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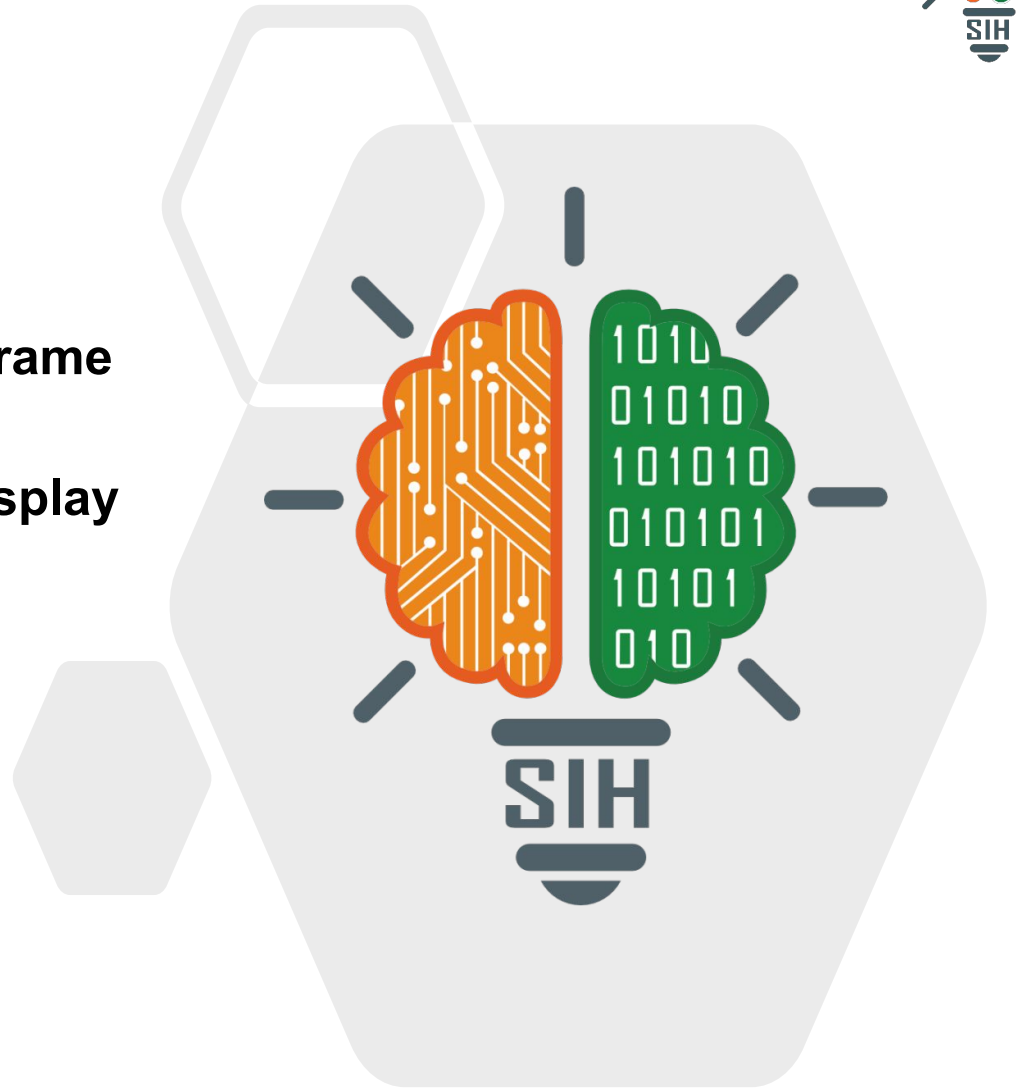

- **Problem Statement ID – 1736**
- **Problem Statement Title- AI based frame interpolation, video generation and display system for WMS services**
- **Theme- Smart Automation**
- **PS Category- Software**
- **Team ID- 15831**
- **Team Name - BILLI GANG_VIT**

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Flow Enhanced Interpolation Network

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- Our custom made Machine Learning based model which generates **smooth AI Generated Video** out of satellite images received, provided a WMS Server.
- The Model is compatible to **generate videos** from satellite images received (realtime as well as 30 minutes apart) without compromising on the accuracy.
- The output is shown on **leaflet** (popular open source JS Framework for Interactive maps) and is embedded on our website.
- Our source of dataset for the entire project was **MOSDAC INSAT 3DR** Satellite data.

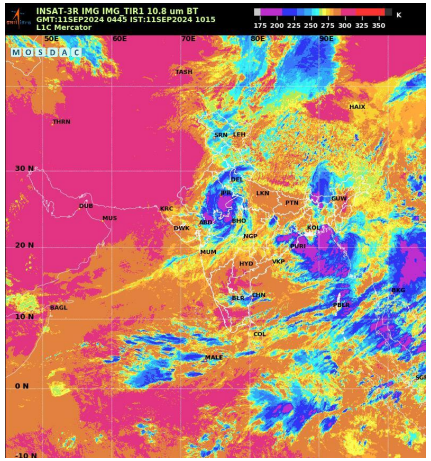

Fig1

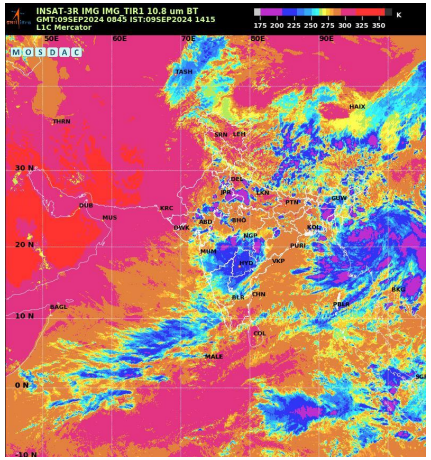

Fig2

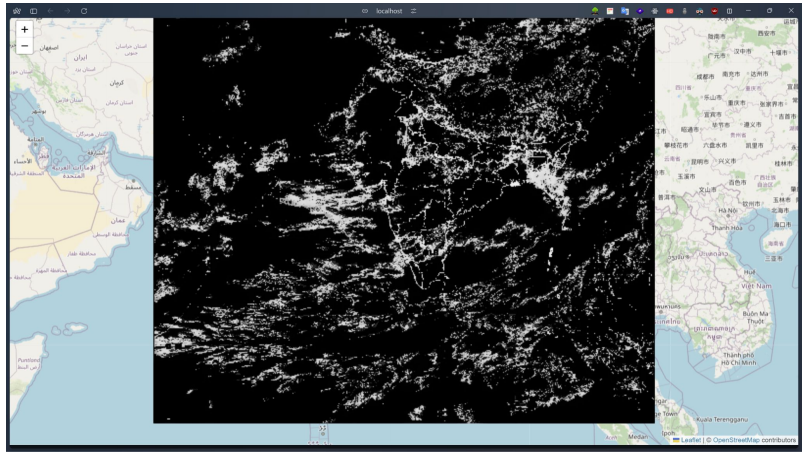

Fig3

- Fig1 and Fig2 are sample inputs received 30 mins apart, while Fig3 is the images generated between **two (provided)** images.
- Fig3 is the snapshot of the final processed moving objects' video and has been integrated with leaflet **(colour inverted for visibility)**

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TECHNICAL APPROACH

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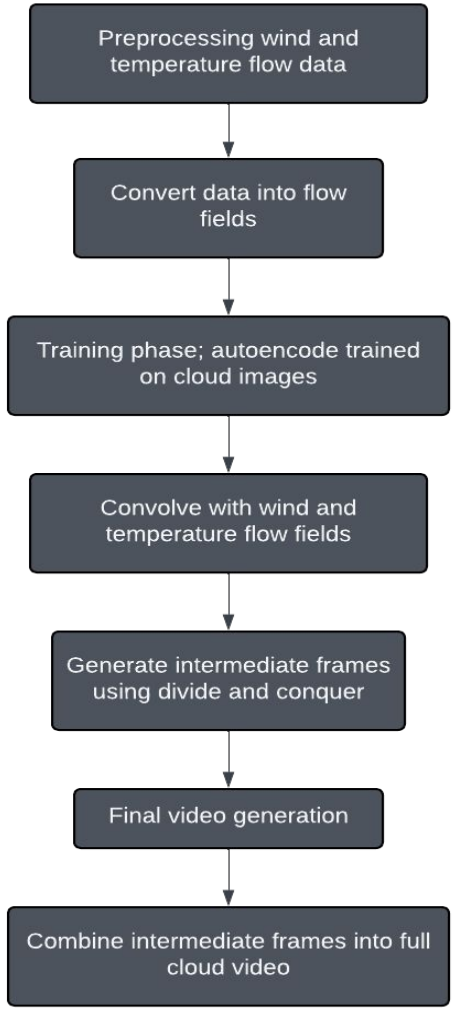
- Machine Learning Model (FEIN) uses - Python, ReactJS, NumPy, Flask, Leaflet
- Hardware - GPUs/NPUs, Cloud Services for faster processing

- **Specialized Frame Interpolation Model**: Traditional models assume clouds move in straight paths between two frames. Our model, like a neurologist, factors in environmental data such as wind speed and direction for more accurate cloud movement predictions, especially during extreme conditions like cyclones.
- **Autoencoder Architecture**: Our model uses an auto-encoder with two parts: the encoder processes cloud patterns and wind data separately through convolution layers, and the decoder reconstructs an intermediate frame using transposed convolution layers.
- **Wind Data Extraction**: We utilize MOSDAC's EOS-06 scatterometer wind data (provided by ISRO) to model wind flow fields. Wind direction and strength are converted into 2D vectors and aligned with satellite imagery, forming a NumPy array that mirrors the cloud movement.
- **Dataset Collection and Challenges**: Due to lack of access to MOSDAC, we manually downloaded 10,000 satellite images (wind and infrared). Aligning wind data with cloud imagery was challenging, but we achieved precise mapping through careful calculation of wind speed, direction, and cloud density.
- **Importance of Wind Alignment**: By aligning wind data with satellite imagery, we model the wind as a flow field. This helps predict how wind influences cloud movement, improving our model's accuracy in forecasting weather patterns.



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FEASIBILITY AND VIABILITY

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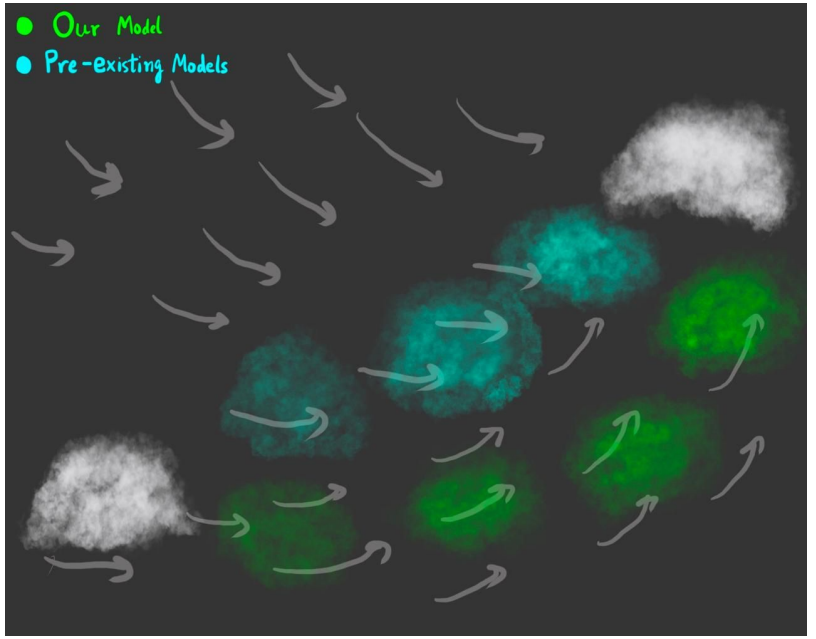

- **Feasibility** - Realtime Infrared Data of moving objects on earth **does not exist** (temperature management on the satellite, preprocessing required), hence the output we generate holds value for scientists to study and see **smooth visualization** of not so user friendly data.
- **Novelty** - Frame Interpolation models exist, but they currently predict displacement **not the distance.** Our model takes in account the environmental factors which affect the moving clouds **(eg- wind direction, temperature)** and provides the **best predicted realistic result** in what happened between the two frames time periods apart.
- **Scalability** - Various use cases can be handled (such as forest fires) by the model including **realtime smooth weather visualization**, using cloud resources makes the entire process viable
- **Challenges & Risks** - Interpolating frames for **deformable objects like clouds**, which may change shape, disappear, or appear between frames, is complex. Our model takes care of this as we have additional factors in account for the prediction
- Tough on the Implementation as the processing power required is huge. We have accounted for the **utilisation of on-device GPUs/NPUs** available in modern desktop/mobile devices for better processing than CPU. The ETA reduces by 32.7%.

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IMPACT AND BENEFITS

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- **Potential Impact on the target Audience** - The target audience for this solution includes **WebGIS application developers**, **scientists**, **researchers**, **environmental monitoring agencies**, and **end users** of satellite data visualization platforms like VEDAS, MOSDAC, or BHUVAN. The system will significantly enhance their ability to visualize, analyze, and interpret satellite data in real time, offering smoother and more detailed insights into dynamic phenomena.

- **Environmental and Disaster Monitoring Agencies:** Agencies responsible for tracking weather patterns, monitoring environmental changes, or predicting natural disasters will benefit from more accurate, real-time visual data. This could enhance decision-making and timely interventions.

- **Real-Time Data Interpolation:** With AI-driven frame interpolation, the solution generates smoother transitions in satellite imagery, offering detailed insights into **rapidly changing phenomena** like cloud movements or storms, enhancing analysis and interpretation.

- **Cost-Efficient, Open-Source Technology:** By leveraging open-source GIS libraries, the solution reduces development costs, making advanced satellite data visualization accessible to a wider range of users and organizations.

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RESEARCH AND REFERENCES

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- RIFE (Real-Time Intermediate Flow Estimation) - https://github.com/styler00dollar/Colab-RIFE
- DAIN (Depth-Aware Video Frame Interpolation) - https://github.com/baowenbo/DAIN
- FILM (Frame Interpolation for Large Motion) - https://github.com/google-research/frame-interpolation
- Leaflet - https://leafletjs.com/reference.html
- MOSDAC for Dataset - https://mosdac.gov.in/gallery/#
- Web Map Service - https://www.ogc.org/standard/wms/
- Stanford CNN - https://www.youtube.com/playlist?list=PL3FW7Lu3i5JvHM8ljYj-zLfQRF3EO8sYv