

# Effect of Land Control Points Spatial Allocation for the Image Registration of Remote Sensing Images



Harshlata Vishwakarma, Sunil Kumar Katiyar

**Abstract:** With the development in space technology, new remote sensing satellites are launched around the world tremendously. The high resolution camera gives high resolution satellite images and the large data is produced by remote sensors persistently. Because of high efficiency, the vast inclusion of data with not being restricted by the spatial parameter, satellite representation winds up one of the imperative way to obtain geo-spatial data. With this data, the obtaining of land control points is essential in the image registration and geometric improvement of satellite pictures. In this research work, the influence of the quantity and geographical distribution of land ground control point in image registration and accurateness is examine through Voronoi Diagram (Thiessen polygon). A simulation investigation was carried out using remote sensing pictures to analyze the impact of distributed patterns of land control points on image registration and correction. The corrected values are measured by square root mean error (SRME) and with residual separations. It exhibits that the center distribution gives the most reduced SRME. Additionally, demonstrates that the land control point distribution in the center of image is less distorted in comparison to land control points positioned at borders and corners. Subsequently, the centralized uniform distribution of ground control points shows better results taking into consideration the overall deformation rate on the complete image registration.

**Keywords:** Geometric Correction, RMSE, Residual, SP-80, SPSO, GNSS.

## I. INTRODUCTION

The registration process of remotely sensed image is a significant step in application of remote sensing and Gis[8]. The original image have significant geometric distortion so this information isn't utilized direct with map based items in topographical data framework [15]. Remote sensing images have geometric data which relies on the attributes of the detecting instrument for its position with respect to objects, the topography of a region, satellite imaging process, the projection, scanner and climatological condition in which the picture was captured [9].

Adding to this the researcher analyzed that remote sensing images, a geometric correction implies picture to map and registration implies picture to picture which must be yielded on the grounds that yield items are over layed on a map or converged into the geographic database [23,25,29]. The principle reason for geometric rectification or registration to find the window function uses land point and find out the element intensity in the correct remotely sensed images [26].

According to researcher precision level, numbers and the geographical allocation of land points influence the correctness and reliable corrected pictures [24, 16, 37, 19, 40]. In particular, a number of researchers analyzed the cause of the spatial distribution of land ground control points on the image rectification and registration. In this work [24] first studied this area and conducted a quantitative analysis of the relation between the spatial distribution of land points for a land sat images and geometric correction inaccuracy. This research concluded that the positional accuracy of the four corner points for one specific image and a few areas rely on number of land points. Land ground control points have significant role in image registration and geometric correction. As per literature two methods are applied for attribute matching functions and intensity matching functions for which [29] developed a semi-automatic method. The accurateness of the geometric rectification relies on factor like the geographical resolution of the images, the numbers and allocation of land ground control points and their dependability. The ground control points quality depend on ground control points source quality [30, 9, 37]. Topographic maps are the only source of GCPs in previously but these maps are not updated frequently. There are many other ways of land ground control points collection on the basis of data resource like, digital ortho photo, digital line graphic, ground surveying or digital raster graphic. The above finding shows that researchers have carried out lot of work on the distribution of land points. The research stated [15] shows maps large than 1:31,680 scale covers 31% of the complete world compared to the emergent countries which have more than 90% unmapped at this scale. The surfacing of land ground control points provide solutions to these problems [34]. However, the distribution of ground control points has a enormous effect on the geometric correctness of the satellite image. In a research carried [33,19] which shows that the distribution of land points should be identical in sufficient quantity and exact so it completely controls the accuracy of mapping functions. The differences between sensors, ground resolution,

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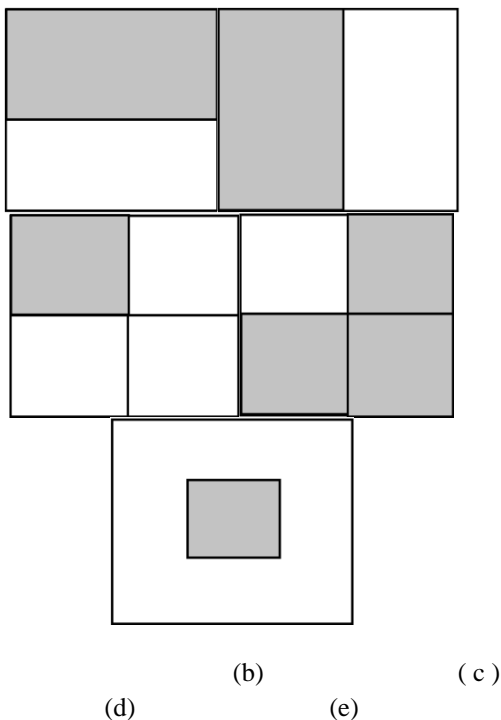
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topographic changes and correction methods are responsible for the analysis of uniform standard for land points selection. The aim is to observe the uniformly distributed land ground control points, near the corner of image so that accuracy shall be controlled for mapping of a region or each part of the image. The points selected are located on the road section, building corners and landmarks and so on as a ground control points [19]. The factors such as surveying work, approach and capability to evaluate the site for GCPs selection. To craft the collection of GCPs systematically, the relation is developed among GCPs distribution and quantity.

**II. METHODOLOGY**

The data survey and collection was carried on October 12, 2018, in Bhopal Madhya Pradesh, India. To observe the allocation of land points, nine different kinds of distribution patterns of land points and checkpoints are designed given in figure 1. Selection of land points and checkpoints carried out manually or by computer. In this experiment, selection of ground control points was carried out on the base of the features, object accessibility and the subjective basis through the device DGPS SP-80. The 41 locations were selected for GCP collection for the selected study area as shown in Fig. 2. Mainly the road corners, road section and building corner points were selected. The baseline pre-processing of GCP's has been carried out using Spectra Precision Survey Office Software (SPSO) environment. The Spectra Precision Survey Office software (SPSO) desktop application was applied for land point processing and evaluation of optical survey data. On the basis of features land points are collected and the checkpoints of the distributions shown in Table1.



(f) (g) (h)  
(i)

**Fig. 1 Nine allocations of GCPs and checkpoints**

c

**Fig. 2 GCPs for Study area.**

**Table1. Number of GCP's and checkpoints**

	a	b	c	d	e	f	g	h	i
GCPs(Ground control points)	3 1	2 6	2 2	2 0	1 4	2 8	2 1	1 2	8
Check Points	1 1	1 6	2 0	2 2	2 8	1 4	2 1	3 0	3 4

**III. EXPERIMENTAL RESULTS**

**3.1 Experiment for Spatial Distribution of GCP**

Data preparation and generation are important step in this experimental work. The preprocessing of ground control points data is carried out with SpectraPrecision-80 software. Other experiments were carried with QGIS and ArcGIS software. The dataset used for this investigation were obtained from National remote sensing center, Hyderabad. The data collected were of Cartosat-1 image resolution 2.5m, date of pass 6 Apr 2006 of Bhopal, India. For ideal conditions features may be evenly distributed but it's not possible in some cases, so ground control points are not in evenly distributed. The study is carried out with 31 ground control points and 11 checkpoints for the same selected area and the error in X and Y positions as shown in table 2 below.

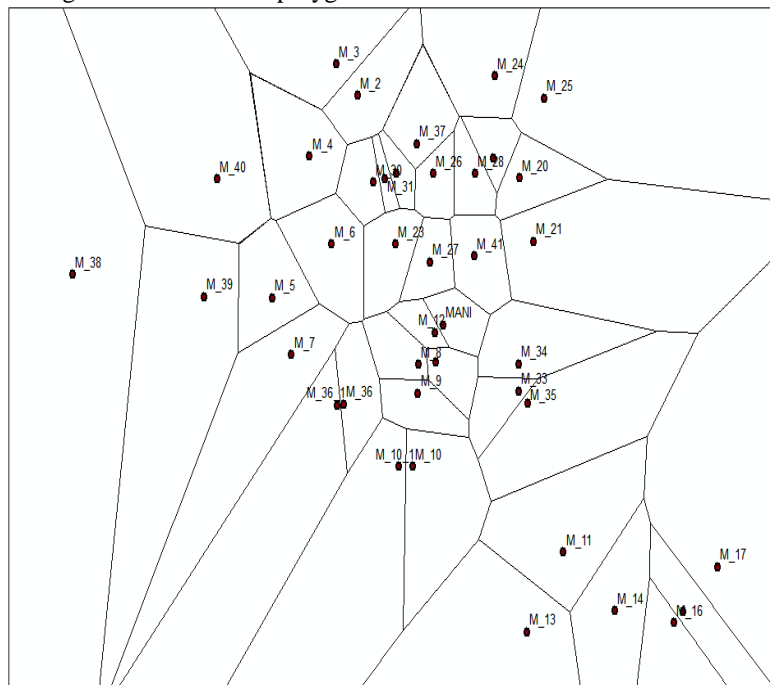
**Table 2. Displacement Error Of Different Land Point Pattern**

ERROR	a	b	c	d	E	F	g	h	i
X	13.532	8.318	26.686	12.196	2.036	3.053	0.337	17.257	15.776
Y	10.707	13.955	12.192	33.364	34.164	0.538	0.176	27.629	9.5117
TOTAL RMSE	17.2564	16.2468	29.3392	35.523	34.225	3.100	0.381	32.576	18.421

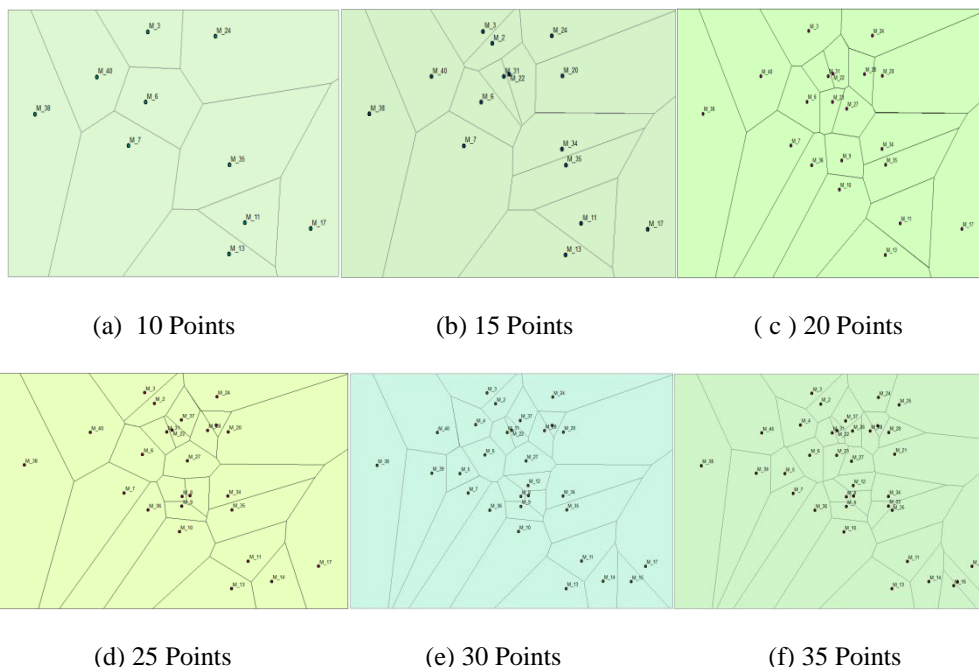
**3.2 Optimization Methods of GCP**

In second experiment as per literature review the selection of land points had three optimization methods which are longest distance, Voronoi diagram method and regular grid methods [33]. Regular grid technique is used to divide the area of survey, but this type of region is not present in the real world and is not necessarily a regular area because in regular grid method each grid has similar number of land points with higher accuracy. This is very simple which can be actualized easily, but it is not possible to obtain the features in every region. Therefore, the regular grid method does not satisfy the ground control points distribution provision. The longest distance technique results depend on the reading point order. The different results are produced by computer's dissimilar reading order. [33]. These are the limitations of the present methods. In order to overcome these limits, the Voronoi diagram is applied for optimization of land points and measure the allocation condition by the value called important value. The above stated experiments were executed in ArcMap 10.2 and QGIS environment. Use all ground control points to generate Thiessen polygons

(Fig.3). On the basis of the first experiment it shows that many distributions of ground control points, hence Voronoi diagram is created for all these ground control points distribution as shown in Fig.4. The experiment is divided into six various distributions of land ground control points and contain various numbers of land ground control points in 10, 15, 20, 25, 30 and 35 for optimization. Based on each ground control points polygon area, each polygon is Thiessen polygon and this area is the affected area of that particular ground control points. The large affected region has the higher importance of ground control points in distribution. This is percentage of each ground control points area of the total area as an important value. However, the proportion of highest and lowest values of ground control points is important value as objective standard to evaluate the uniform distribution of ground control points. As per ideal condition of uniform distribution, shows that the significant values of ground control points are identical, it means the ratio is 1 [33].



**Fig.3 Voronoi Diagram**



**Fig.4 Voronoi Diagram For All Optimized Ground Control Point**

Optimization shows uniformity in distribution than previous values, on the subjective basis. It also shows that quantitatively the ratio of the maximum and minimum area of each ground control point for Voronoi area. In a uniform

state, the ratio is close to 1 after optimization. Ratio and the maximum-minimum result given in Table 3.

**Table 3. Ratio Of Maximum And Minimum Area Of GCP's**

	Maximum GCP Voronoi Area	Minimum GCP Voronoi Area	Ratio
10	0.45146	0.100796	4.0194
15	0.404098	0.025807	15.6584
20	0.389872	0.021342	18.2627
25	0.389872	0.010002	38.9794
30	0.337398	0.010002	33.73305
35	0.337398	0.006564	51.4012
41	0.337398	0.004143	81.8380

**Table 4. Maximum, Minimum Area Ratio Between Different Situations**

	a	b	c	d	e	f	g	h	i
Maximum	0.164	0.17866	0.14630	0.16555	0.048267	0.32709	0.337398	0.200289	0.082135
Minimum	4.123	0.004123	0.004123	0.1149	0.00861	0.004123	0.004143	0.022679	0.006928
Ratio	39.777	43.33	35.484	14.408	5.605	79.333	81.438	8.831	11.855

**Table 5. Important Value And Errors**

	a	b	c	d	e	f	g	h	i
Ratio	39.777	43.33	35.484	14.408	5.605	79.333	81.438	8.831	11.855
Total RMSE	17.2564	16.2468	29.3392	35.523	34.225	3.100	0.381	32.576	18.421



The results shown in table 4 for second experiment show the different distributions of ground control points with their maximum and minimum important values and the ratio are shown in Table 4. The relation between allocation of land points and accurateness of image geometric rectification or registration as given in table 5. In this table 5 it is also shows that the positive relation among the ratios of highest, lowest and displacement errors of check points.

#### IV. DISCUSSIONS AND CONCLUSIONS

As per the analysis carried out it is suggested that the distribution of ground control points must be uniformly allocated in survey area, but sometimes no features are identified for ground control points. For perceptiveness of uniform distribution, there is no such ideal condition but center uniform distribution with low root mean square error and high accuracy is acceptable. In this research nine types of ground control points distribution were considered. The root mean square error and residual error are obtained to evaluate the results of geometric correction. The low values of root mean square error give higher accuracy with a particular type of distribution. The results of the first experiment shows that in figure 1(g) the distribution gives the lowest residual error. Hence, it is concluded that the more evenly distributed ground control points gives higher accuracy. From the second experiment, it is concluded through algorithm of Voronoi diagram when area of each Voronoi polygon is same; hence the accurate registered images are obtained. Through optimization of land ground control points based on Voronoi diagram also show the relative relation between the area of each land ground control points affected, maximum and minimum area generated by ground control points should be close to 1. Finally, it is observed that the image registration and geometric process are highly influenced by human factor, number of land points and spatial pattern.

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