

Deteksi Fitur Jalan Dari Citra Satellite

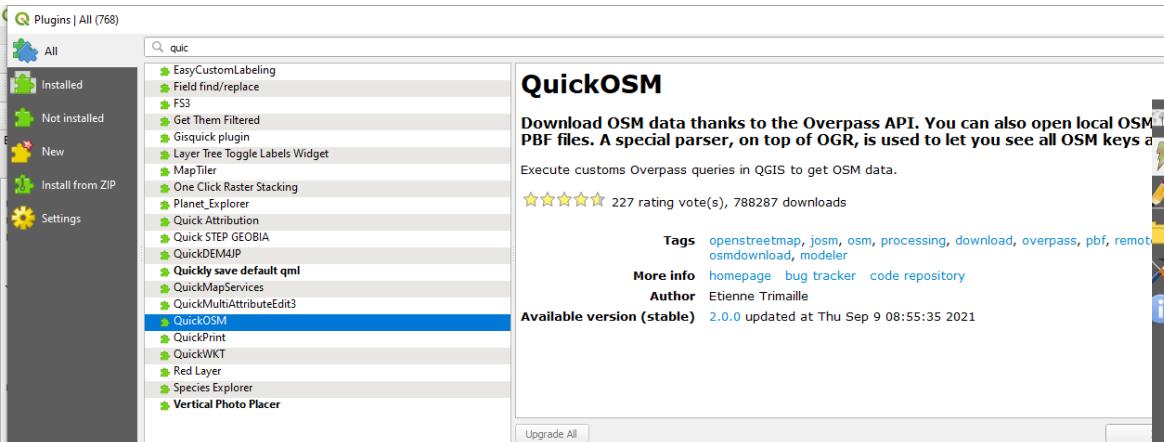
Keperluan Deteksi Jalan

- Informasi mengenai jalan diperlukan dalam menentukan alamat sebuah bangunan/ rumah
- Dalam hal ini Sumber data yang dieksplor untuk memenuhi hal tersebut adalah open street map untuk data jalan, dan citra satellite untuk area yang mungkin belum tersedia

Data Jalan OSM

- OSM Memberikan akses open source kepada data yang dimilikinya.
- Dalam hal ini mendownload data OSM dapat dilakukan via QGIS, dengan plugin : QuickOSM.

Download QuickOSM



The screenshot shows the QGIS Plugins Manager interface. On the left, there's a sidebar with icons for All, Installed, Not installed, New, Install from ZIP, and Settings. A search bar at the top has the text "quic". Below it, a list of plugins is shown, with "QuickOSM" highlighted by a blue selection bar. Other visible plugins include EasyCustomLabeling, Field find/replace, FS3, Get Them Filtered, Gisquick plugin, Layer Tree Toggle Labels Widget, MapTiler, One Click Raster Stacking, Planet_Explorer, Quick Attribution, Quick STEP GEOBIA, QuickDEM4JP, Quickly save default qml, QuickMapServices, QuickMultiAttributeEdit3, QuickOSM, QuickPrint, QuickWKT, Red Layer, Species Explorer, and Vertical Photo Placer. At the bottom of the list is an "Upgrade All" button.

QuickOSM

Download OSM data thanks to the Overpass API. You can also open local OSM PBF files. A special parser, on top of OGR, is used to let you see all OSM keys and values.

Execute customs Overpass queries in QGIS to get OSM data.

★★★★★ 227 rating vote(s), 788287 downloads

Tags: openstreetmap, josm, osm, processing, download, overpass, pbf, remotegis, osmdownload, modeler

More info: [homepage](#) [bug tracker](#) [code repository](#)

Author: Etienne Trimaille

Available version (stable) 2.0.0 updated at Thu Sep 9 08:55:35 2021

Upgrading QuickOSM to version 2.0.0

QuickOSM Preset

Help with key/value

Preset: Not mandatory. Ex: bakery

Key	Value
Query on all keys	Query on all values

In: A village, a town...

Named area is required when the query is "In".

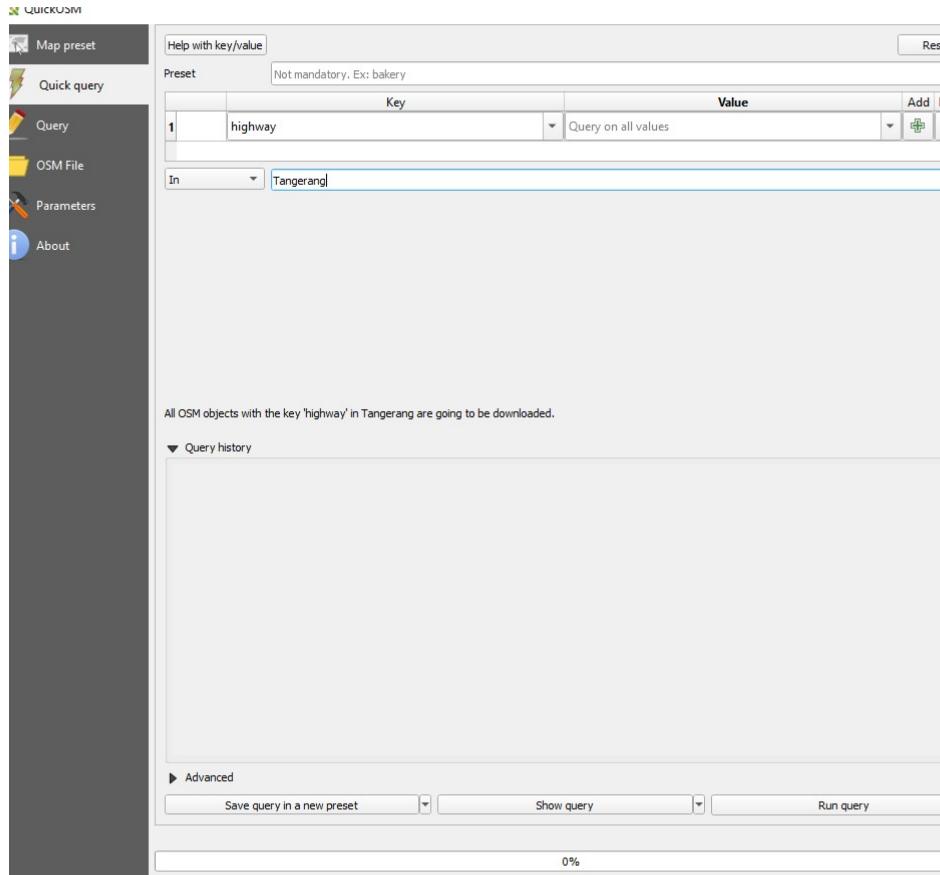
▼ Query history

▶ Advanced

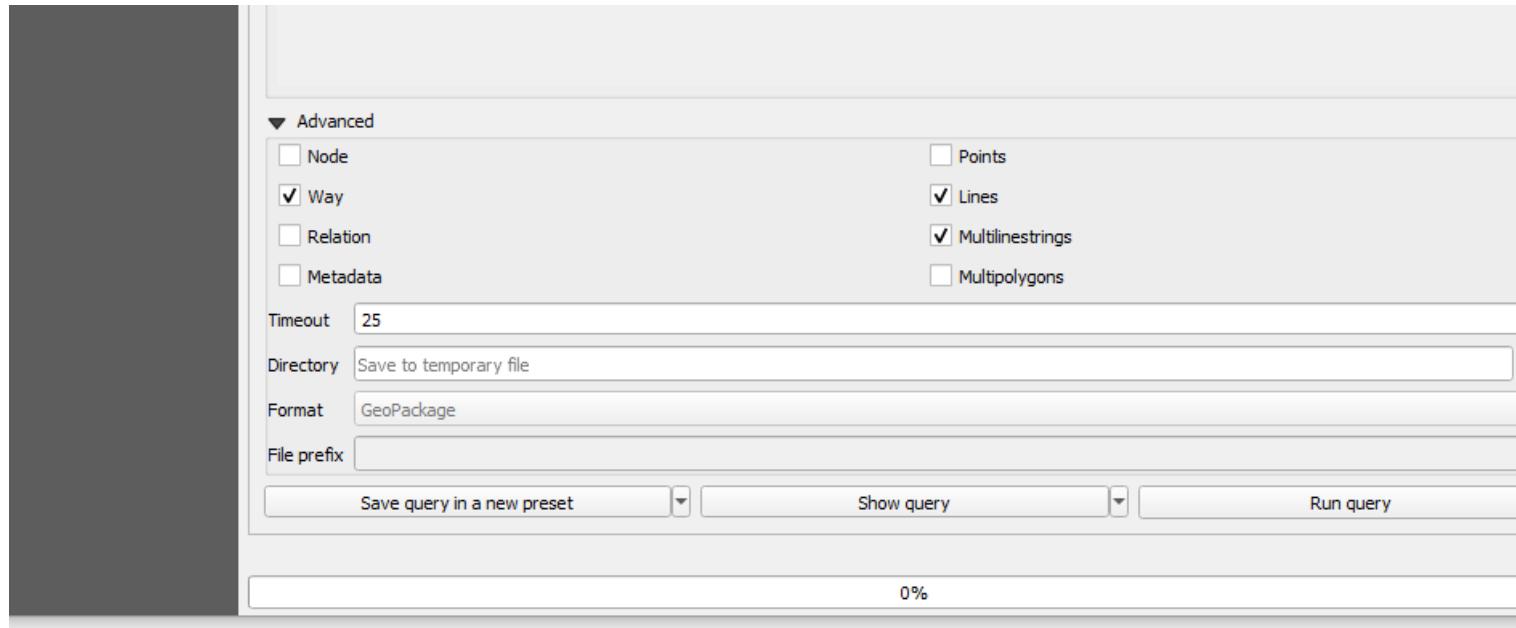
Save query in a new preset Show query Run query

0%

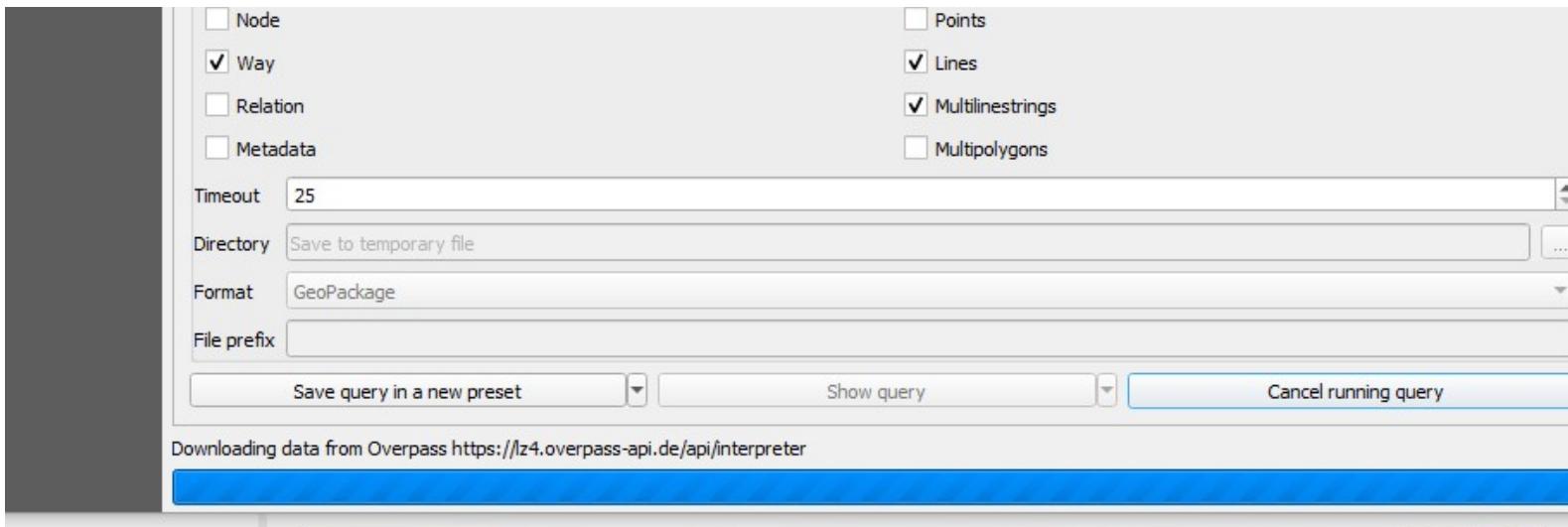
Query dengan key="Highway" di Tangerang



Tentukan jenis polygon yang hendak difilter, untuk jalan pilih way, lines dan multilinestrings



Run Query nya



Example : Jalan Tol Jakarta

Q highway_motorway_Jakarta — Features Total: 4, Filtered: 4, Selected: 0

full_id	osm_id	osm_type	highway	wikipedia	type	toll	route	ref
1 r12430955	12430955	relation	motorway	id:Jalan Tol Jakarta-Cikampek	route	NULL	road	22
2 r5385541	5385541	relation	motorway	id:Jalan Tol Jakarta-Cikampek	route	yes	road	22
3 r12430954	12430954	relation	motorway	id:Jalan Tol Jakarta-Merak	route	NULL	road	22
4 r12430953	12430953	relation	motorway	id:Jalan Tol Jakarta-Merak	route	NULL	road	22

Example : Jakarta Trunk Roads

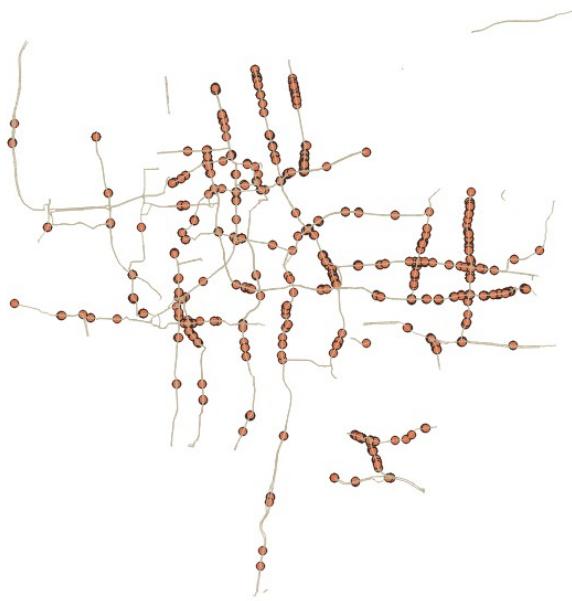


highway_trunk_Jakarta — Features Total: 1268, Filtered: 1268, Selected: 0

	ref	width	surface	smoothness	oneway	name	motorcycle	lanes
1	2	NULL	asphalt	NULL	yes	Jalan Jenderal Gatot Subroto	NULL	3
2	NULL	NULL	asphalt	NULL	yes	Jalan Cawang Underpass	NULL	2
3	2	NULL	asphalt	NULL	yes	Jalan Jenderal Gatot Subroto	NULL	3
4	2	6	asphalt	good	yes	Jalan Raya Bogor	yes	3
5	2	6	asphalt	good	yes	Jalan Raya Bogor	yes	2
6	12	NULL	NULL	NULL	yes	Jalan Pondok Pinang Raya	NULL	NULL
7	12	NULL	NULL	NULL	yes	Jalan Pondok Pinang Raya	NULL	3
8	1	10	asphalt	good	yes	Jalan R.E. Martadinata	yes	3
9	1	10	asphalt	good	yes	Jalan R.E. Martadinata	yes	4
10	NULL	6	asphalt	good	yes	Jalan Tahi Bonar Simatupang	yes	2
11	NULL	6	asphalt	good	yes	Jalan Tahi Bonar Simatupang	yes	4
12	2	10	asphalt	excellent	yes	Jalan Mayor Jenderal Sutoyo	NULL	3
13	2	10	asphalt	excellent	yes	Jalan Mayor Jenderal Sutoyo	NULL	6
14	2	10	asphalt	excellent	yes	Jalan Mayor Jenderal Sutoyo	NULL	3
15	2	10	asphalt	excellent	yes	Jalan Mayor Jenderal Sutoyo	NULL	4
16	12	NULL	asphalt	NULL	yes	Jalan Tentara Pelajar	NULL	3

Show All Features

Example: Jakarta Primary Road

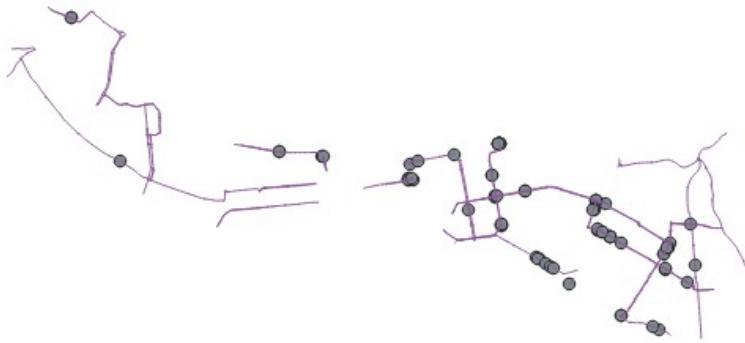


highway_primary_Jakarta — Features Total: 3252, Filtered: 3252, Selected: 0

	access	est_width	width	surface	smoothness	oneway	name	motorcycle
1	NULL	NULL	7	asphalt	intermediate	yes	Jalan Akses Marunda	yes
2	NULL	NULL	12	asphalt	bad	yes	Jalan Tanjung Duren Timur II	yes
3	NULL	NULL	5	concrete	good	yes	Jalan Marunda Bidara	yes
4	NULL	NULL	5	concrete	good	yes	Jalan Marunda Bidara	yes
5	NULL	NULL	8	asphalt	excellent	yes	Jalan Raya Pondok Gede	yes
6	NULL	NULL	5	concrete	good	yes	Jalan Marunda Bidara	yes
7	NULL	NULL	NULL	asphalt	NULL	yes	Penggilingan Raya	NULL
8	NULL	NULL	NULL	asphalt	NULL	yes	Tarum Barat	NULL
9	NULL	NULL	NULL	asphalt	NULL	yes	Jalan Matraman	NULL
10	NULL	NULL	NULL	asphalt	NULL	yes	Jalan Haji Oemar Said Cokroaminoto	NULL
11	NULL	NULL	12	asphalt	good	yes	Jalan Pramuka	yes
12	NULL	NULL	12	asphalt	good	yes	Jalan Pramuka	yes
13	NULL	NULL	12	asphalt	good	yes	Jalan Pramuka	yes
14	NULL	NULL	12	asphalt	good	yes	Jalan Pramuka	yes
15	NULL	NULL	7	asphalt	good	yes	Jalan Robert Wolter Monginsidi	yes
16	NULL	NULL	NULL	asphalt	NULL	yes	Jalan Haji Oemar Said Cokroaminoto	NULL

Show All Features

Example : Jakarta Utara Secondary Roads

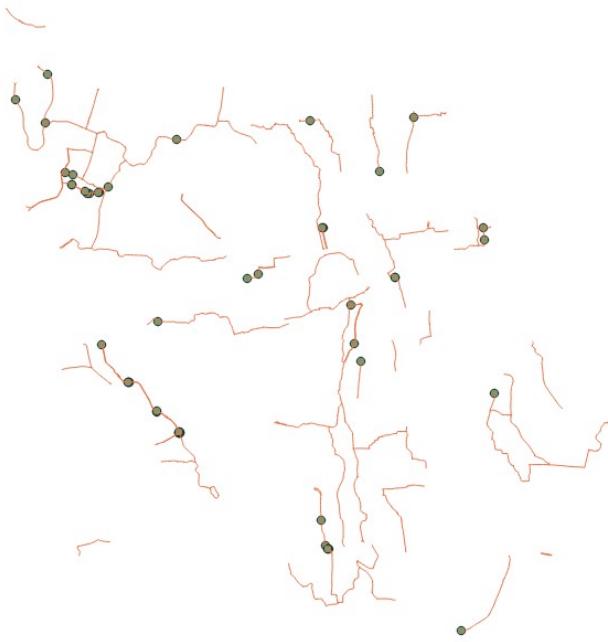


highway_secondary_Jakarta Utara — Features total: 662, Filtered: 662, Selected: 0

	destination	motorcycle	width	smoothness	surface	oneway	name	lanes
67	NULL	yes	5	intermediate	asphalt	no	Jalan Raya Tipar Cakung	2
68	NULL	yes	5	intermediate	concrete	no	Jalan Raya Tipar Cakung	2
69	NULL	yes	5	intermediate	concrete	no	Jalan Raya Tipar Cakung	2
70	NULL	yes	5	intermediate	concrete	no	Jalan Raya Tipar Cakung	2
71	NULL	NULL	NULL	NULL	concrete	NULL	Jalan Raya Tipar Cakung	2
72	NULL	yes	5	intermediate	concrete	no	Jalan Raya Tipar Cakung	2
73	NULL	NULL	NULL	NULL	asphalt	yes	Jalan Raya Kelapa Nias	2
74	NULL	NULL	NULL	NULL	asphalt	yes	Jalan Raya Kelapa Nias	2
75	NULL	NULL	NULL	NULL	asphalt	yes	Jalan Raya Kelapa Nias	2
76	NULL	yes	6	good	asphalt	yes	Jalan Raya Kelapa Nias	2
77	NULL	yes	5	good	asphalt	yes	Jalan Raya Kelapa Nias	2
78	NULL	yes	5	good	asphalt	yes	Jalan Raya Kelapa Nias	2
79	NULL	NULL	NULL	NULL	asphalt	yes	Jalan Raya Kelapa Nias	2
80	NULL	NULL	NULL	NULL	asphalt	yes	Jalan Raya Kelapa Nias	2
81	NULL	yes	5	good	asphalt	yes	Jalan Raya Kelapa Nias	2
82	NULL	yes	5	good	asphalt	yes	Jalan Raya Kelapa Nias	2

Show All Features

Example : Tangerang Selatan Tertiary Roads



highway_tertiary_Tangerang Selatan — Features Total: 443, Filtered: 443, Selected: 0

	postal_code	width	smoothness	oneway	motorcycle	surface	name	lanes	lat
1	NULL	NULL	NULL	NULL	NULL	concrete	Jalan Cenderawasih Nandjar	2	NULL
2	NULL	NULL	NULL	NULL	NULL	concrete	Jalan AMD Raya	2	NULL
3	NULL	NULL	NULL	NULL	NULL	asphalt	NULL	2	NULL
4	NULL	NULL	NULL	NULL	NULL	concrete	Jalan Cenderawasih Nandjar	2	NULL
5	NULL	NULL	NULL	yes	NULL	concrete	NULL	2	NULL
6	NULL	NULL	NULL	yes	NULL	concrete	NULL	2	NULL
7	NULL	NULL	NULL	NULL	NULL	asphalt	Jalan Suka Mulya Raya	2	NULL
8	NULL	NULL	NULL	yes	NULL	concrete	NULL	2	NULL
9	NULL	NULL	NULL	NULL	NULL	asphalt	Jalan Kelurahan	2	NULL
10	NULL	NULL	NULL	NULL	NULL	asphalt	Jalan Kelurahan	2	Jalan Kelurahan
11	NULL	NULL	NULL	NULL	NULL	asphalt	NULL	2	no
12	NULL	NULL	NULL	NULL	NULL	asphalt	NULL	2	no
13	NULL	NULL	NULL	NULL	NULL	concrete	NULL	2	NULL
14	NULL	NULL	NULL	NULL	NULL	concrete	NULL	2	NULL
15	NULL	NULL	NULL	NULL	NULL	NULL	Jalan Puskesmas	NULL	NULL
16	NULL	NULL	NULL	yes	NULL	concrete	Jalan Cenderawasih Nandjar	1	no

Example : Tangerang Selatan Residential Roads



highway_residential_Tangerang Selatan — Features Total: 28920, Filtered: 28920, Selected: 0

addr:city	lane_markings	width	smoothness	oneway	motorcycle	lanes	access	surface	name
1 ULL	NULL	NULL	NULL	NULL	NULL	NULL	NU...	co...	ISCI
2 ULL	NULL	4	intermediate	no	yes	1	pri...	pa...	Jalan Cirendeue Permai Raya
3 ULL	NULL	4	intermediate	no	yes	1	pri...	asp...	Jalan Cirendeue Permai I
4 ULL	NULL	4	intermediate	no	yes	1	pri...	asp...	Jalan Cirendeue Permai II
5 ULL	NULL	3	good	no	yes	1	NU...	asp...	Jalan Haji Djabir
6 ULL	NULL	4	good	no	yes	1	NU...	asp...	Jalan Haji Ilyas
7 ULL	no	4	good	no	yes	2	NU...	asp...	Jalan Sailin I
8 ULL	NULL	NULL	NULL	NULL	NULL	NULL	NU...	NU...	NULL
9 ULL	NULL	4	good	no	yes	1	NU...	asp...	Jalan Kavling Pondok Permai
10 ULL	NULL	3	good	no	yes	1	NU...	asp...	Jalan Cempaka
11 ULL	NULL	NULL	NULL	NULL	NULL	NULL	NU...	NU...	NULL
12 ULL	NULL	4	good	no	yes	2	NU...	asp...	Jalan Kenari
13 ULL	NULL	4	good	no	yes	2	NU...	asp...	Jalan Peluru
14 ULL	NULL	NULL	NULL	NULL	NULL	NULL	NU...	NU...	NULL
15 ULL	NULL	4	good	no	yes	2	NU...	asp...	Jalan Penerangan VI
16 ULL	NULL	NULL	NULL	NULL	NULL	NULL	NU...	NU...	Jalan Bintaro Melati Raya

OSM Docker Local Host

- Untuk menghindari error request server OSM , berupa “Too many Request”, atau “Server Busy”, maka diperlukan sebuah local hosting data OSM, yang dilakukan via docker

Download Data OSM Compressed

- Download data dari:

<http://download.geofabrik.de/asia/indonesia.html>

Download OpenStreetMap data for this region:
Indonesia (with East Timor)

[\[one level up\]](#)

Slide 1
The OpenStreetMap data files provided on this server do **not** contain the user names, user IDs and changeset IDs of the OSM objects because these fields are assumed to contain personal information about the OpenStreetMap contributors and are therefore subject to data protection regulations in the European Union.
[Extracts with full metadata](#) are available to OpenStreetMap contributors only.

Note
East Timor is included in the Indonesia extract but if you are looking for just East Timor, [it is listed here](#) as a separate country.

Commonly Used Formats

- [indonesia-latest.osm.pbf](#), suitable for Osmium, Osmosis, imposm, osm2pgsql, mkgmap, and others. This file was last modified 9 hours ago and contains all OSM data up to 2021-10-21T20:21:06Z. File size: 1.3 GB; MD5 sum: [b7bb26193c296002bb795be2e49646cf](#).
- [indonesia-latest-free.shp.zip](#) is not available for this region; try one of the sub-regions.

Other Formats and Auxiliary Files

- [indonesia-latest.osm.b2z](#), yields OSM XML when decompressed; use for programs that cannot process the .pbf format. This file was last modified 11 days ago. File size: 2.6 GB; MD5 sum: [848ffdc8c313f991a38b528e29c938](#).
- [indonesia-interval-edb.pbf](#) The history file contains personal data and is available on the [internal server](#) only. See notice above for further information.
- [.poly_file](#) that describes the extent of this region.
- [.osc_gz_files](#) that contain all changes in this region, suitable e.g. for Osmosis updates
- [raw_directory_index](#) allowing you to see and download older files

Sub Regions
Click on the region name to see the overview page for that region, or select one of the file extension links for quick access.

Sub Region	Quick Links
	.osm.pbf .shp.zip .osm.bz2
Java	[.osm.pbf] (677 MB) [.shp.zip] [.osm.bz2]
Kalimantan	[.osm.pbf] (122 MB) [.shp.zip] [.osm.bz2]
Maluku	[.osm.pbf] (22.2 MB) [.shp.zip] [.osm.bz2]
Nusa-Tenggara	[.osm.pbf] (140 MB) [.shp.zip] [.osm.bz2]
Papua	[.osm.pbf] (26.3 MB) [.shp.zip] [.osm.bz2]
Sulawesi	[.osm.pbf] (135 MB) [.shp.zip] [.osm.bz2]
Sumatra	[.osm.pbf] (201 MB) [.shp.zip] [.osm.bz2]

GEOFABRIK® downloads



Not what you were looking for? Geofabrik is a consulting and software development firm based in Karlsruhe, Germany specializing in OpenStreetMap services. We're happy to help you with data preparation, processing, server setup and the like. [Check out our website](#) and contact us if we can be of service.

Nicht das Richtige dabei? Die Geofabrik ist ein auf OpenStreetMap spezialisiertes Beratungs- und Softwareentwicklungsunternehmen in Karlsruhe. Gern helfen wir Ihnen bei der Datenaufbereitung, Datenkonvertierung, Serverinstallation und ähnlichen Aufgaben. [Besuchen Sie unsere Webseite](#) und sprechen Sie mit uns, wenn wir Ihnen helfen können.

Sumber Docker Image untuk Overpass API

- 1. Sumber 1:
<https://github.com/mediasuitenz/docker-overpass-api>
 - Masalah: Sudah outdated, format query sudah tidak sesuai dengan yang zaman kini.
- 2. Sumber 2:<https://github.com/wiktorn/Overpass-API>
 - Masalah: Dalam running docker file terdapat error, yang menyebabkan tidak dapat menginput data OSM ke database.

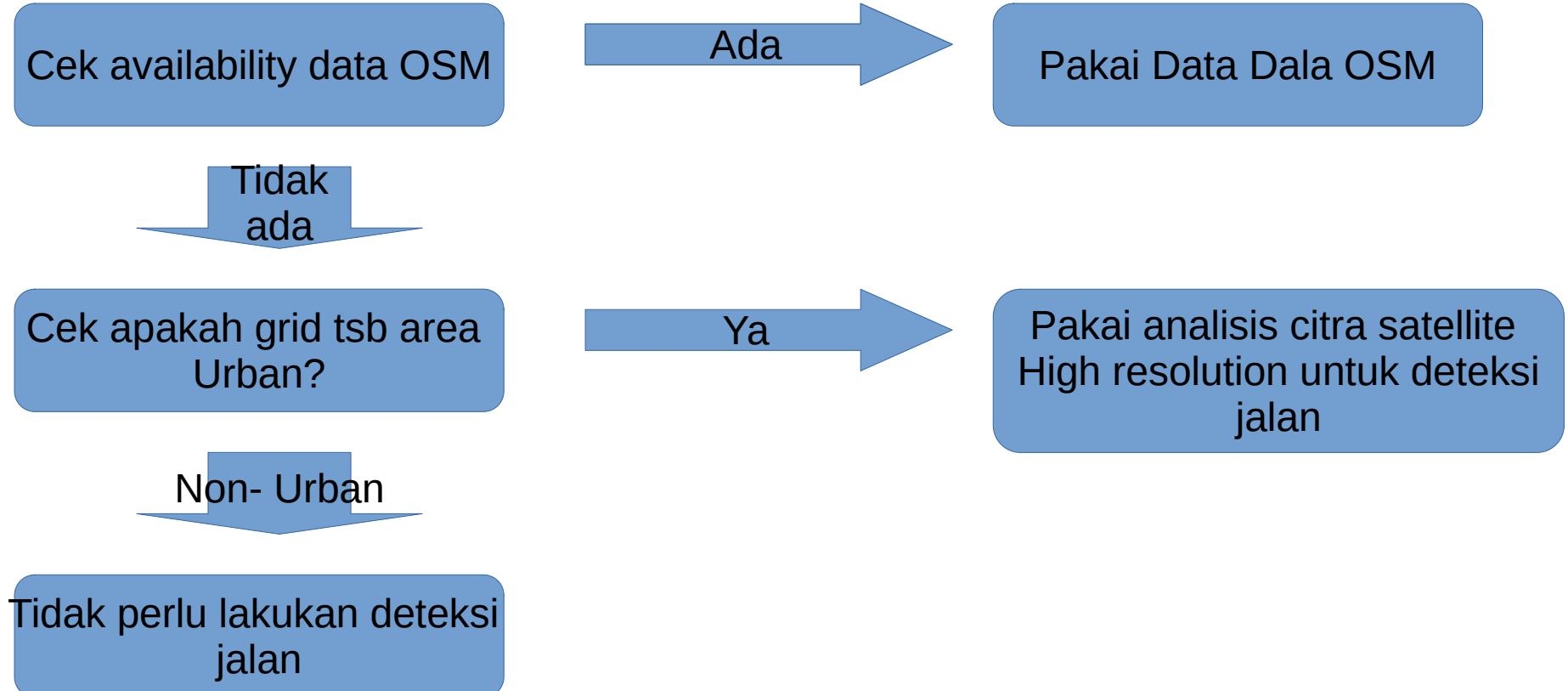
Python Script load data dari local overpass api

- Dibuat sebuah python script untuk secara automatic mendownload data yang diperlukan langsung dari overpass api yang sudah diset di local environment.
- Akses ke lokal host pada port 80.

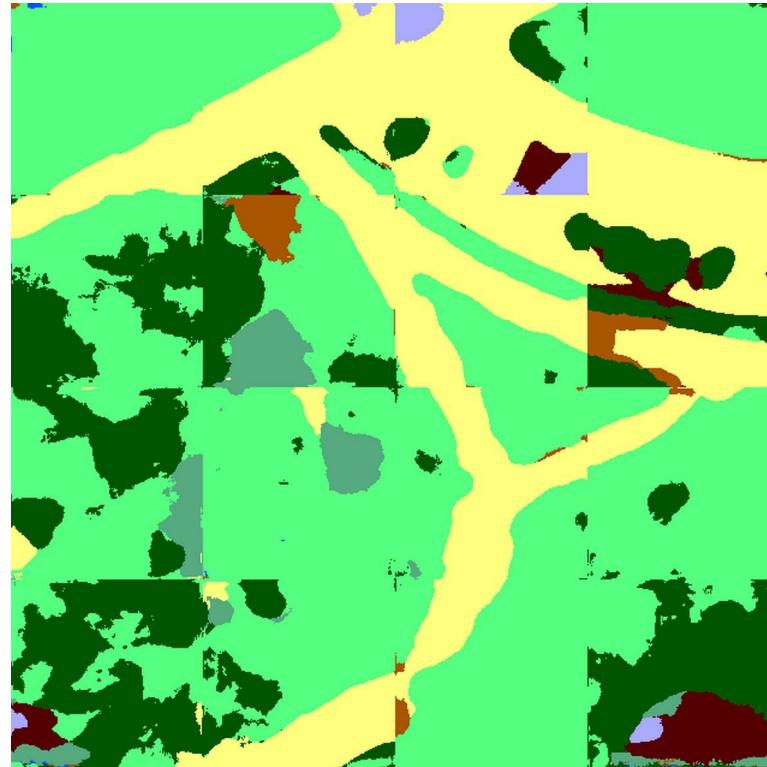
Deteksi Jalan Berdasarkan Citra Satelite

- Untuk kasus dimana data jalan tidak tersedia data jalan pada OSM, maka dapat digunakan pendekatan analisis citra satelit.
- Dalam hal ini dilakukan pendekatan semantic segmetation, dengan fokus pada deteksi [iksle yang merupakan jalan/ jalan tol.
- Setelah itu dilakukan proses untuk mengubah raster prediksi jalan menjadi polygon/ polyline

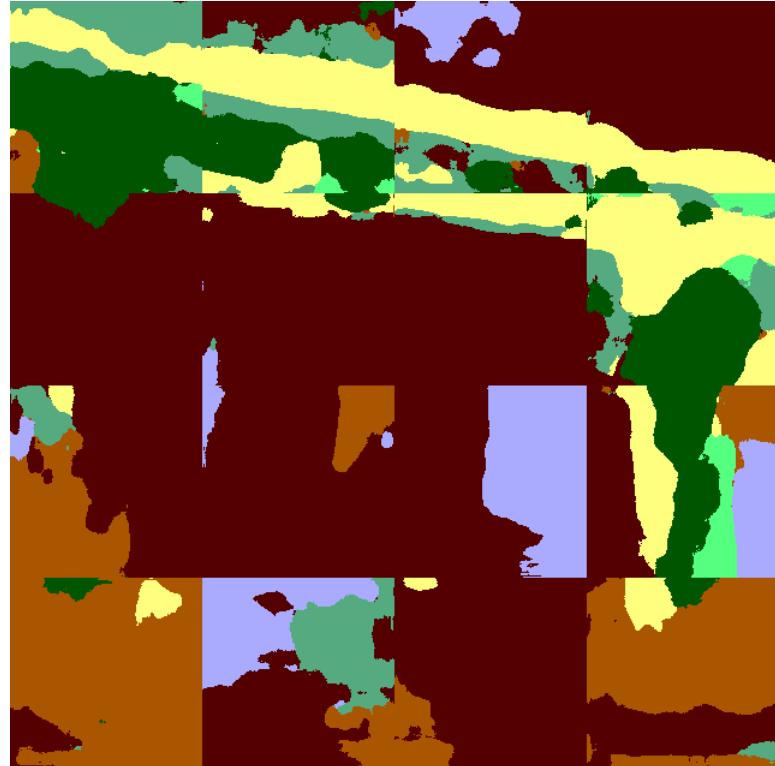
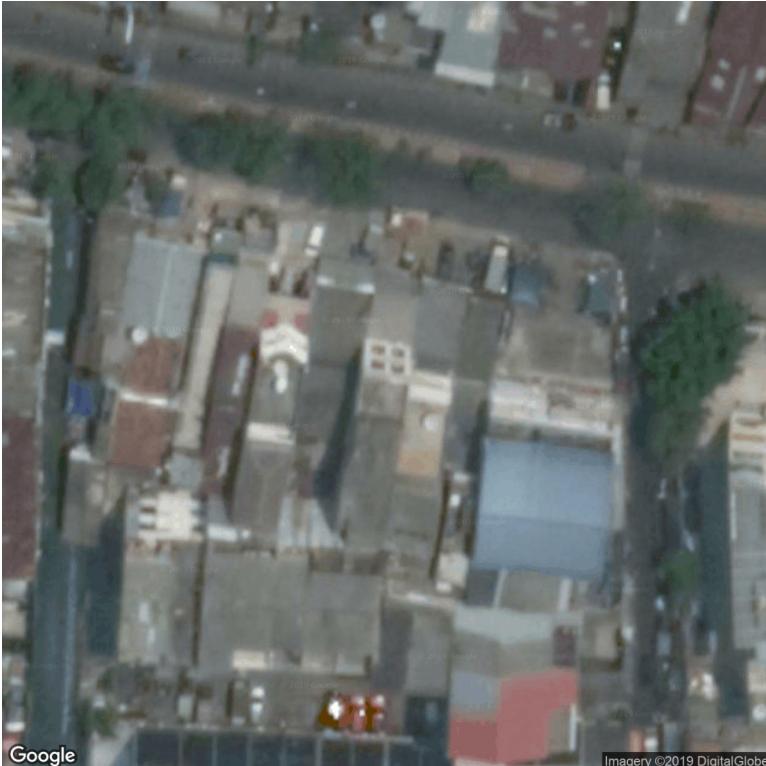
Skema Deteksi Jalan



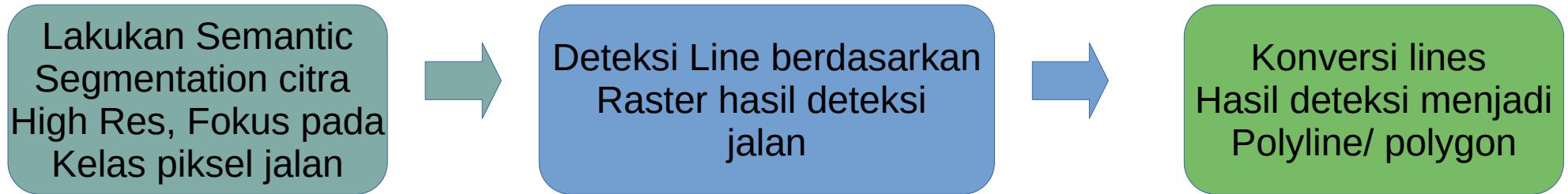
Beberapa contoh semantic segmentation deteksi jalan



Beberapa contoh semantic segmentation deteksi jalan



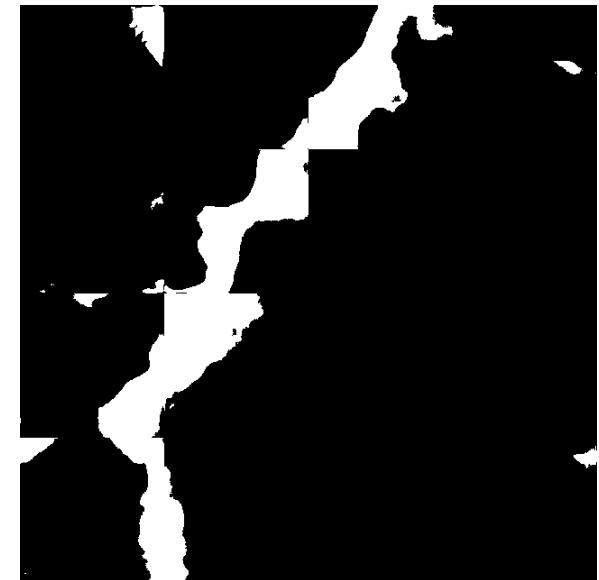
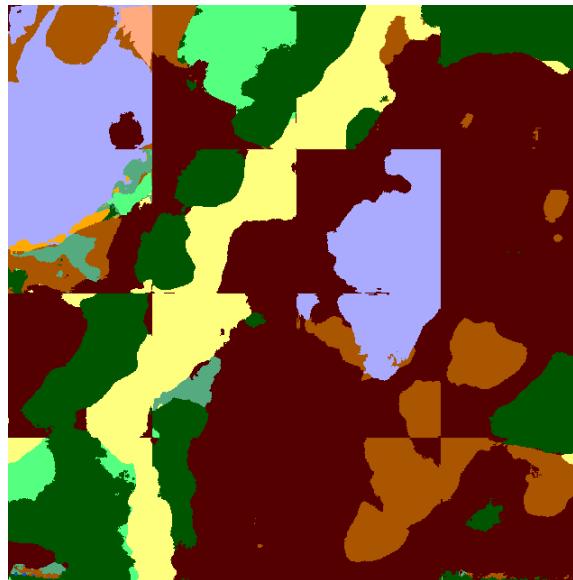
Skema Deteksi Jalan via Citra Satelite



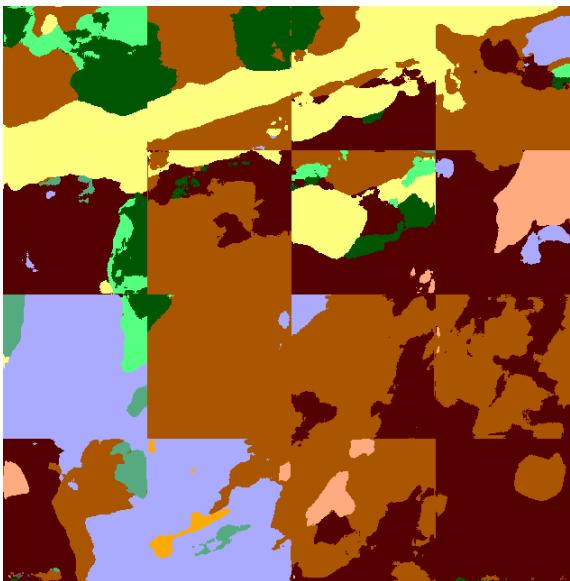
Deteksi Piksel Jalan pada Citra Satelit



Deteksi Piksel Jalan pada Citra Satelit



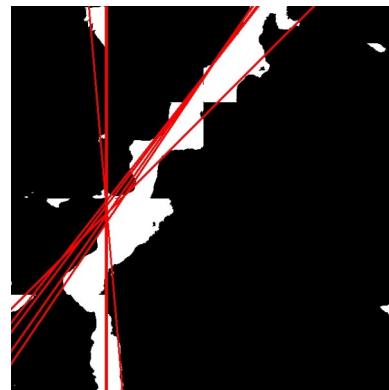
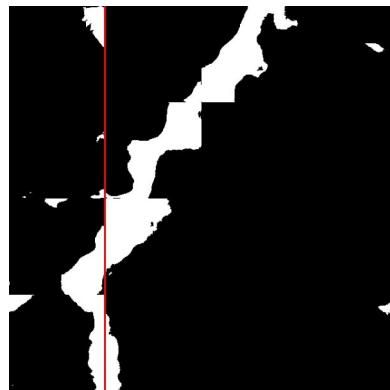
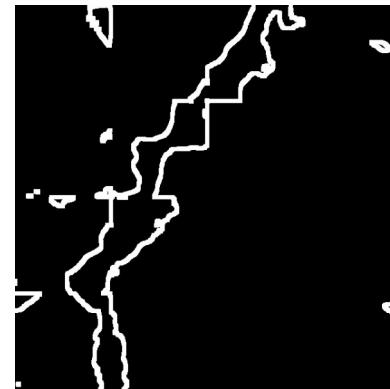
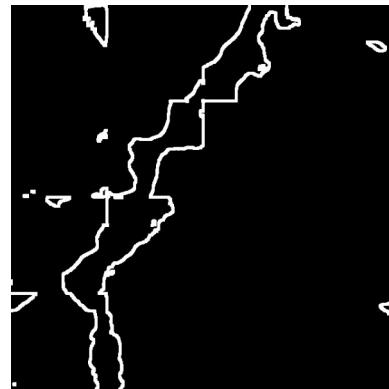
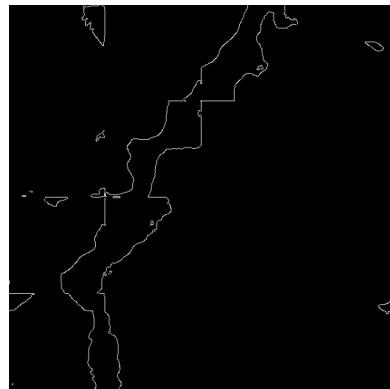
Deteksi Piksel Jalan pada Citra Satelit



Deteksi Lines pada citra satellite

- Menggunakan metode berbasiskan Hough Transform
- Memiliki beberapa parameter yang perlu dituning, seperti:
 - Parameter dilasi
 - Parameter Thresholding Hough Transform
 - Parameter Smoothing

Deteksi Lines – Parameter Dilasi



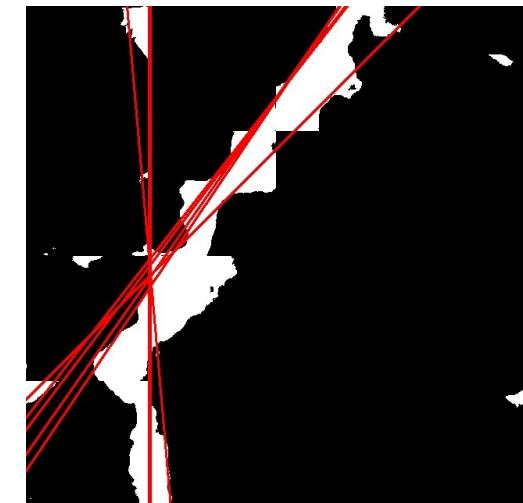
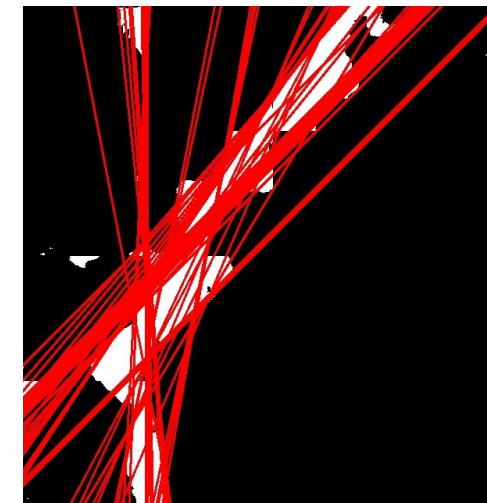
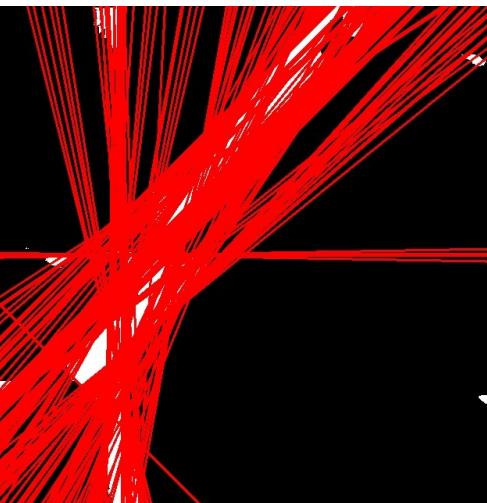
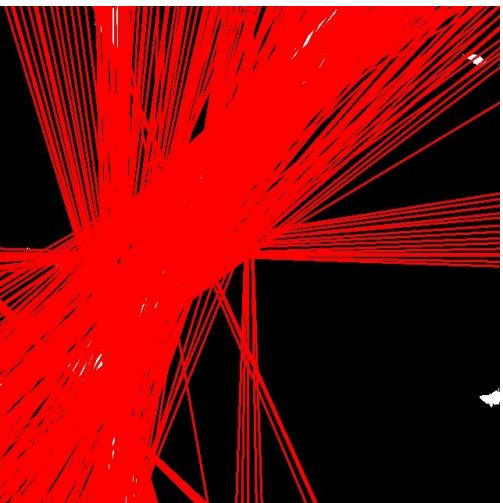
Tidak ada

5x5

7x7

11x11

Deteksi Lines – Parameter Threshold (Dilation 5x5)



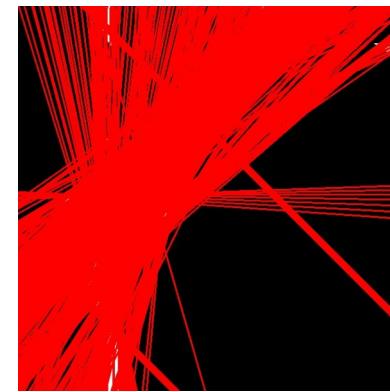
100

125

155

200

Deteksi Lines – Parameter Gaussian Smoothing (Dilation 5x5, Threshold 200)



3x3

5x5

7x7

11x11

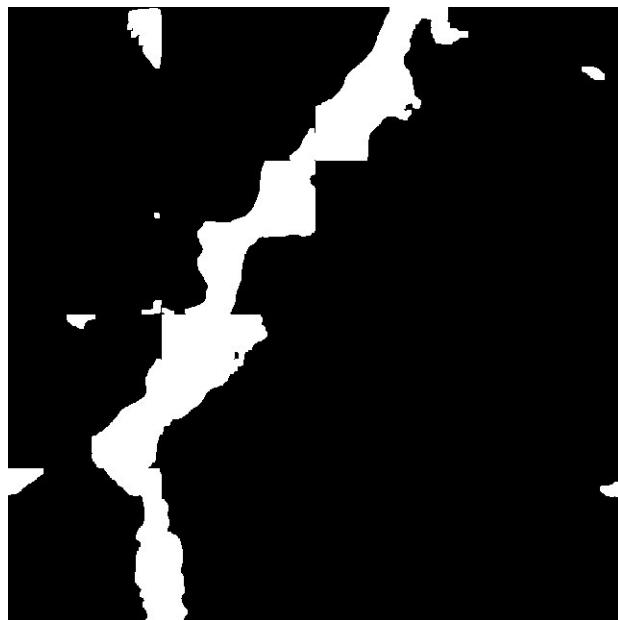
Opening untuk menghilangkan False-positive dan Noise

- Dalam proses semantic segmentation untuk menandai piksel jalan, terlihat banyak false positive yang menjadi noise dalam hasil semantic segmentation,
- Perlu suatu metode untuk menghilangkan “pulau-pulau” false positive tersebut, dalam hal ini diimplementasikan algoritma Opening.

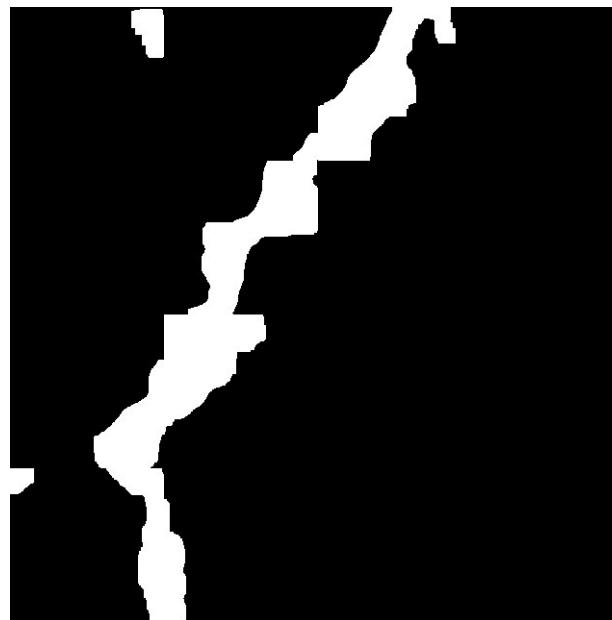
Algoritma Opening

- Algoritma Opening menggunakan dua tahapan, yakni sebuah operasi erosion dan dilation.
- Erosion, merupakan operasi untuk menghilangkan noise-noise yang blobs false positive.
- Dilation, merupakan operasi untuk merestorasi pengurangan yang terjadi selama operasi erosion.

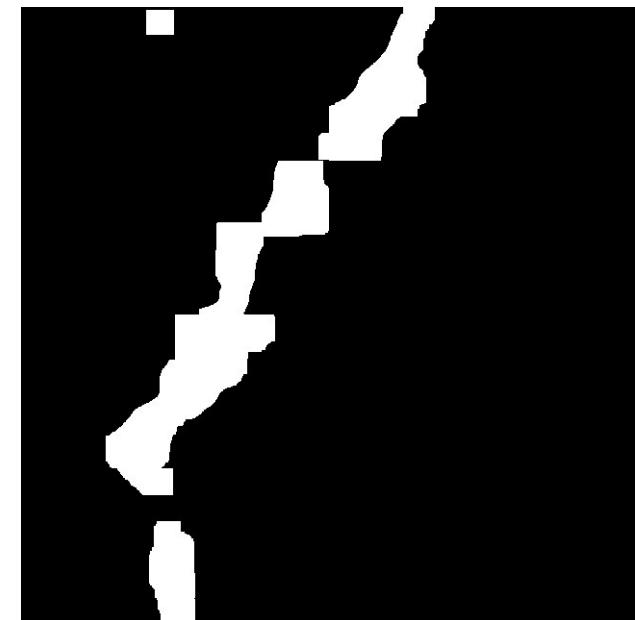
Deteksi Jalan – Opened Images



5x5



15x15



25x25

Deteksi Jalan – Opened Images



5x5



15x15

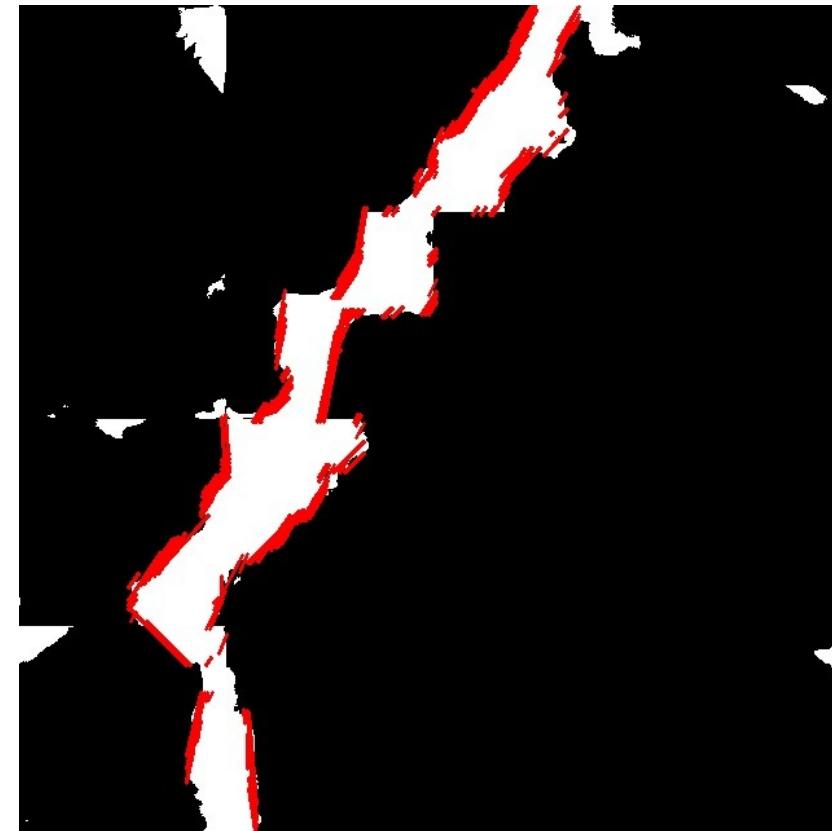
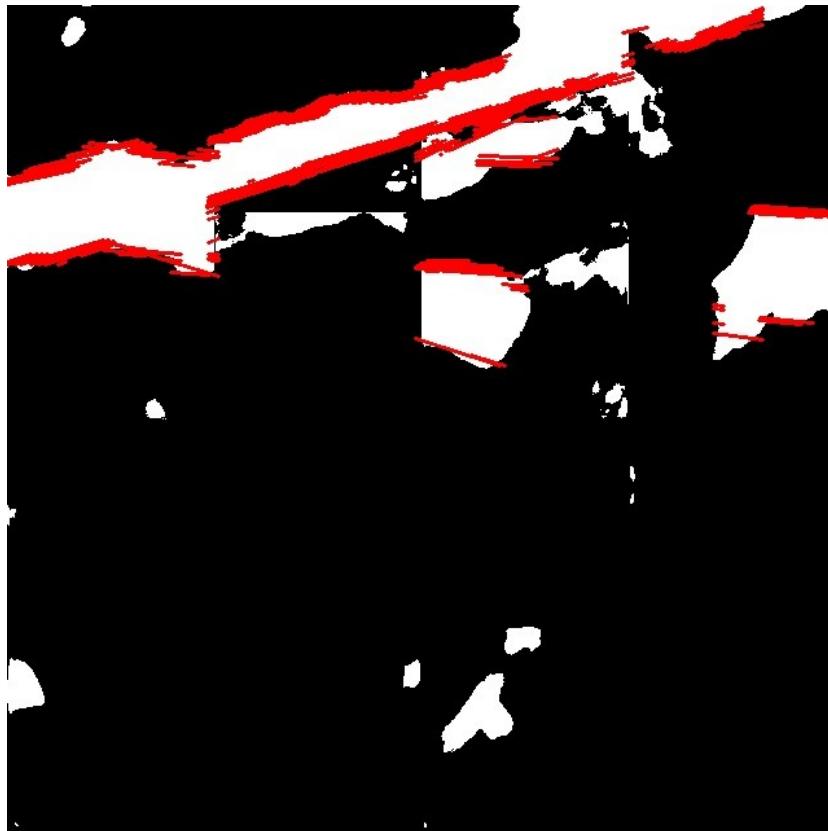


25x25

Probabilistic Hough Transform

- Probabilistic Hough Transform menggunakan sampling point edges yang mungkin membentuk line
- Probabilistic Hough transform merupakan otpimalisasi dari Hough transfrom yang hasil deteksinya bisa berupa lines yang sepotong - potong

Hasil deteksi Probabilistic Hough Transform



Masalah Probabilistic Hough Transform

- Beberapa masalah yang teramati antara lain:
 - Garis yang dideteksi cenderung sepotong-sepotong dan tidak menyambung, perlu skema penyambungan
 - Banyak gari terdeteksi dalam satu area yang sama, perlu sebuah skema filtering

Ganti Sumber Citra Satelite

- [https://server.arcgisonline.com/ArcGIS/rest/
services/World_Imagery/MapServer/tile/{z}/{y}/
{x}](https://server.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer/tile/{z}/{y}/{x})

Metode deteksi jalan via polygonisasi

- Metode kedua yang diuji adalah metode deteksi jalan dengan metode polygonisasi
- Metode ini mengubah raster hasil deteksi semantic segmentation deteksi piksel jalan ke dalam bentuk polygon, baru kemudian dideteksi polyline jalan

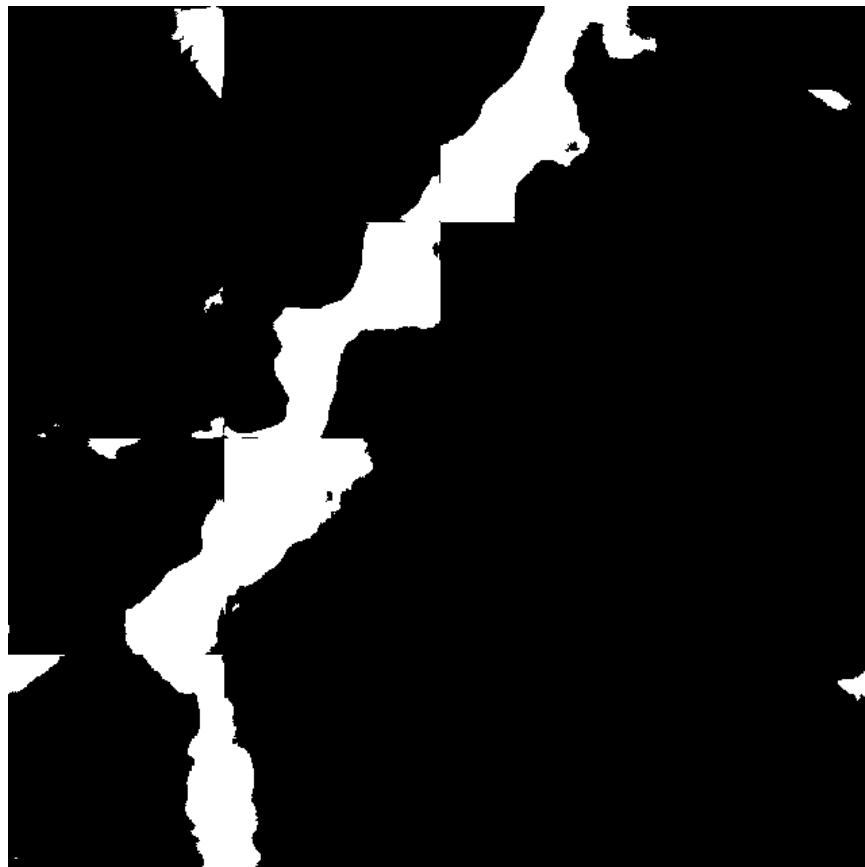
Dua pendekatan deteksi polygonisasi jalan

- Ada dua pendekatan yang diuji coba untuk deteksi polygonisasi jalan, yakni:
 - Metode OpenCV Countour Approximation
 - Metode OpenCV Watershed
 - Metode “Raster to Vector” ArcGIS

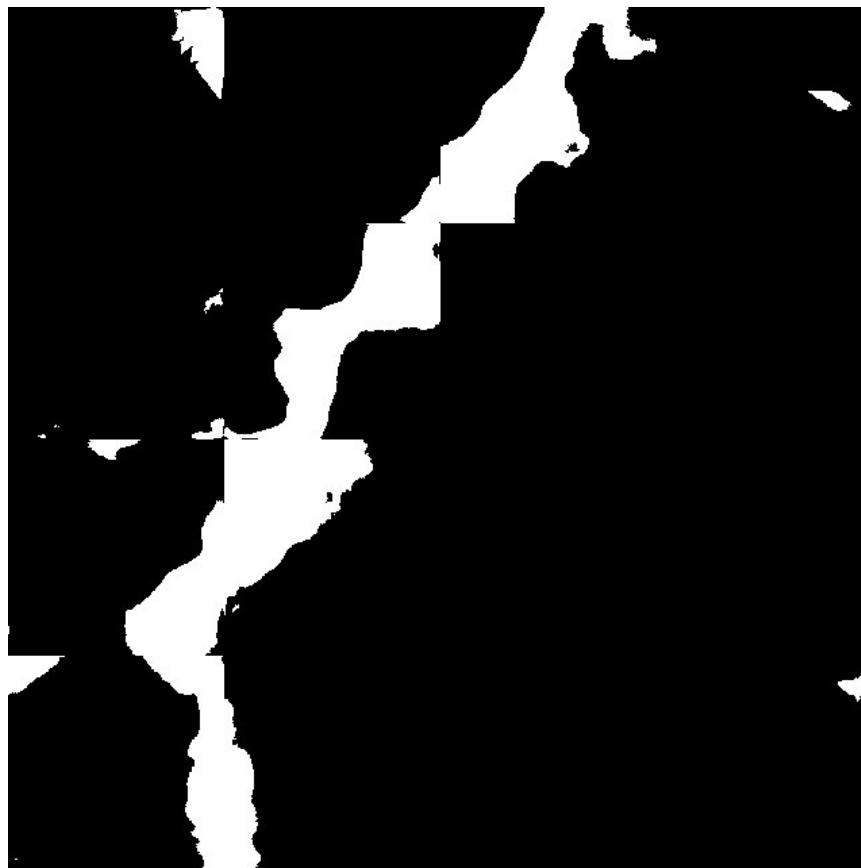
1. Metode polygonisasi OpenCV - Countour

- Metode polygonisasi OpenCV terdiri atas steps berikut:
 - 1)Countur Detection (cv.findContours)
 - 2)Aproksimasi Polygon (cv.PolyDp)
 - 3)Filtering Polygon (Remove Noise)
 - 4)Get Polygons

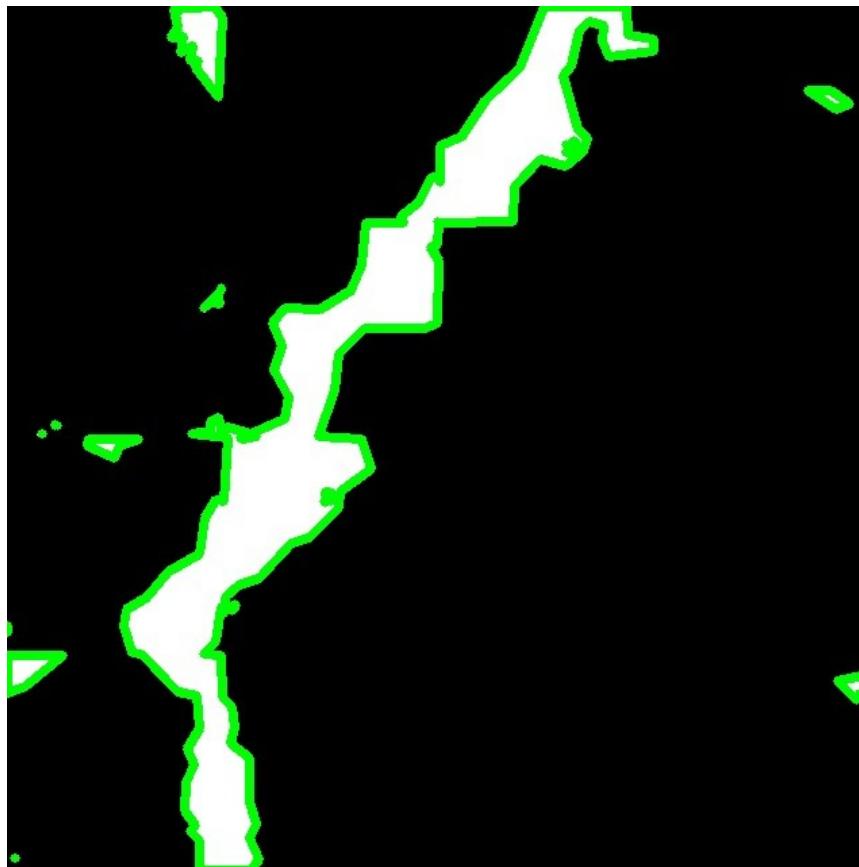
Input. Mask Image Jalan



1. GrayScale Image



2. Get Countours



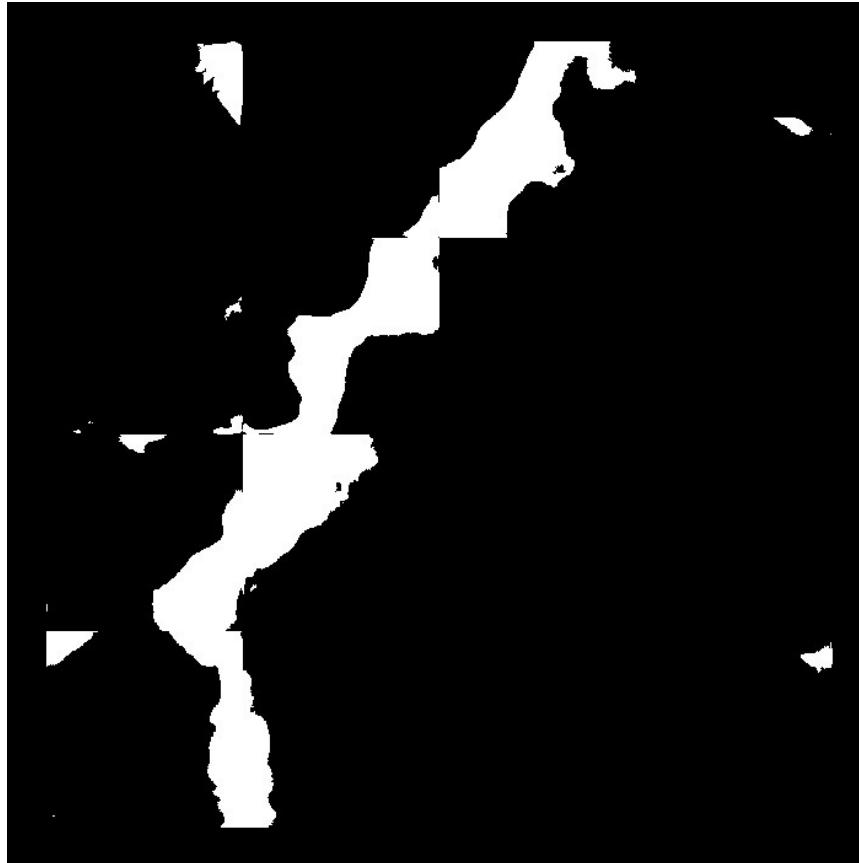
3. Filter Contours



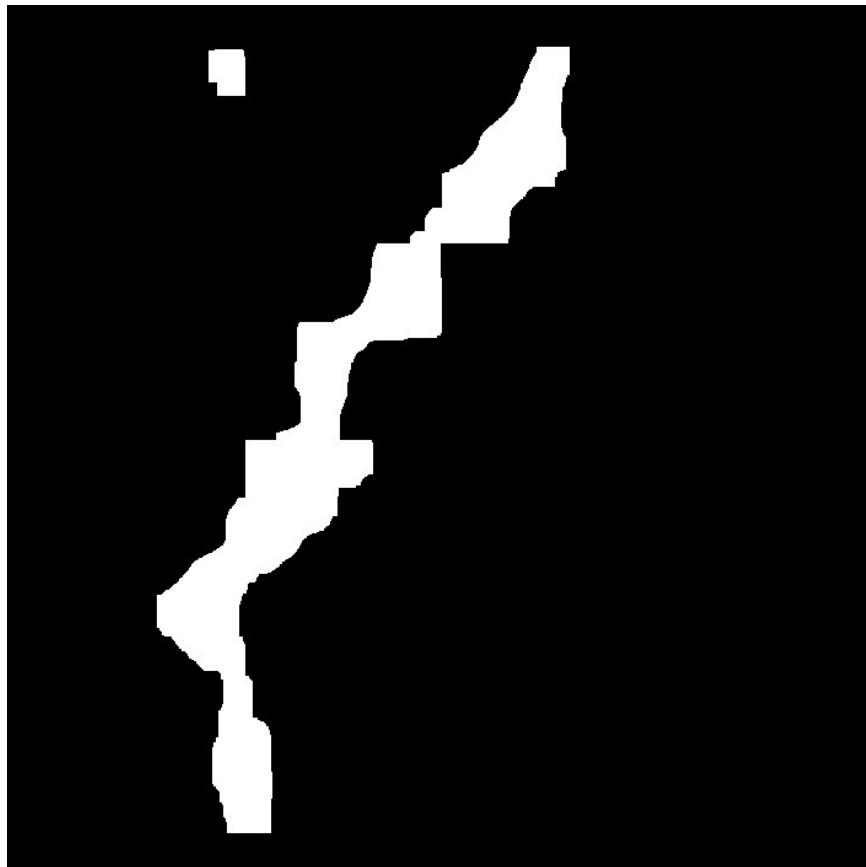
2. Metode polygonisasi OpenCV - WaterShed

- Metode polygonisasi OpenCV terdiri atas steps berikut:
 - 1)Bordering Image (cv.copyMakeBorder)
 - 2)Open and Close to cleanup mask (cv.morphologyEx)
 - 3)Get Background mask ()
 - 4)Run Watershed (cv.WaterShed)
 - 5)Get Polygons

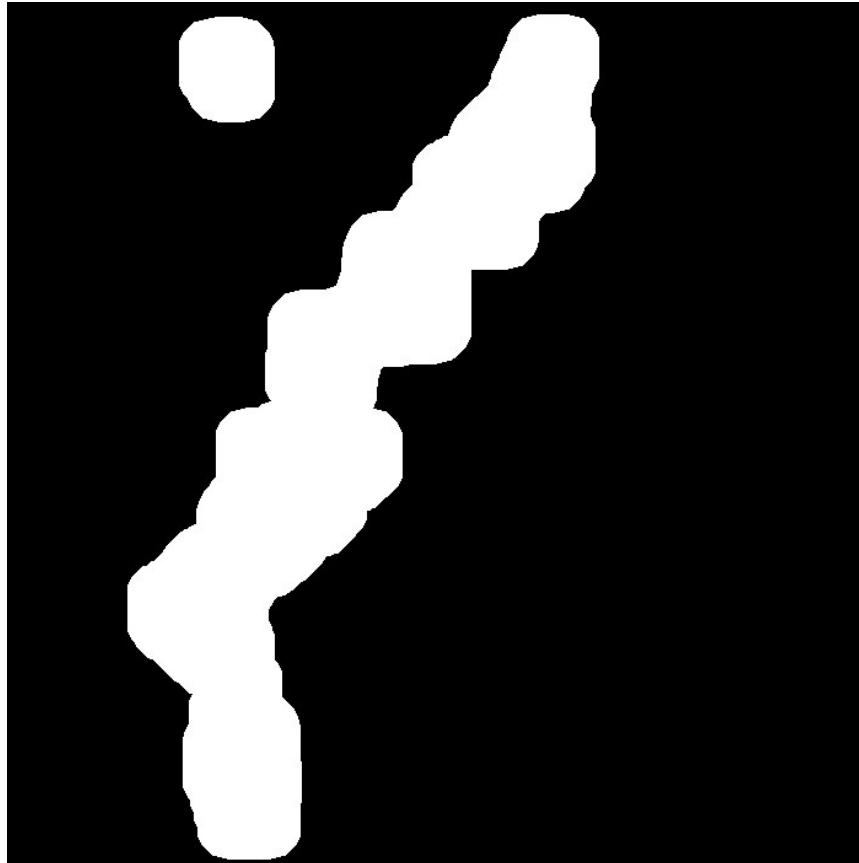
1. Bordered Image Result



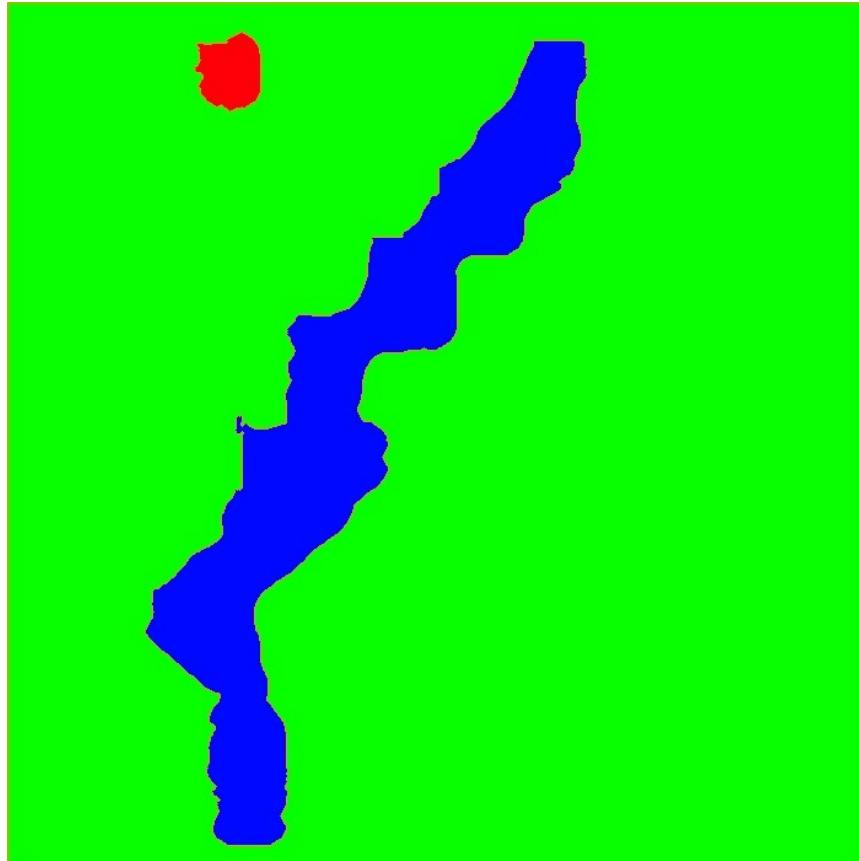
2. Cleaned Image



3. Get Background Mask



4. Menjalankan WaterShed



Countur Method VS Watershed

- Countour: Deteksi polygon langsung dari image mask
 - Pros: bagus untuk jalan yang single segment
 - Cons: untuk jalan yang harusnya satu segmen tunggal bisa terpotong
- Watershed: Deteksi polygon berdasarkan ketetanggan nilai piksel yang sama
 - Pros: mungkin lebih baik untuk jalan yang tersegmentasi
 - Cons: jalan akan terbagi menjadi segmen – segmen lebih kecil, polyline bisa putus - putus

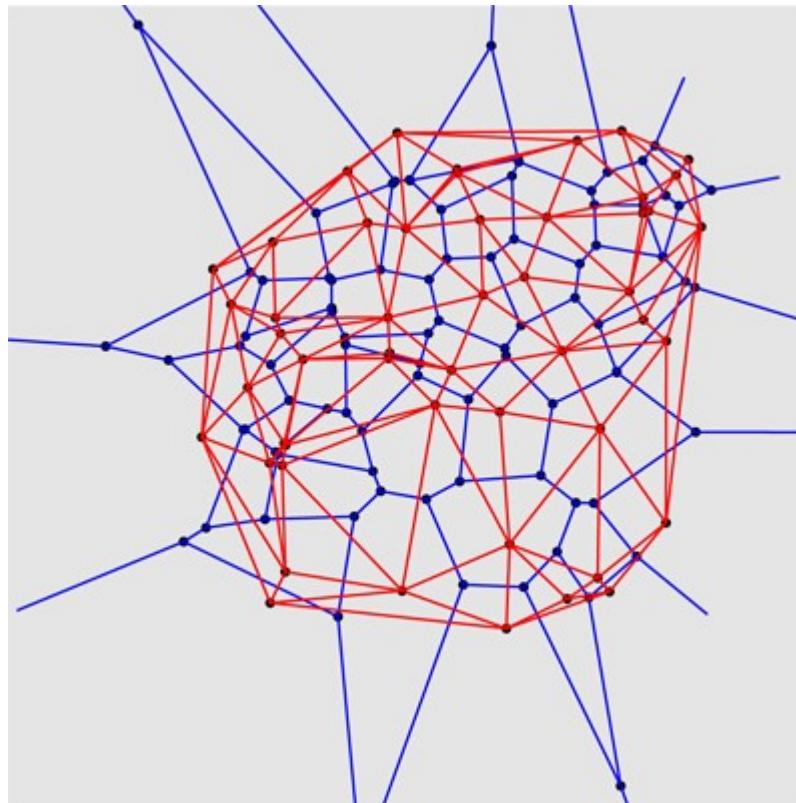
Skeletonisasi Polygon

- Skeletonisasi polygon merujuk pada method untuk mendapatkan polyline jalan dari polygon jalan yang berhasil terdeteksi
- Dalam hal ini ada dua metode yang hendak dieksplor, yakni:
 - Metode Voronoi diagram
 - Metode Straight Line

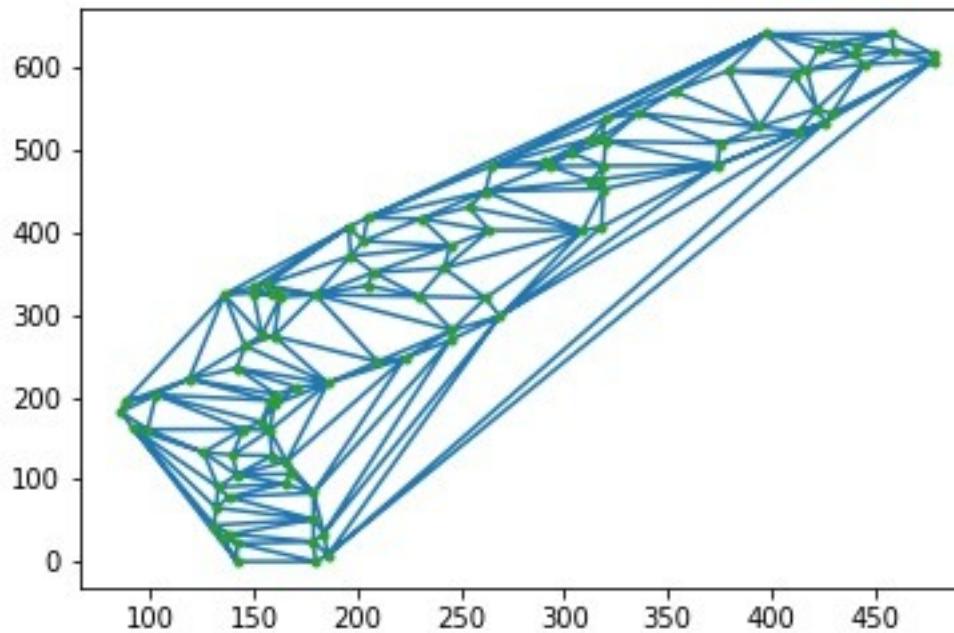
Metode Voronoi Diagram

- Memanfaatkan skema diagram voronoi untuk mendapatkan skeletonisasi polygon jalan, dengan tahapan ayng perlu dilakukan sbb:
 - 1)Membuat triangulasi delauney dari polygon
 - 2)Konversi ke voronoi, dan Mencari vertices voronoi didalam polygon
 - 3)Hasilnya adalah edges voronoi yang menghubungkan vertices internal

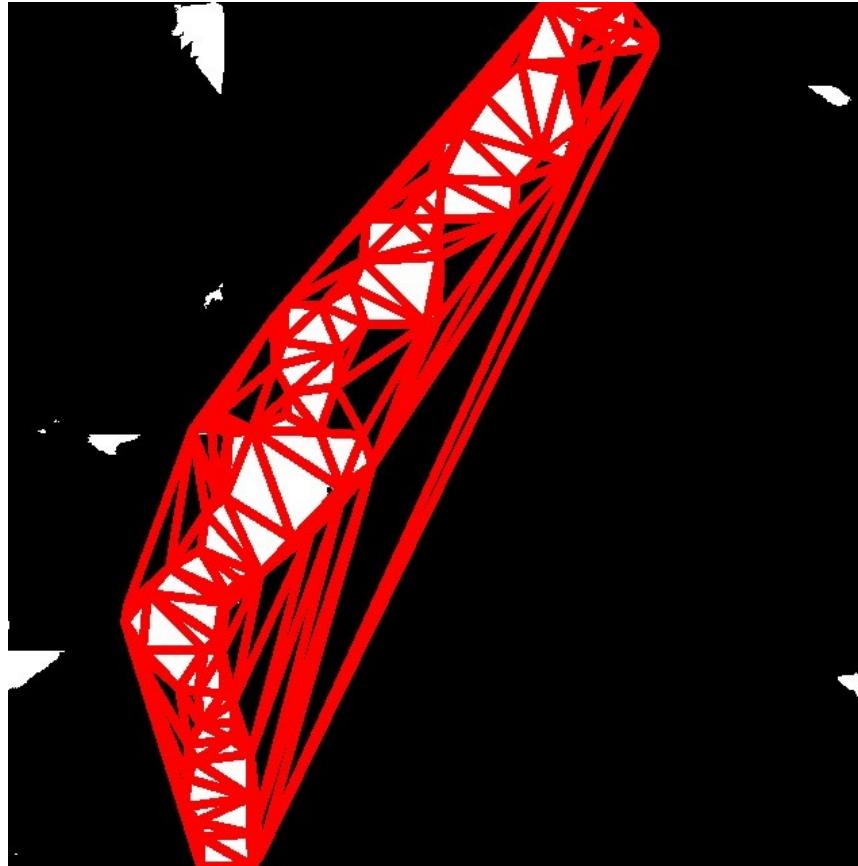
Voronoi vs Delauney



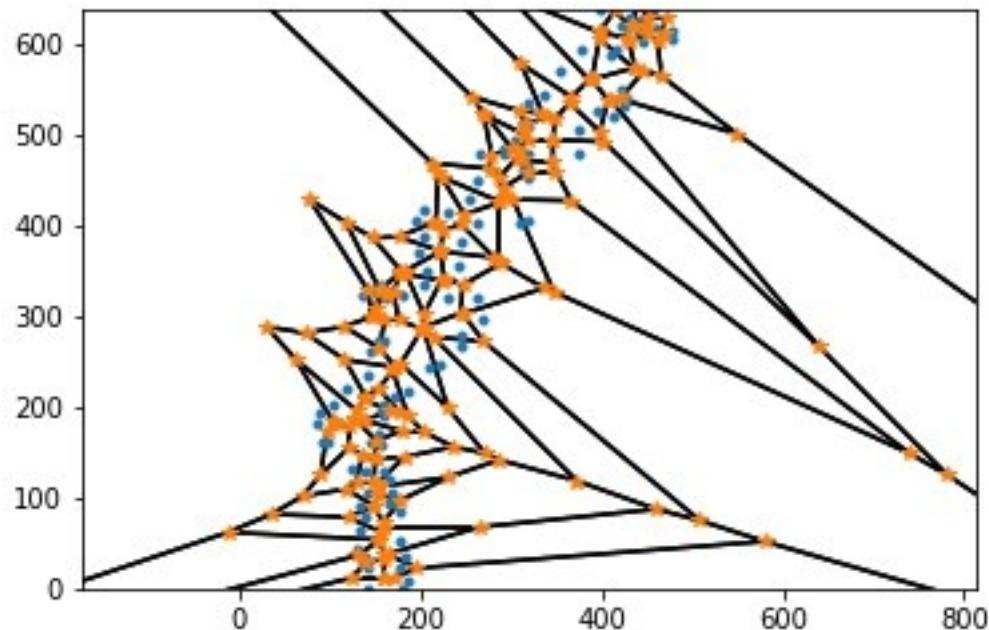
1. Delauney Triangulation



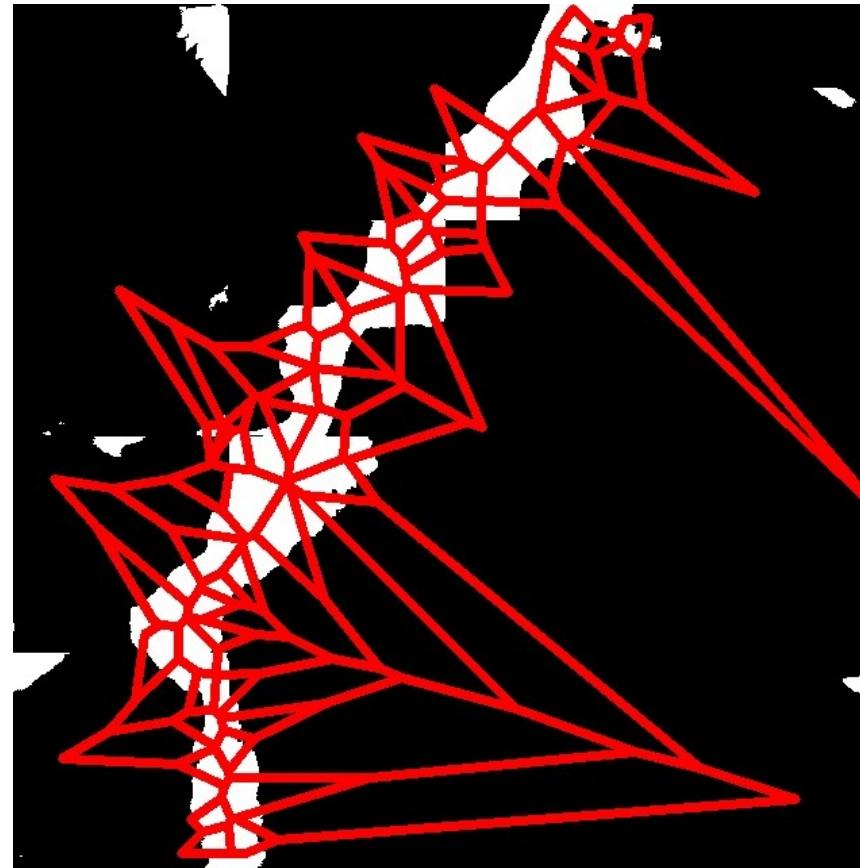
Delauney Triangulation



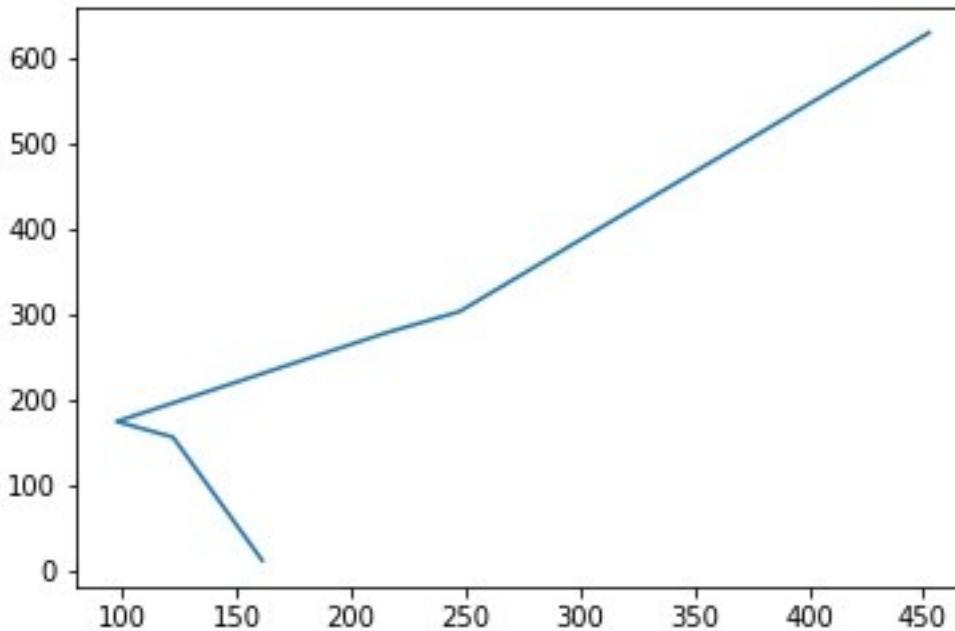
2. Buat Voronoi Diagram



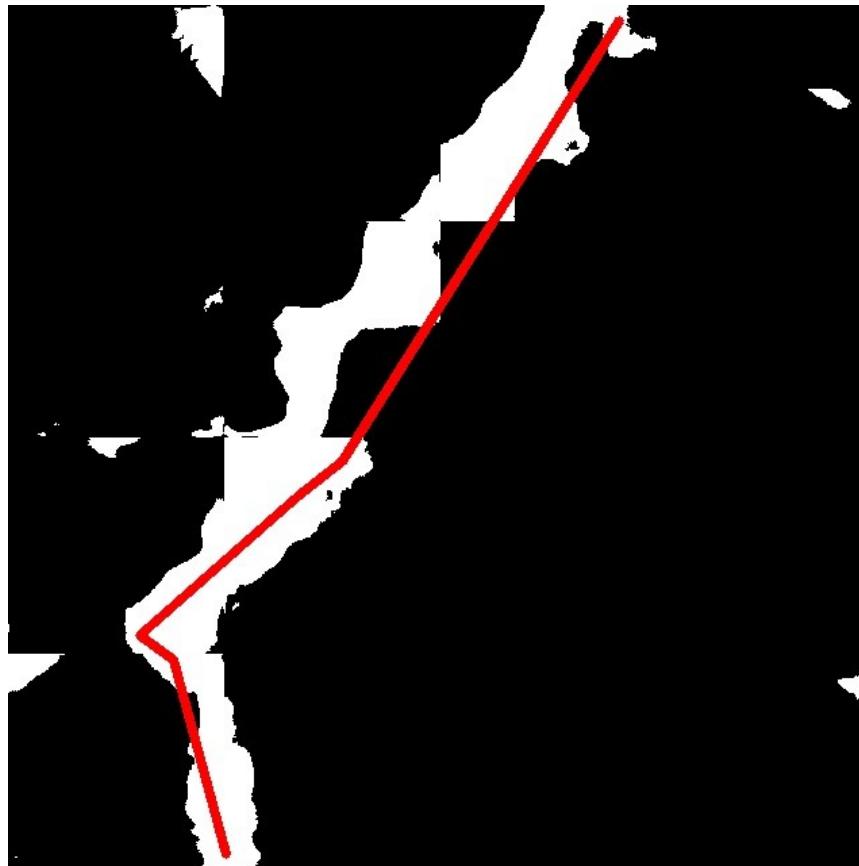
Voronoi Diagram



3.Ambil Semua point voronoi didalam Polygon



Hasil Deteksi Polylines Jalan



Deteksi Jalan berdasarkan streetmap imagery

Data Jalan Street map input image



Steps pengolahan data jalan street map imager

- Langkah langkah dilakukan untuk megolah data streetmap imagery adalah:
 - 1)Membuat mask image
 - 2)Deteksi contour untuk membuat polygon jalan
 - 3)Delauney Triangulation
 - 4)Voronoi Diagram
 - 5)Deteksi titik titik jalan dan drawing lines titik jalan
 - 6)Mengubah format ke longitude/latitude

1. Masking Image Streetmap



2A. Hasil Deteksi Countour



Countour Hierarchy

- Dalam kasus ini ditemukan kondisi ada kontur didalam kontur, dengan kata lain perlu dibuat sebuah hirarki kontur,
- Dipakai skema hirarki maksimum sampai 2 tingkat saja, dengan kata lain ada kontur dengan tingkat parent dan ada dengan tingkat child, dan juga childless
- Memakai flag : cv2.RETR_CCOMP

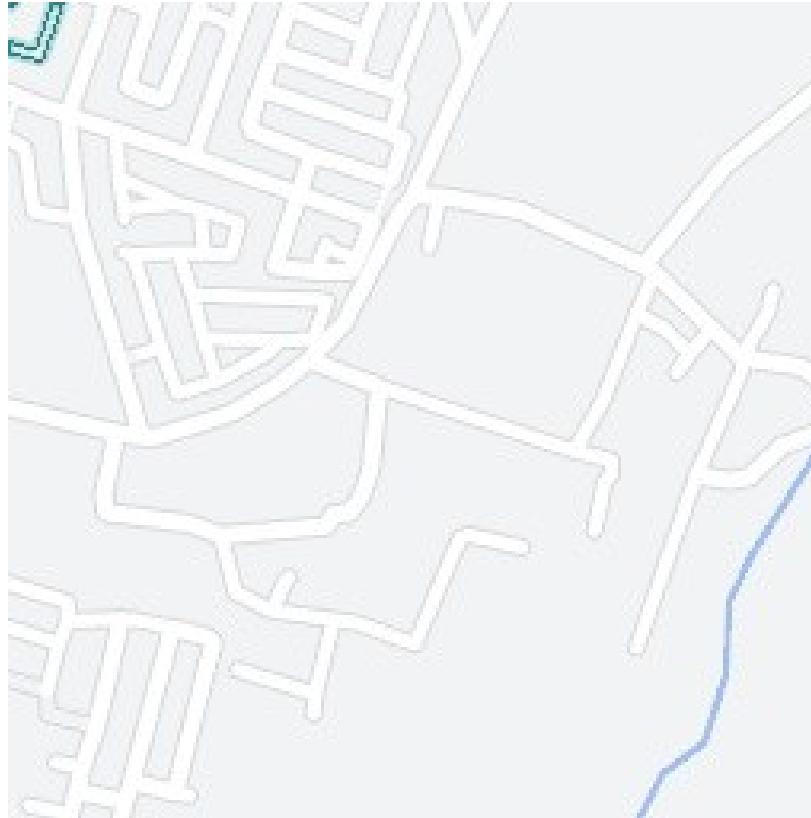
2B . The parent Contours



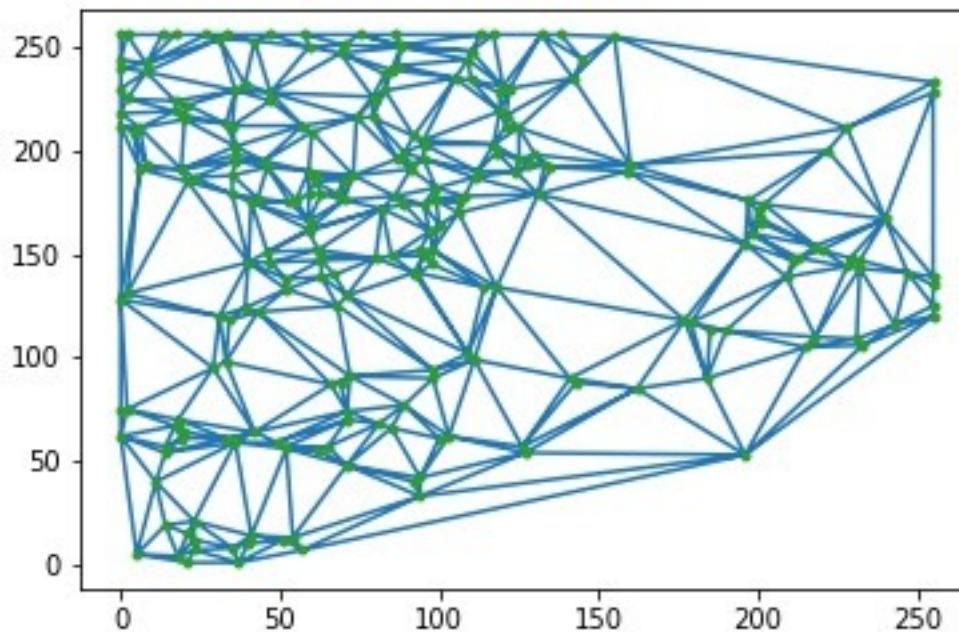
2C. The Child Contours



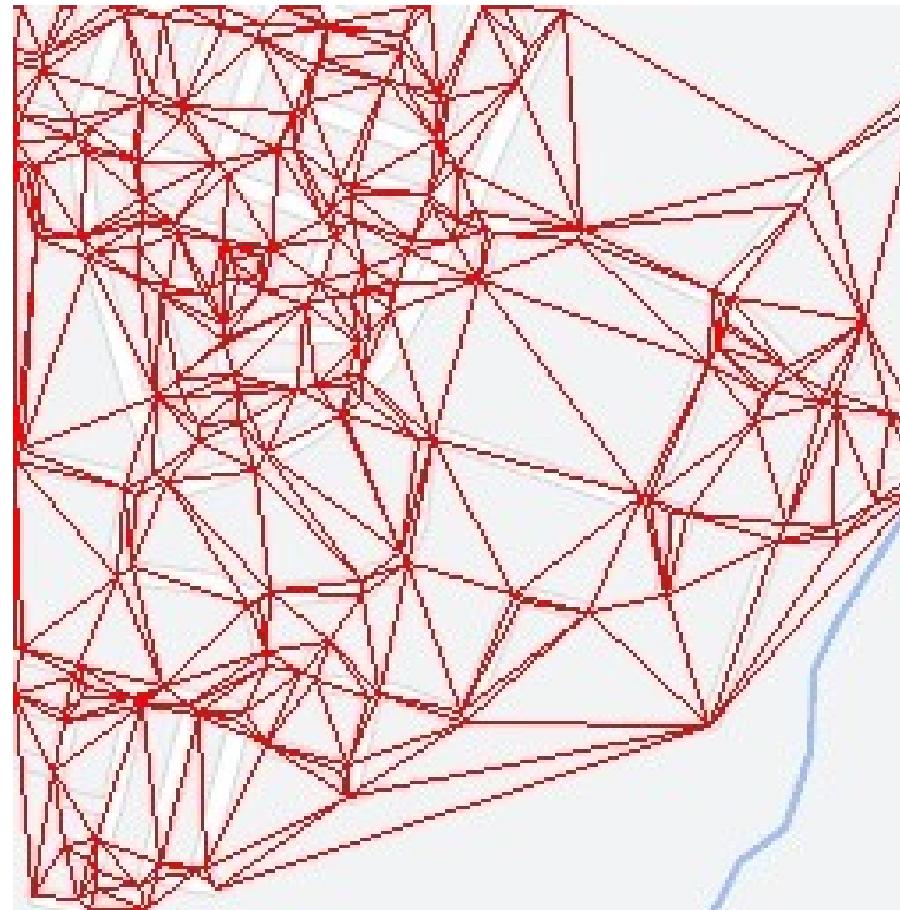
2D. Childless contours



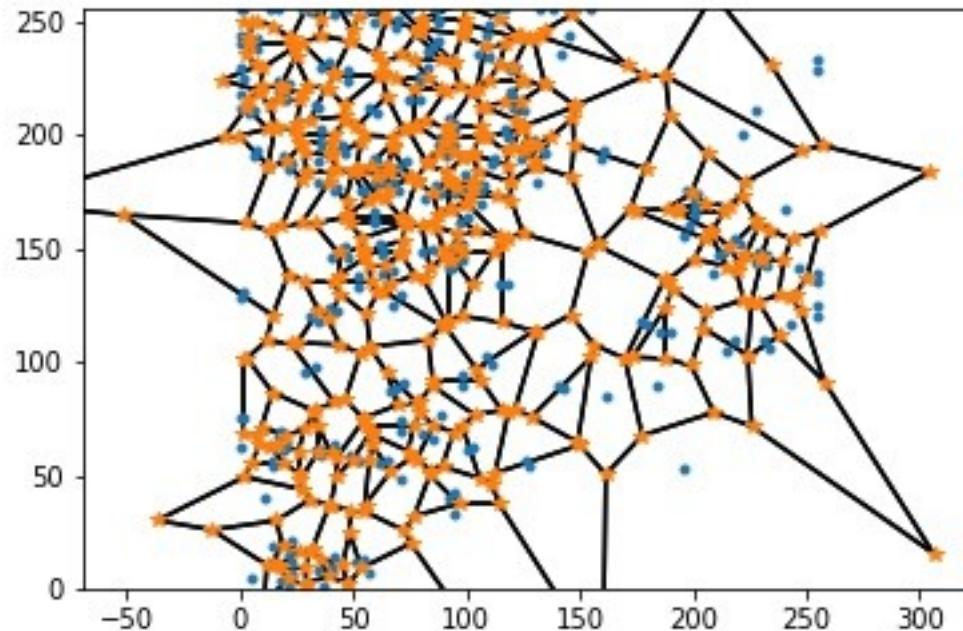
3A. Delauney Triangles



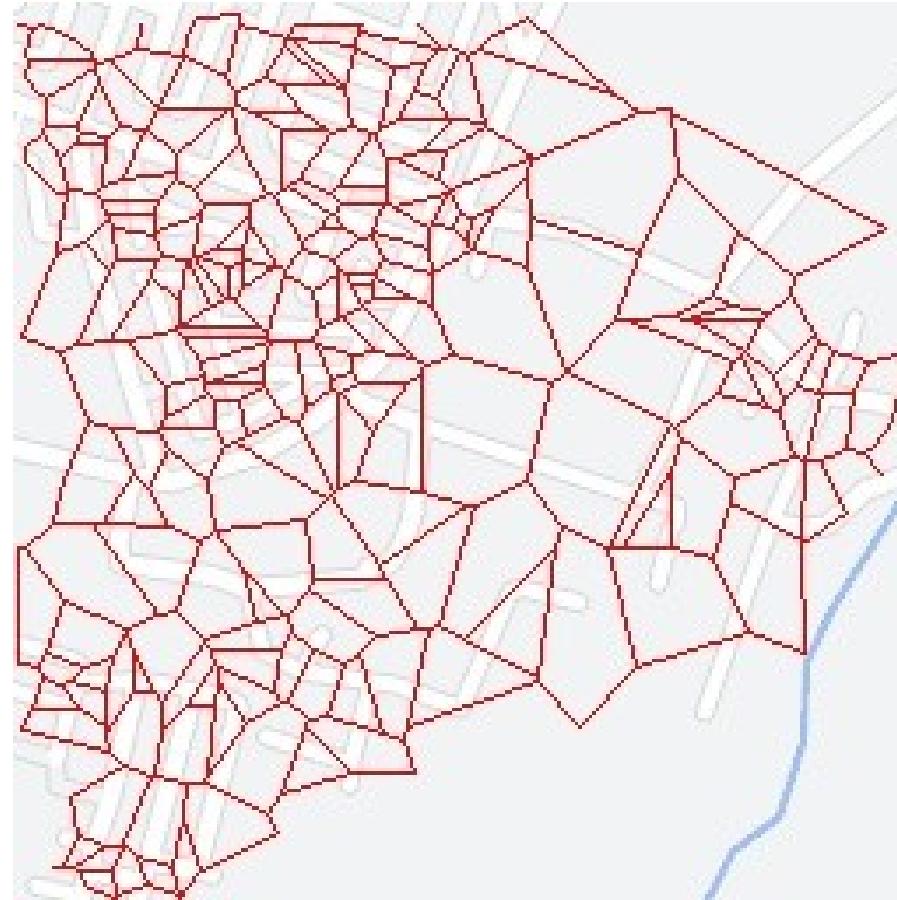
3B. Delauney Triangulation Result



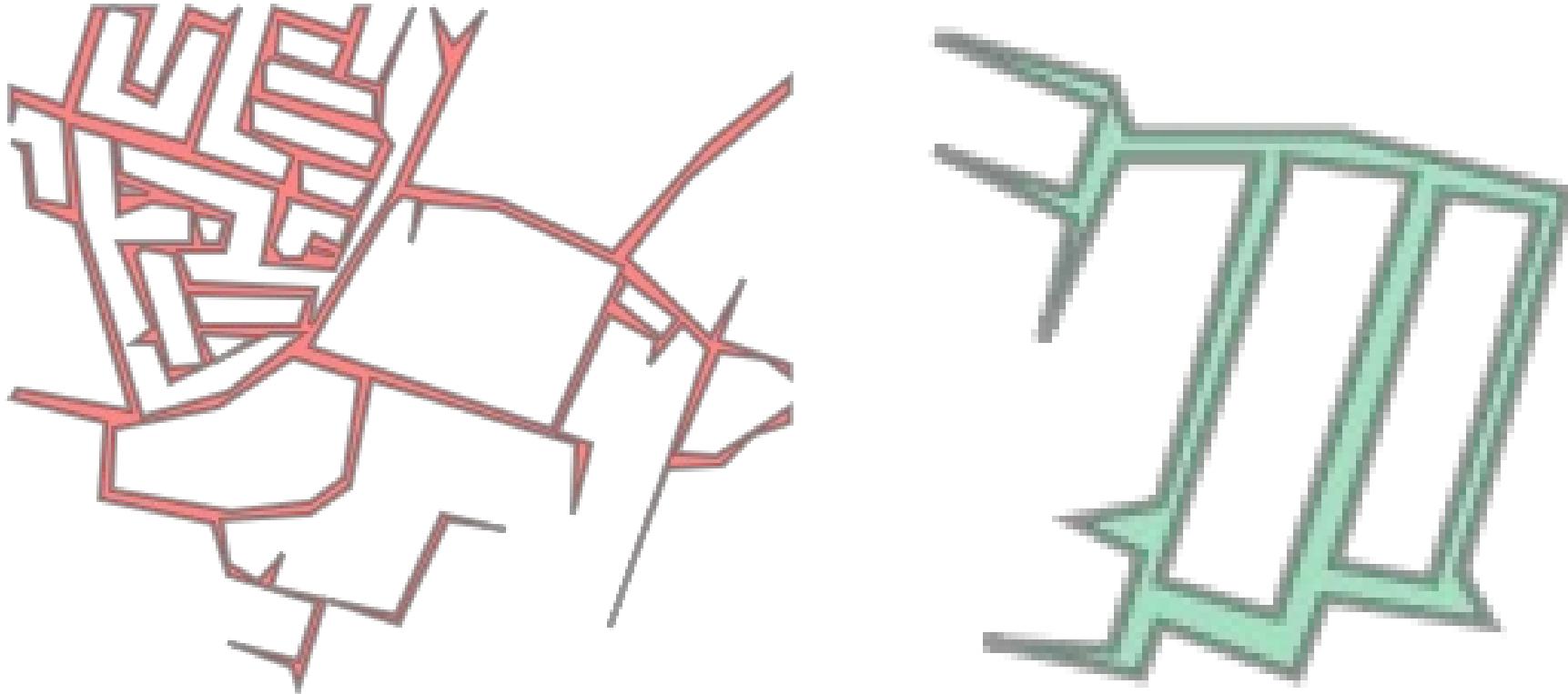
4A. Voronoi Diagram



4B. Voronoi pada Image



5A. Defining Parent Polygon dengan Holes (Children)



5B. Defining The Multipolygon



5C. Finding All Voronoi points within the multipolygon (Yakni Points Pada Jalan)



5D. Filtering Close together points



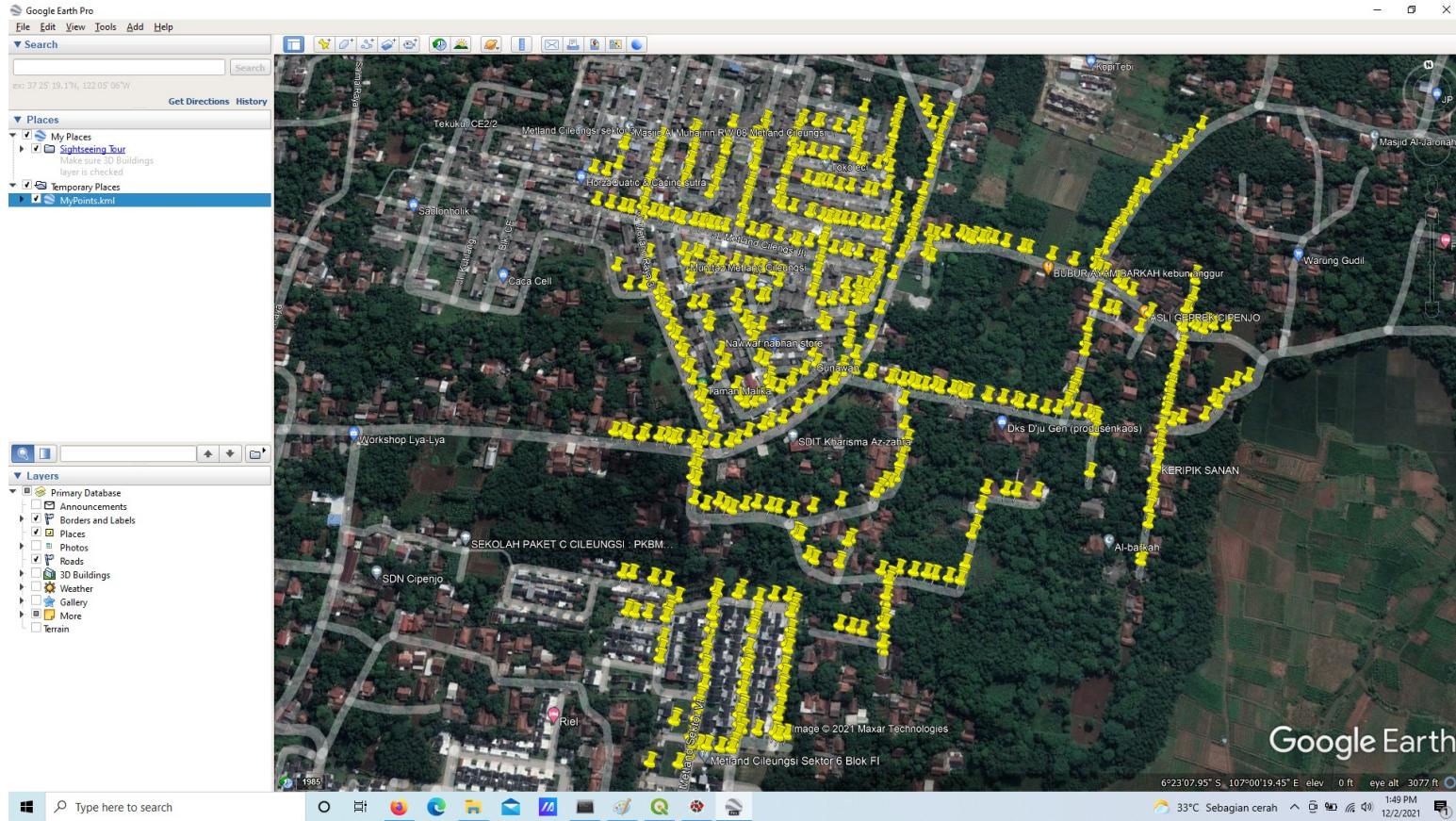
Drawing Lines Rules

- Given sebuah vertex, boleh dibuat sebuah edges ke vertex tetangga dengan rules:
 - Distance euclidean < 24
 - Hanya boleh 1 edges saja yang dibuat, bilamana ada lebih, maka diambil edge dengan distance terkecil
 - Graf yang dihasilkan asiklik

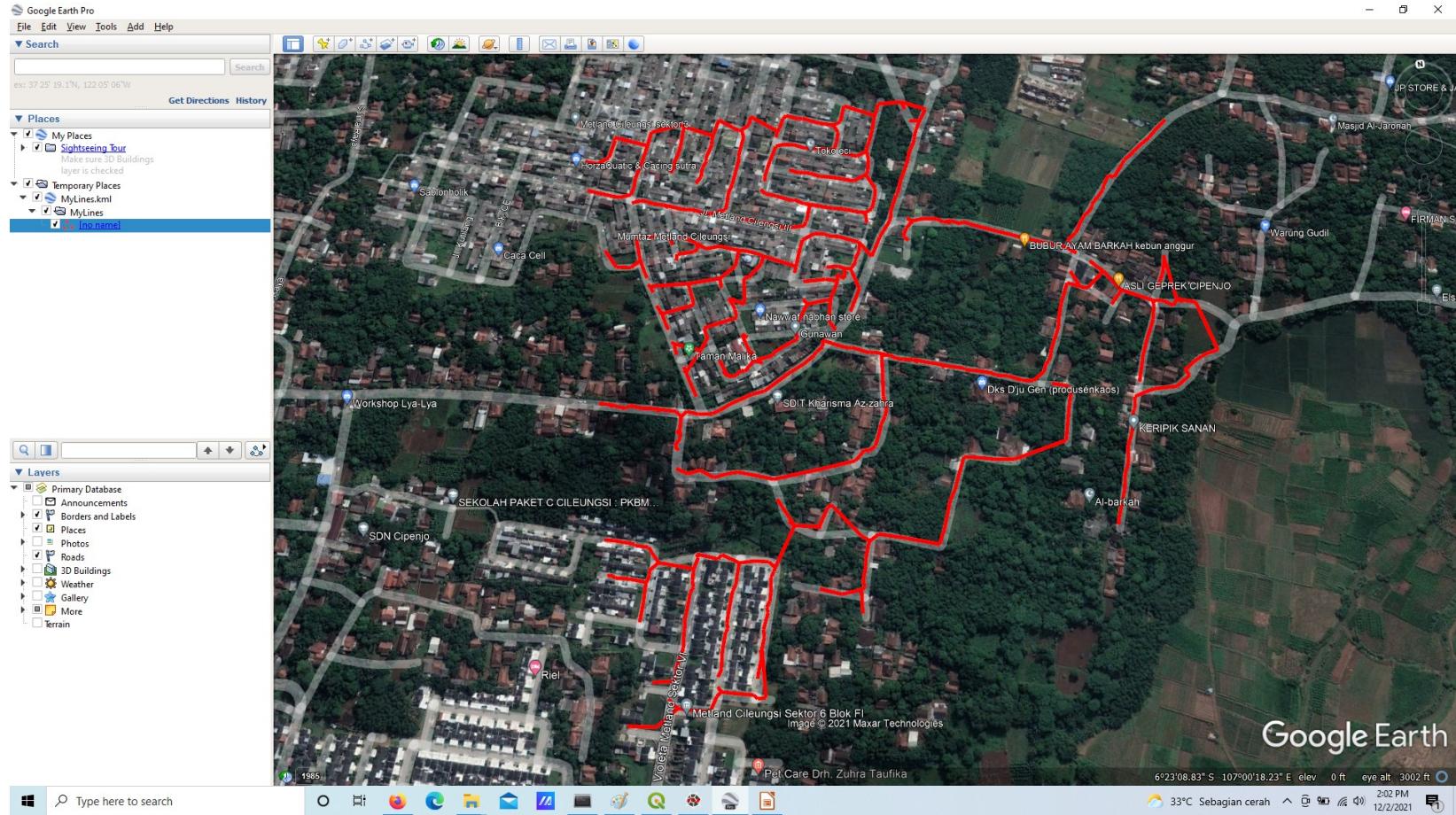
5E. Drawing lines



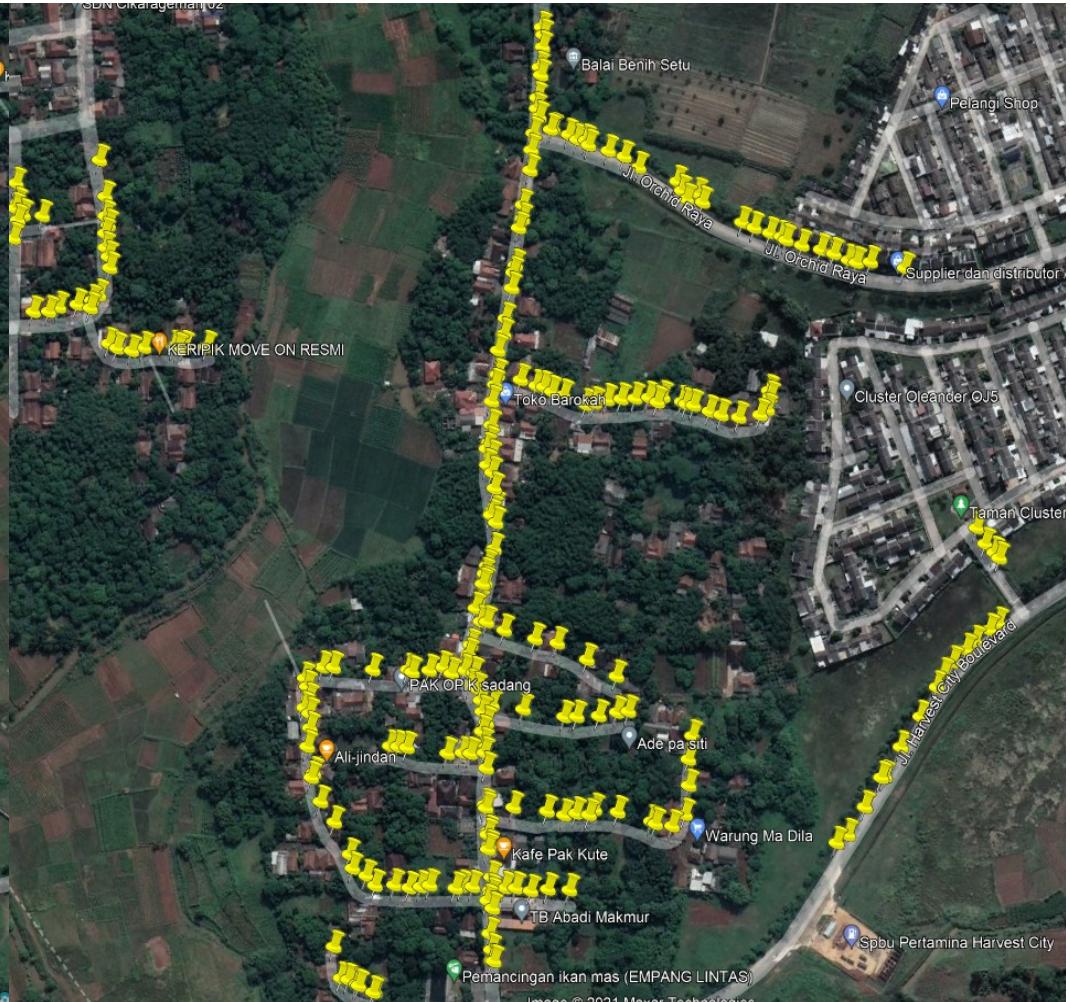
6A. Convert Points to Long/Lat



6B. Convert Lines to Long/Lat



Other Results: Points



Other Results: Lines

