with the results of Shortlisting dataset.
8. During offline evaluation, the hash value of the model will be verified.

B. Offline Solution Evaluation after Stage-1 Deadline

a. Selected participants will be asked to demonstrate their capability offline at IIT Delhi.

b. Participants will be allotted the slots in which they need to run their solution on reference data provided by the organizers on organizer's resources with following specifications: -
    a. OS – Ubuntu 24.04 LTS
    b. CPU – 48+ core
    c. RAM – 256+ GB
    d. GPU - 40 GB
    e. 2 Hours
c. During offline evaluation, the hash value of the model file will be generated and compared with the previous submission during online stage, to check for integrity and verification for nil changes using this Hash value at offline stage, subsequent upon which further evaluation will be carried out.
d. Based on the results from solution demonstration and presentation, final scores will be computed based on Evaluation Metrics as mentioned below:

Category	**Criteria**	**Description**	**% Weight**
Solution Evaluation	Jaccard Score	Score based on official metric on hidden hold-out satellite imagery pair	50
Resource Utilization	Inference Time and Solution Memory Footprint	Solution Execution time on test dataset and Memory used by Solution during execution	15
Problem Understanding and Team Capabilities	Start-up Capability to understand the problem and Technical Capabilities of Start-up Team	Start-up need to understand the problem and challenges for development of the solution. They will also be evaluated on parameters like Team Composition, Qualifications, Experience and ability to complete the challenge end to end.	25
Approach	Methodologies of Solution Development	Start-up need to present Solution development approaches & proposed Architecture/ Innovation.	10

e. Top 6 teams will be selected for Stage-2, based on final score of offline evaluation.

9. Evaluation Criteria for Stage-II is mentioned below:

a. Selected participants will be provided details of dataset source and the object/feature classes as mentioned in Stage-2 under Section 4 – Datasets.

b. Stage-II evaluation will be based on the results from solution demonstration and presentation, final scores will be computed based on Evaluation Metrics as mentioned below:

Category	**Criteria**	**Description**	**% Weight**
Metric Evaluation	Confusion Matrix/Jaccard Index metric/ F1 Score	Score based on official metric on hidden hold-out satellite imagery pair	50
Resource Utilization	Inference Time and Solution Memory Footprint	Solution Execution time on holdout dataset and Memory used by Solution during execution.	30
Approach	Methodologies of Solution Development	Start-up need to present Solution development approaches & proposed Architecture	20

10. Evaluation Criteria for Stage-III will be shared with selected participants of Stage-3. It would be on similar lines as Stage-2.