To localize the centroids in image we are given with 5 ground control points. I manually found the pixel location of the points in the image sent, for example:

First point was located at:

"1": {

"lat": {"degree": 37, "minutes": 28, "seconds": 29.4454},

"lon": {"degree": 126, "minutes": 53, "seconds": 54.9389},

"x": 824,

"y": 153,

}

To convert latitude or longitude in terms of a single number you can do:

**coordinate = degree + minute/60 + seconds/3600**

Where x and y are the coordinates of image in terms of pixel of image size: 854,378.

Using these 5 points I calculated change in latitude and longitude with change of 1 pixel in x or y direction by creating combination of these 5 points (5c2).

[('2', '3'), ('2', '5'), ('2', '6'), ('2', '8'), ('3', '5'), ('3', '6'), ('3', '8'), ('5', '6'), ('5', '8'), ('6', '8')]

Change in latitude longitude was calculated using formula:

dx = (lat2 - lat1) / (x2 - x1)

dy = (lon2 - lon1) / (y2 - y1)

dx all values:

[-1.8765964239819943e-06, -1.9461189913232077e-06, -1.8133561643800047e-06, -1.7180886243430733e-06, -2.058127572039607e-06, -1.7201035781872401e-06, -1.798732943457612e-06, 1.930555555418323e-06, -1.8609876543172909e-06, -1.778562801931734e-06]

dy all values:

[-3.936111110647289e-05, -1.732744107819213e-06, -3.4809782607310256e-06, -2.7853333333496268e-06, -2.0156641604406694e-06, -3.086691086601994e-06, -3.07561728392997e-06, -2.4507688491937074e-06, 1.7063492062366743e-05, -3.080261136663399e-06]

The dx and dy are calculated as median of the above list combined.

Where lat 2 is latitude of second point and lat1 is latitude of first point.

This dx and dy was calculated for each combination (thus total number of dx and dy calculated is 10 each). I took mean of all dx and dy value calculated to get the final delta values. These values can be used to predict the latitude and longitude of each point on the image using formula:

x1, y1 = 0, 0

lat\_pred = origin\_lat + (x2 - x1) \* d\_x

lon\_pred = origin\_lon + (y2 - y1) \* d\_y

Here x2, y2 are the pixel coordinates of the point for which we want to calculate the output, origin\_lat is basically latitude and longitude of any of the 5 gcp given, x1,y1 is the pixel coordinate of choosed gcp.

**You can calculate the prediction for the evaluation points using these values of d\_x,d\_y, origin and pixel coordinates:**

1. origin\_lat = 37.47645790555556

2. origin\_lon = 126.8989458388889

Here are the pixel coordinates of all points for your reference in x,y format:

1. 805,168

2. 579,151

3. 405,150

4. 406,285

5. 297,283

6. 287,59

7. 654,60

8. 747,276

**Example to do the calculation on one of the evaluation point:**

For point 1 x = 805, y = 168 putting these value in equation given:

lat\_pred = origin\_lat + (805-0) \* -0.000002 = 37.47645790555556 – 0.00161= 37.47484790555556

lon\_pred = origin\_lon + (168-0) \* -0.000002 = 126.8989458388889 – 0.0000336 = 126.8986098388889

**Here are the result on evaluation points:**

distance 1.4013290255731221

ground truth 37.474845944444446 126.8985941388889

predicted 37.47484790555556 126.8986098388889

distance 1.507304726261864

ground truth 37.475654194444445 126.89836230555557

predicted 37.47564590555556 126.89837583888891

distance 1.1309982497019788

ground truth 37.47514 126.89882305555557

predicted 37.47514990555556 126.89882583888891