Guided Transformer Network for Detecting Methane Emissions in Sentinel-2 Satellite Imagery

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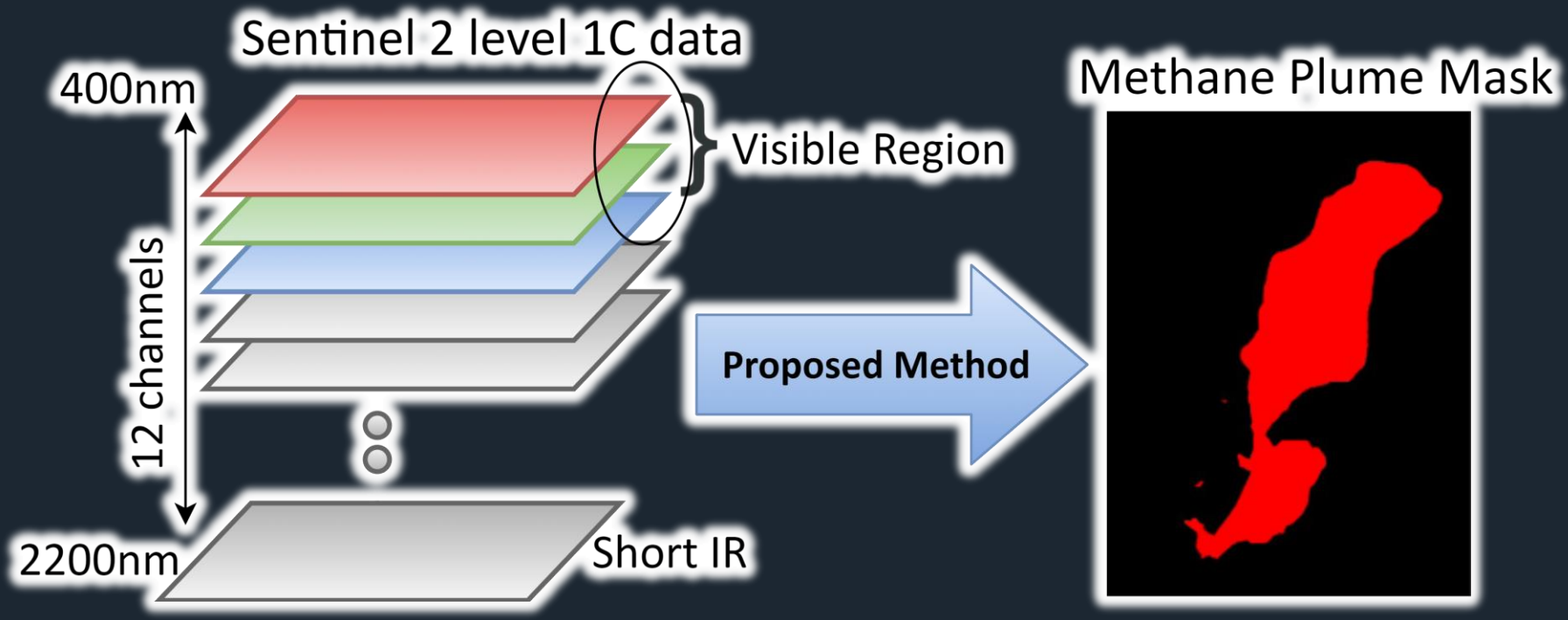
GOAL

Detect Methane Emissions using multispectral imagery from Sentinel-2 satellite.



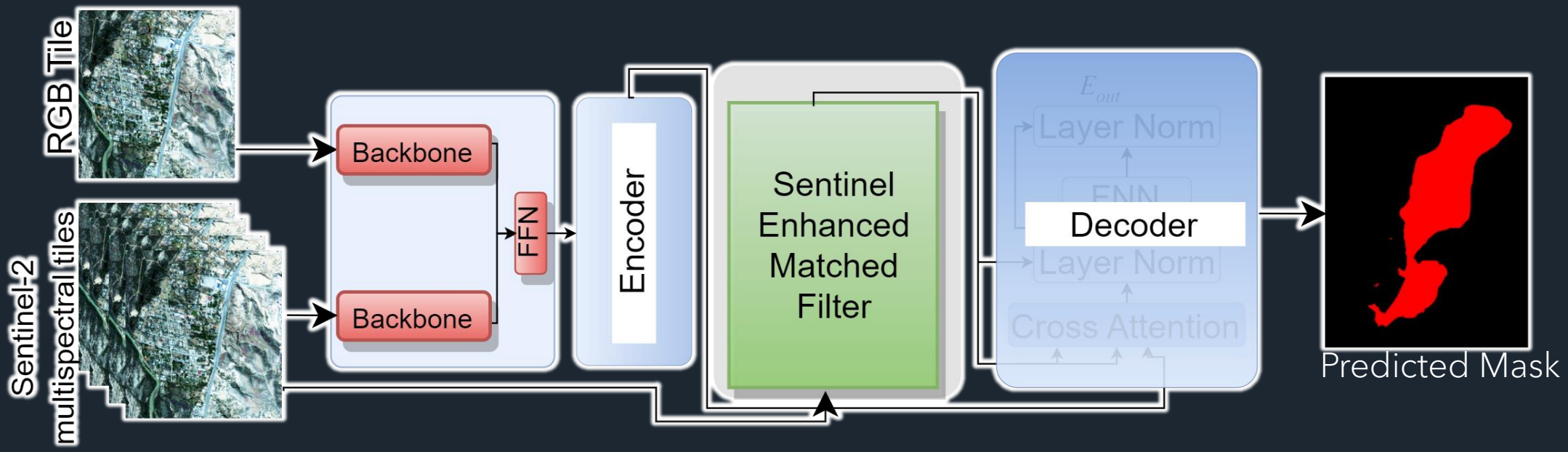
LIMITATIONS OF EXISTING METHODS

- Existing methods works well but rely on temporal information
- Assume relatively non-changing ground terrain condition
- Use ancillary data like ground wind speed
- And still produce noisy detections

PROPOSED SOLUTION

- We propose a Guided Transformer Network for Methane plume detection
- Unlike existing methods, our network use only same day data to make detection without any dependency on temporal information
- Our Network learns about the ground terrain distribution from RGB channels in the input data
- We do not use any ancillary data such as wind speed

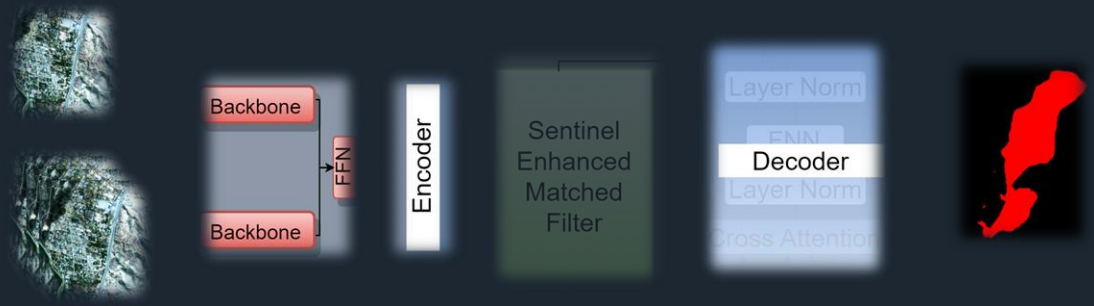
PROPOSED ARCHITECTURE OVERVIEW



An encoder-decoder based transformer architecture

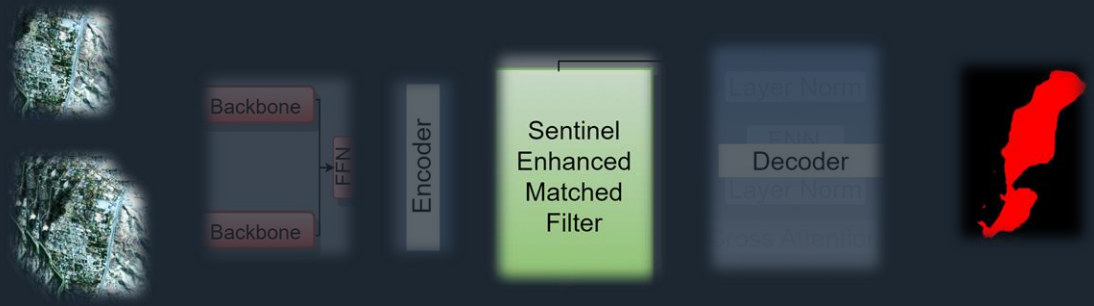
ARCHITECTURAL DETAILS

- An encoder-decoder based guided transformer architecture to detect methane emission plume mask



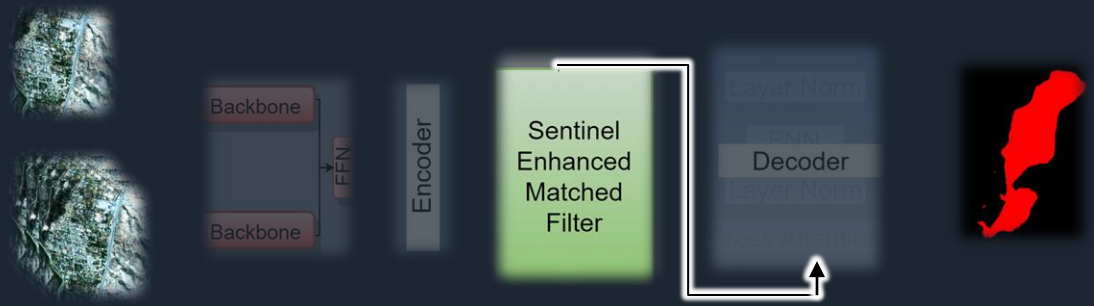
ARCHITECTURAL DETAILS

- An encoder-decoder based guided transformer architecture to detect methane emission plume mask.
- A novel Sentinel Enhanced Matched Filter (SEMF) for detection of potential methane site candidates.



ARCHITECTURAL DETAILS

- An encoder-decoder based guided transformer architecture to detect methane emission plume mask
- A novel Sentinel Enhanced Matched Filter (SEMF) for detection of potential methane site candidates
- These methane candidates are used as guided queries for decoder module
- The guided queries make better prediction



SENTINEL ENHANCED MATCHED FILTER (SEMF)

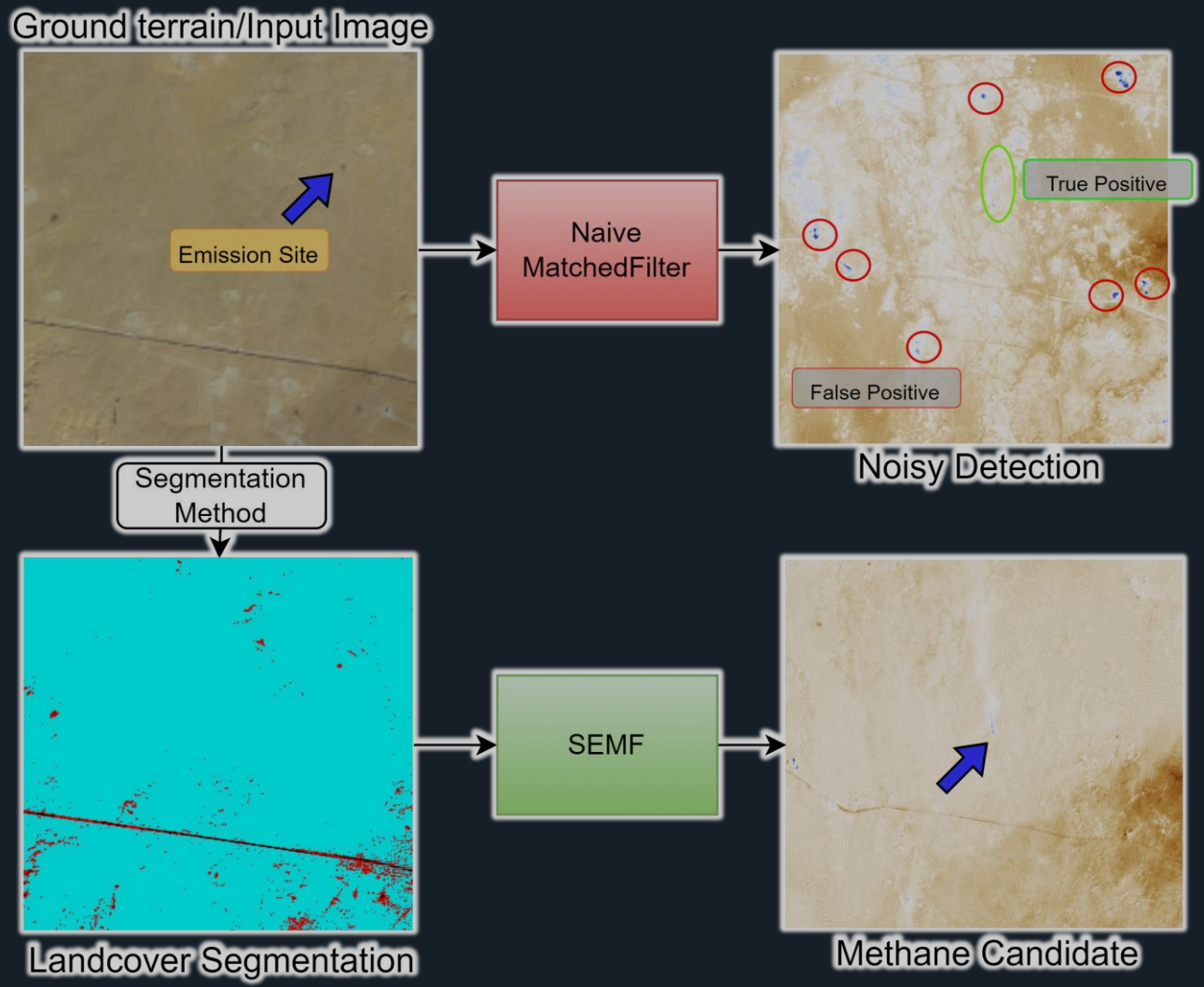
- Novel matched filter approach using Sentinel multispectral data
- Our SEMF whitens the background noise and amplifies the methane signature
- Landcover classification proves to be effective in whitening the background noise
- The amplified methane signature is matched pixel wise with absorption spectra
- This operation generates a 2-D methane enhancement map

$$SEMF(\mathbf{r}_i) = \frac{(\mathbf{r}_i - \mu)^T \mathbf{Cov}^{-1} \epsilon \mathbf{t}}{\sqrt{\epsilon \mathbf{t}^T \mathbf{Cov}^{-1} \epsilon \mathbf{t}}}$$

where, "**Cov**" is covariance of the background based on each land cover class, "***u***" is mean, "***t***" is absorption spectra of methane gas and "r_i" is i^{th} pixel in input image

QUALITATIVE EVALUATION OF SEMF

- Figure shows the comparison of Naïve performance of matched filter with SEMF.
- These methane candidate regions are used to guide queries.



SUMMARY

We propose a novel one-stage approach to detection methane plume

Our approach does not use any ancillary data like ground wind speed etc.

Our preliminary testing of SEMF shows better qualitative detections than existing methods

Our end-to-end architecture will be very modular and easy to replicate.

THANK YOU

Please reach out to :

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