
Team Name :Kalam  Crew
Name of College: IIT ROPAR

Team Members Details:

1. Ashish Yerra
2. Jatin Kumar
3. Rahul
4. kshitij

# Detailed solution and Approach (250-300 words)

Here we have our solution in 3 parts:
1.data collection
2.training the model and detection of craters and boulders by models
3.Output  shapefile generation

1.Data Collection:

We have taken kaggle Martian/Lunar Crater Detection Dataset for building a prototype model. The dataset mainly contains:
Image Data: Images of Mars and Moon surface which MAY contain craters. The data source is mixed. For Mars images, images are mainly from ASU and USGS; Currently all
Moon images are from NASA Lunar Reconnaissance Orbiter mission. All images are preprocessed with RoboFlow to remove EXIF rotation and resize to 640*640.

Labels: Each image has its associated labelling file in YOLOv5 text format. The annotation work was performed by ourselves, and mainly serves the purpose of object
detection.

# Detailed solution and Approach (250-300 words)

2. Train the model and detection of crater and boulders:

For training our model we chose YOLOv5 based architecture

**Why YOLOv5?**

- It is built on PyTorch and follows the one-stage object detection approach. Unlike two-stage detectors (such as Faster R-CNN), YOLO processes the entire image in one pass.
- It divides the image into a grid of cells and predicts bounding boxes and class probabilities for objects within each cell.
- The model architecture consists of a backbone (usually a convolutional neural network), followed by detection heads that predict bounding boxes and class scores.

Training and detection on Crater dataset:

- We trained a custom YOLOv5 model based on our dataset (specifically used YOLOv5s variant). We used learning rate of 0.01 for 300 epochs and obtained mAP score of 0.647 .(though it stopped training in last 100 epochs as no improvement is observed after epoch 156)

3.Output: shape file generation:

After detecting craters in the provided images, the model generates a shapefile containing the geographical information of the detected craters. A shapefile is a popular geospatial vector data format for geographic information system (GIS) software. It spatially describes geometries: points, lines, and polygons representing spatial locations and attributes

# Tools and Technology Used (50 words)

-Yolov5s custom model (using train.py and detect.py script provided by Ultralytics (creaters of YOLOv5) for training the model.
[https://github.com/ultralytics/yolov5/tree/master]

-Google Colab Tesla T4 GPU offering 16 GB of GDDR6 memory and 2560 CUDA Cores for training the data for 300 epochs.
[https://colab.research.google.com/]

-kaggle Martian/Lunar Crater Detection Dataset
[https://www.kaggle.com/datasets/lincolnzh/martianlunar-crater-detection-dataset ]

# *Uniqueness of our proposed solution*

**Custom Training on YOLOv5**:

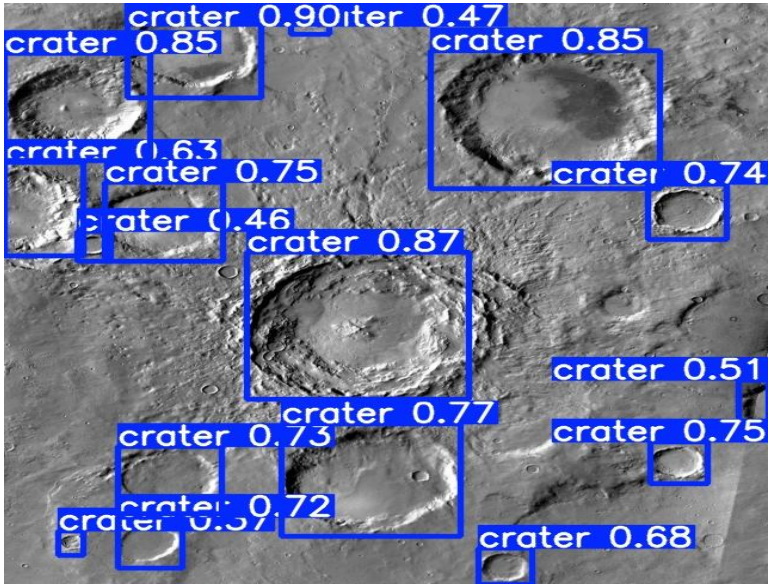
- **State-of-the-Art Architecture**: Our model leverages YOLOv5, one of the most advanced and current object detection models, recognized for its exceptional speed and accuracy.
- **Tailored for Crater Detection**: We have custom-trained the model specifically for crater detection, ensuring it delivers high precision and recall rates for this unique application.

**Enhanced Accuracy**:

- **High Detection Accuracy**: The model achieves superior accuracy in identifying craters of various sizes and shapes, outperforming generic object detection models.
- **Reduced False Positives**: Custom training helps in minimising false positives, resulting in more reliable detection outcomes.

# Proposed architecture/user diagram

Our model is based on YOLOV5 architecture. The training loss curve and some sample images detected by our model are shown below




The shape file was also generated based on these Craters

[*fig shows detected crater in given image along with Confidence values mentioned*]

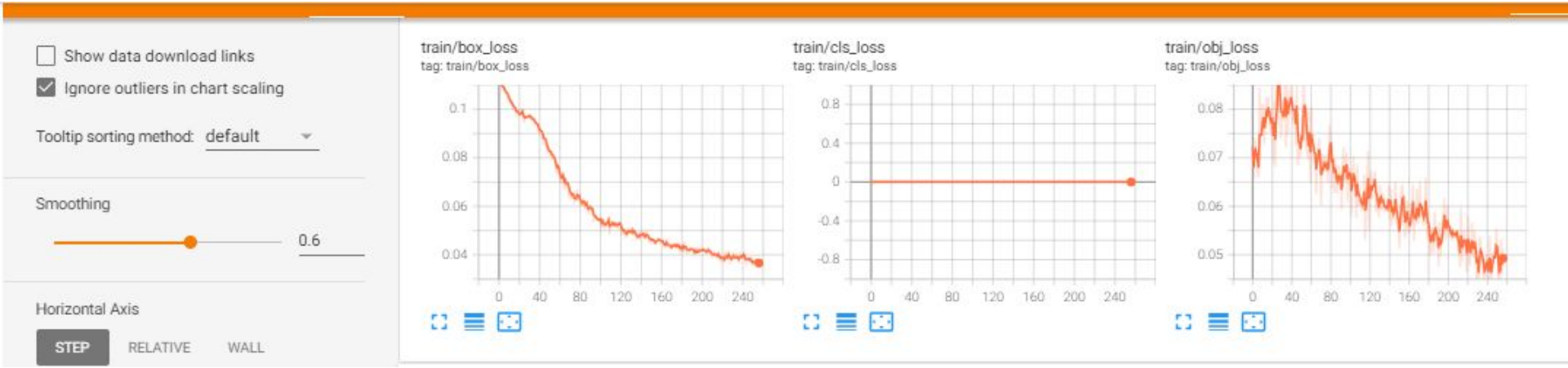



*Fig shows losses during training on lunar dataset.*

# List of features offered by the solution

-The mAP value of 0.647 which can be further improved on preprocessing of images and also using data augmentation to provide more data.
-It will allow in real time detection of craters for the satellites to provide more accurate data about lunar surface [or infact any planet's surface through preprocessing of RGB to B&W format.

# Solution Brief (Overall)

***Crater Detection: Pioneering Lunar and Martian Exploration***

Our project utilizes deep learning to identify craters and boulders on the surfaces of the Moon and Mars. We employed the Kaggle Martian/Lunar Crater Detection Dataset, standardizing images for uniformity. Using the YOLOv5s model, our training process spanned 300 epochs, achieving a mean Average Precision (mAP) score of 0.647. This ensures accurate detection with minimal false positives. After detection, we produce shapefiles with the spatial coordinates of craters for detailed geospatial analysis. This approach enhances real-time exploration, providing significant insights into extraterrestrial landscapes.


BHARATIYA ANTARIKSH HACKATHON 2024
Innovation partner H2S
इसरो isro
THANK YOU