

Web-based Volume Rendering and 3D/4D Visualization of Model Forecast



Organization: Indian Space Research Organization (ISRO)

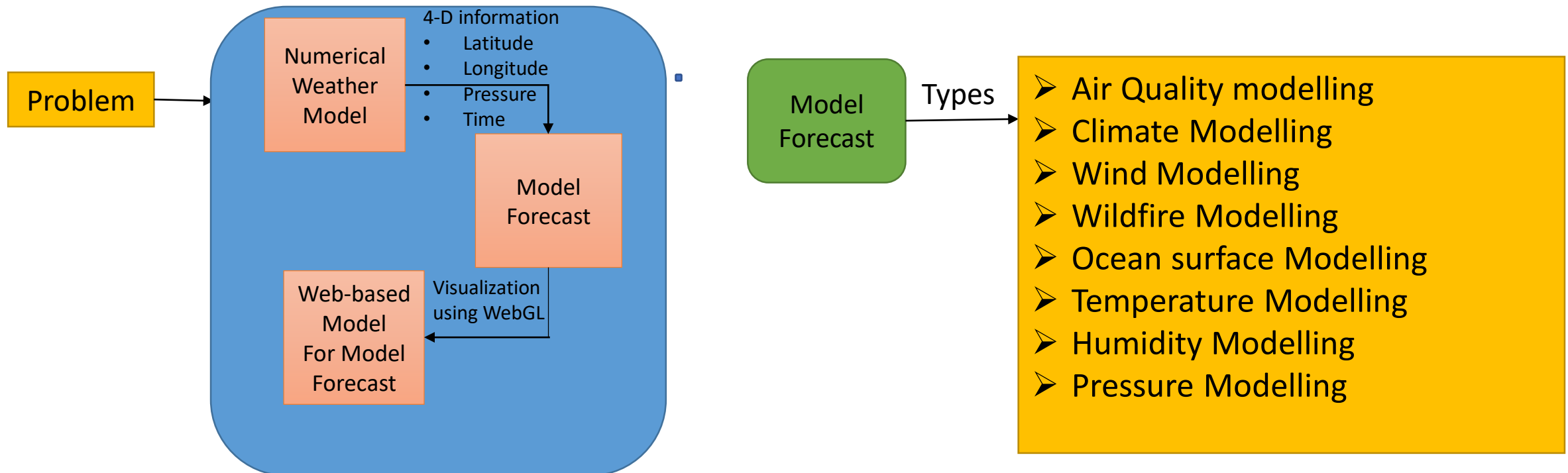
Problem Statement: The numerical weather models are used for generating forecast, these model forecast contains **4D information (i.e., Latitude, Longitude, Height/pressure and Time)**. These model forecasts are **gridded at a defined sampling interval**, and are very useful for planning and decision supports. **WebGL** is a **JavaScript API** for rendering **high-performance interactive 3D and 2D graphics**. The participants must develop a **web-based tool** for **3D/4D visualization** of model forecast.

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Problem Statement Code: NM389

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Implementation Idea

- **Abhigyataa** is a **web based tool** for **3D/4D visualization** of model forecast implemented through web application which performs volume rendering i.e. gives 2D visualization of the data on the map, 3D like visualization on the globe both in space and space/time.
- **Model forecasts** are graded at a **defined sampling interval**.
- Useful for **planning** and **decision support** due to visual tools given.
- **Abhigyataa** provides a **multi model visualization tool** and provide **real-time** visual data using **WebGL and OpenGL**.
- Forecast model ranges from
 - Air quality visualizer
 - Wind map
 - Wild fire visualization
 - Ocean Surface modeling
- Uses **web globe model** representation to depict 4D data.
- **Portal** helps government agencies in making **environment policies**.

Features

- Spatial Searching Algorithm is used for visualization using WebGL.
- Efficient Algorithm like **K-Nearest Neighbour Algorithm**.
- **Range queries in trees** and **KNN queries**.
- Compatible with browser.
- **No need** of running **heavy prediction models** (cloud based model running)
- Provides **Multi-touch environment**
- Provide browser **extension** for **parallel-processing**.
- Multi-colour plotting of data for clear understanding.
- **Web-scraping** in future can be inculcated on the model integrated with the website at business level to solve queries submitted by various organizations and speed can be enhanced through **multi-threading**.

Welcome to Air Quality Visualiser

Query Type:
☐ All Cities
☒ Specific Station

Station Name:
ADANA CATALAN

Select Date-Time Between:

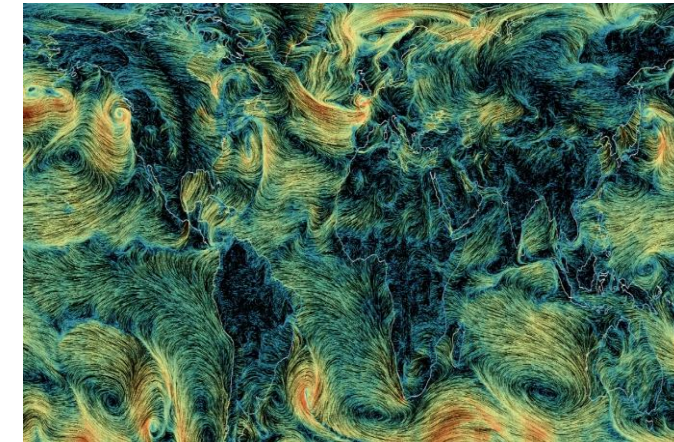
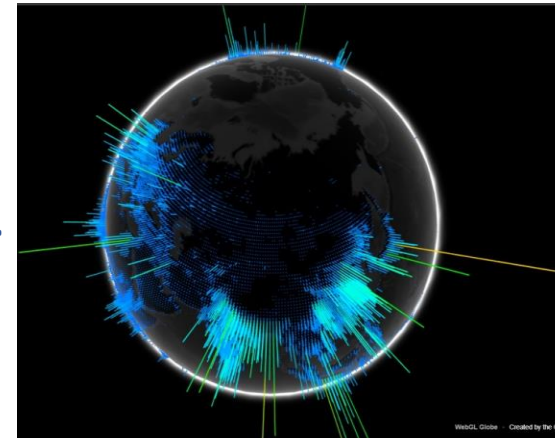
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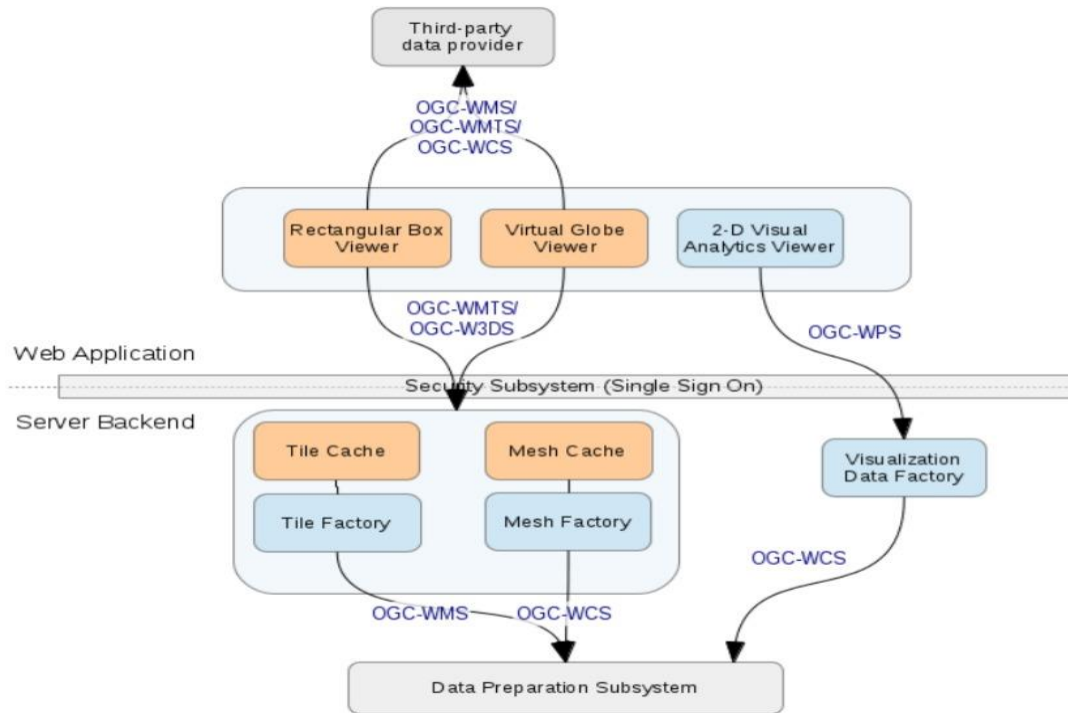
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Limit results to : 100

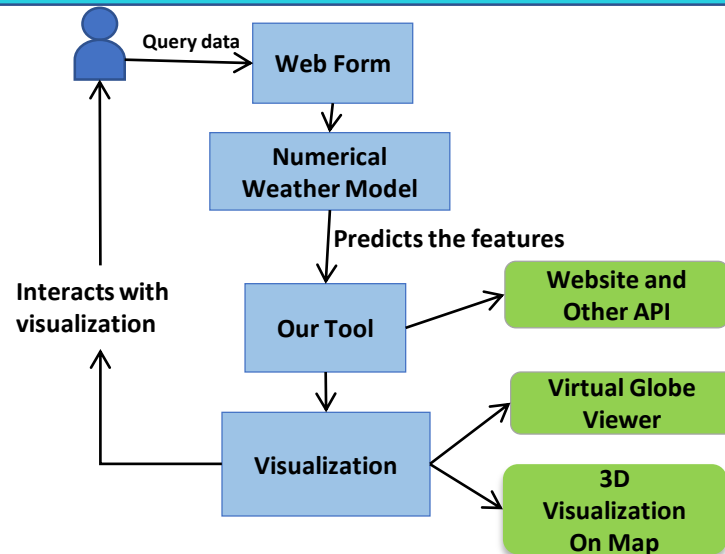
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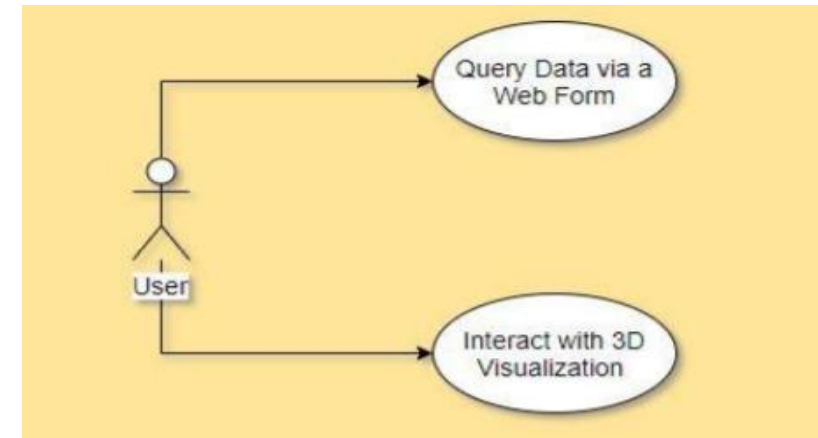
SYSTEM ARCHITECTURE



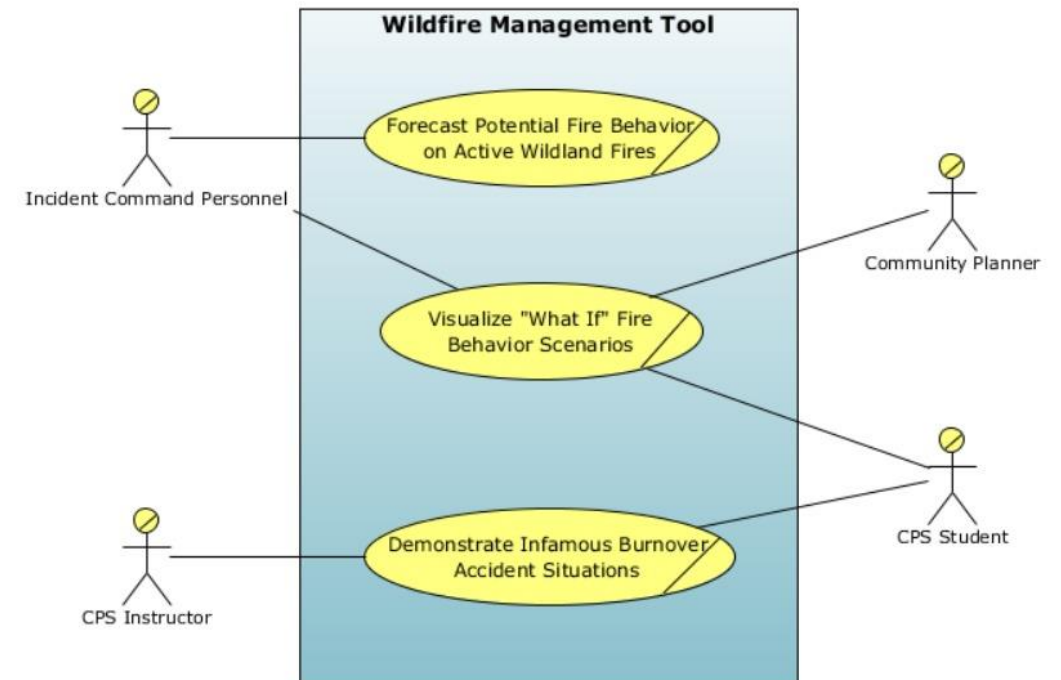
DATA FLOW DIAGRAM OF WORKING



USE CASE DIAGRAMS



WILDFIRE MANAGEMENT MODULE USE CASE



Technology Stack

- WebGL(JavaScript API), OpenGL and AJAX.
- **Python Environment** : time, os, url, re, math, bs4, requests, threading, pathlib, Json
- **Extension + Web Application Frontend**: HTML,CSS,JavaScript, Bootstrap.
- **Extension + Web Application Backend**: Django Framework ,REST API.
- **Cesium JS and Spatial Algorithm.**
- **Machine Learning, Data Visualization**: TensorFlow, Scikit Learn, Pandas, Numpy, Matplotlib.
- **Technologies**: WebGL JavaScript API, Web Development, Multi-Threading, Machine Learning.

Use Cases and Utilities

- **Air Quality Modelling**: Help the government to implement **new environment policies**. Can also aid in the analysis of the **city pollution**.
- **Wildfire Visualization**: Improves **safety of firefighter**, promotes the principles of tenets of **Campbell Production System (CPS)** **predicting nature of wildfire**.
- **Wind Map**: Help in analysing the **cycle of monsoon**, thus can aid in **agricultural planning**, visual model for efficient analysis.
- **Ocean Surface Modelling**: Can be used in **Military Navy operations** and in trades carried out by Merchant Navy in **navigation** to check if depth is appropriate to venture out or not.
- **Climate Modelling**: Can predict wider conditions thus can aid in making **economical choices** relating to **crops, storage** and **inventory, household expenditure pertaining** to **clothing** and **lodging** etc. It can also visualize overall effect on the environment.

Distributed Model

- **REST API Query-Response Model** for platform offer **for platform-independence, portability** and **scalability**. It also offers a customizable and flexible development, and can be used as a service oriented product.
- **Browser Extension** to provide **parallel processing**.

Conclusion

- **Web Application Approach**: No need of installing/updating software on their local machine.
- **Performance of the system**: Speed of data access and data manipulation.
- **Time Slider**: Allow easy interpretation of where and when data is available.
- Several illustration facilities
 - ❑ **2D view on the map**
 - ❑ **Virtual Globe**
 - ❑ **3D views both in space and space/time.**
- **Analytic tools** to display time-series at selected points.
- Can facilitate the **dissemination of spatial high volume data** through efficient visualization.
- **Visualization of temporal/spatial of available data-sources** in one application
- **Multiplier and distributed system** can enhance system efficiency.
- UI of the system will be enhanced by providing web-map based information seeking tool where the user can select an area from the map and send a query to the system using coordinates of the bounding box.
- Made the Application by extending on the **research papers** studied.