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TITLE PAGE

- **Problem Statement ID – SIH 1735**
- **Problem Statement Title-**

  On-device semantic segmentation of WMS services with geospatial data export
- **Theme-** Smart Automation
- **PS Category- Software**
- **Team ID-** 48970
- **Team Name -** Ctrl + Shift + Hack

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SAMARTH

(Segmentation And Mapping for Accurate Remote Terrain Handling)

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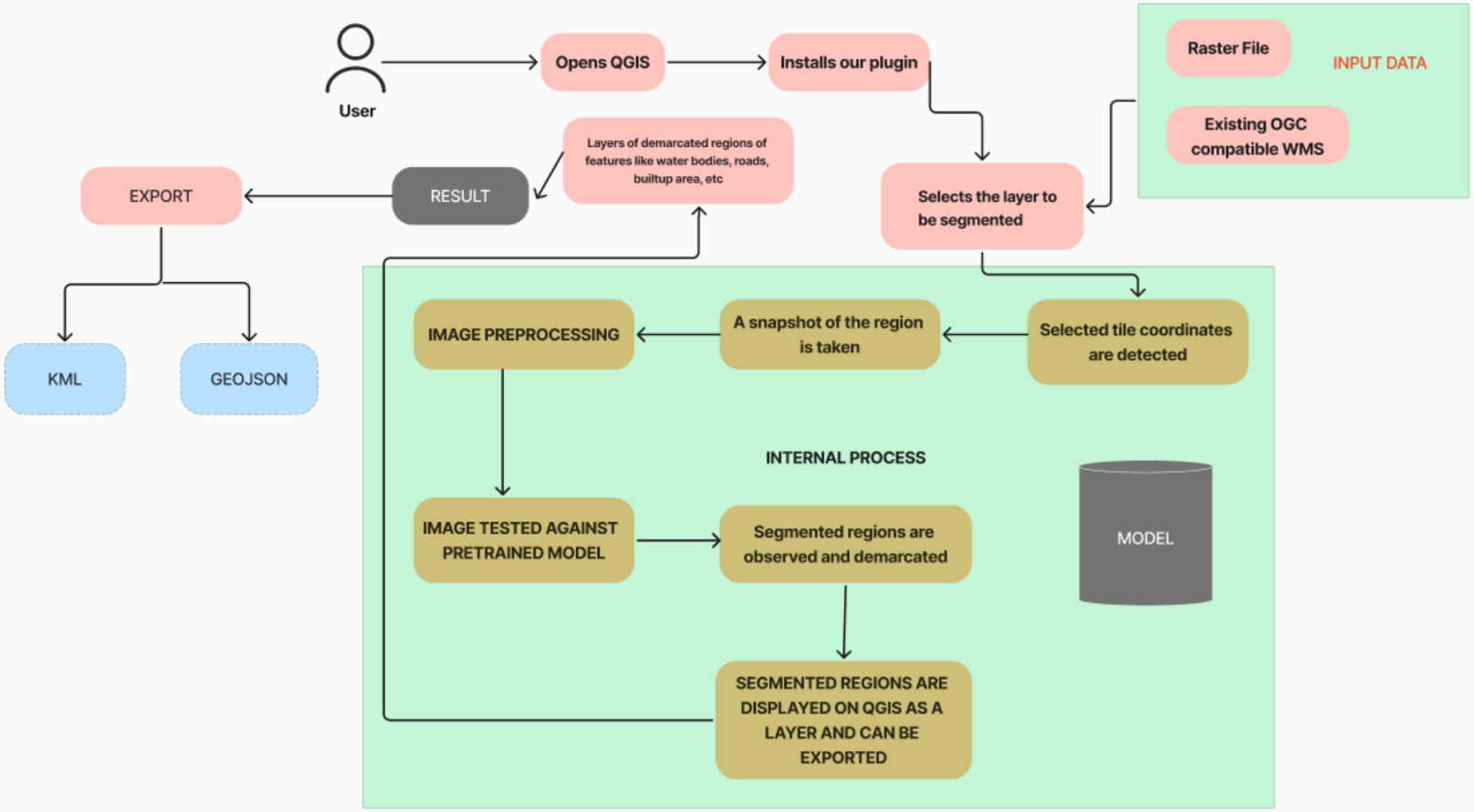

✦ Proposed Solution

- We are developing a QGIS plugin that leverages on-device GPU/NPU for real-time semantic segmentation of images from WMS services.
- The plugin will enable users to select map areas, perform segmentation, and export results as geospatial data in KML or GeoJSON formats.
- Optimized CNN models (e.g., U-Net or SegNeXt) ensure efficient on-device processing.
- This solution improves digitization workflows for remote sensing applications without relying on external servers.

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TECHNICAL APPROACH

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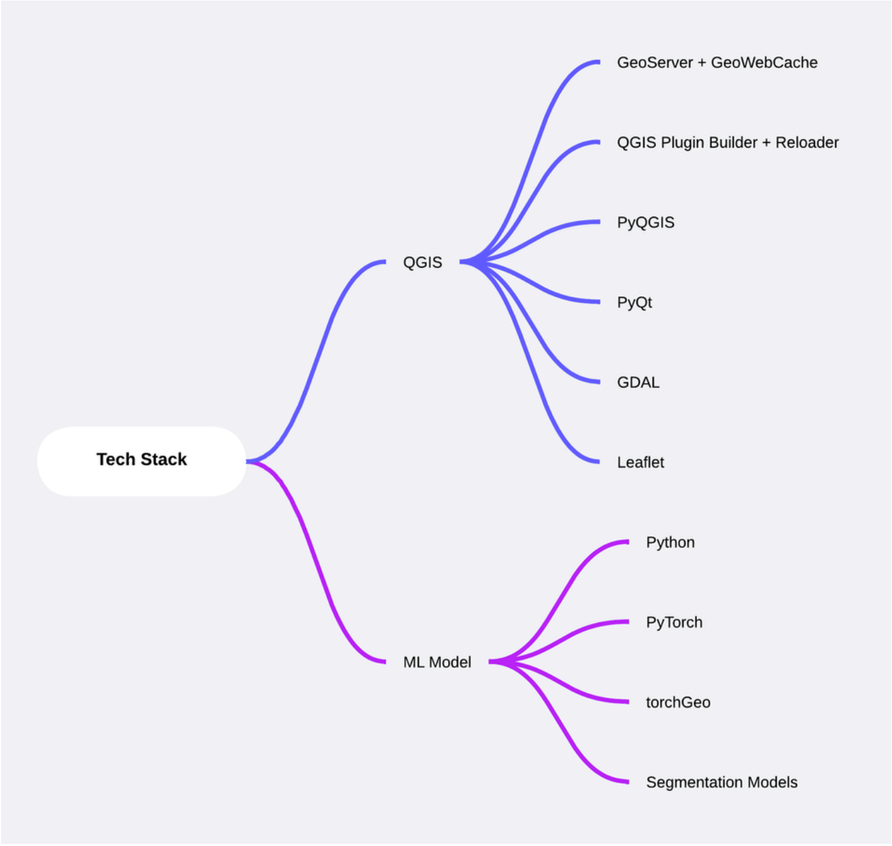
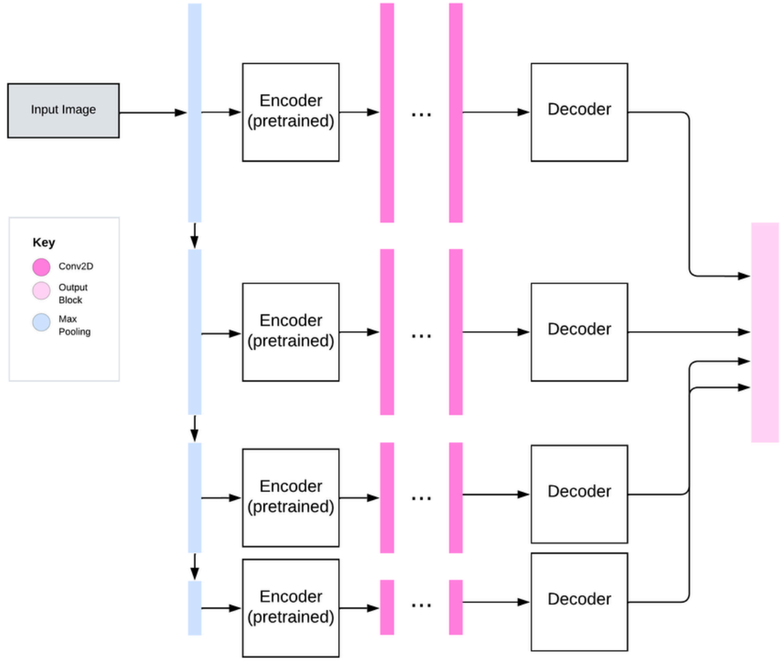
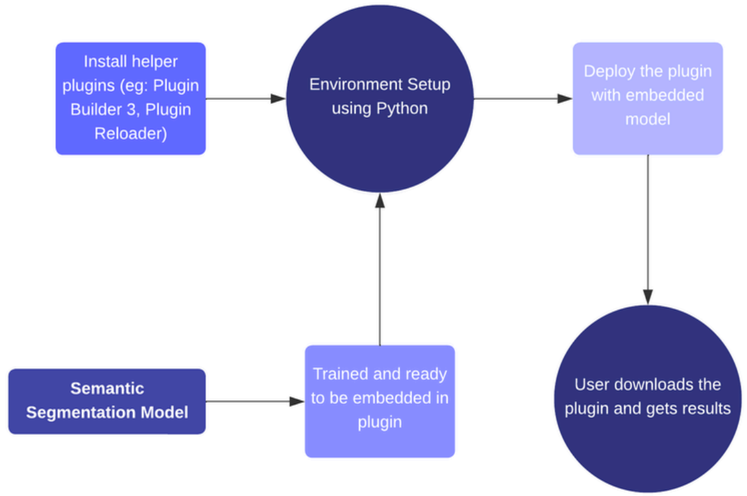


Model Overview



WMS Dev Pipeline



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FEASIBILITY AND VIABILITY

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The use of model architectures like U-Net or SegNeXt, optimized for on-device GPUs/NPUs, ensures real-time segmentation of WMS imagery, making it feasible for desktop platforms. Also, we ensure the reliance on server is nil.

Technical Feasibility

We will be using CNN models instead of Vision Transformers, as PyTorch has better support for CNNs. Additionally, we will ensure that the model size remains small and the response time is low, reducing the load on the user's device while maintaining a satisfactory level of accuracy.

Efficiency

Since we are using a serverless architecture, the system will function effectively regardless of whether we have a few users or millions. Additionally, we support the segmentation of aerial images, which can be accessed either from raster files or via WMS (local or globally hosted)

Scalability

Challenges

To ensure the system is user-friendly and accessible, even for non-technical users

To utilize the computational power of GPUs/NPUs to enhance the performance and responsiveness of the system and reduce reliance on server side GPU compute.

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IMPACT AND BENEFITS

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The solution provides WebGIS application developers and end-users with advanced plugin for accurate and efficient semantic segmentation, leading to enhanced capabilities in urban planning, environmental monitoring, and disaster management.

Social

Improves community engagement in urban planning by enabling local stakeholders to visualize and interact with spatial data effectively

Economic

Reduces operational costs for organizations by minimizing cloud dependency and streamlining workflows for geospatial data analysis.

Environmental

Facilitates better resource management and conservation efforts by enabling precise mapping of land use and vegetation, leading to more informed environmental policies.

Educational

Provides a practical tool for educational institutions and researchers, enhancing the learning experience in geography and environmental studies.

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RESEARCH AND REFERENCES

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Semantic Segmentation

- https://medium.com/@robmarkcole/a-brief-introduction-to-satellite-image-segmentation-with-neural-networks-33ea732d5bce
- https://arxiv.org/abs/2111.12126
- https://arxiv.org/abs/2209.08575
- https://github.com/qubvel-org/segmentation_models.pytorch?tab=readme-ov-file#examples

QGIS

- https://drive.google.com/drive/folders/1enkTDf1Vjn-xyJAsfIldkkgmtXNxtKAO?usp=sharing
- https://docs.qgis.org/3.34/en/docs/pyqgis_developer_cookbook/index.html
- https://docs.qgis.org/3.34/en/docs/pyqgis_developer_cookbook/plugins/index.html

Dataset	Format
DeepGlobeLandCover	• images are RGB data; • masks are RGB image with with unique RGB values representing the class
DFC2022	• images are three-channel geotiffs • DEMS are single-channel geotiffs • masks are single-channel geotiffs with the pixel values represent the class
UC Merced	• images are RGB data; • masks are RGB image with with unique RGB values representing the class
LoveDA	• images are three-channel pngs with dimension 1024x1024 • segmentation masks are single-channel pngs