

RESEARCH ON THE OPTIMAL SPATIAL RESOLUTION OF REMOTE SENSING IMAGE FOR CENSUS AREA DIVISION

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BACKGROUND

Census is a main method that a country used to collect population data. Because of the floating population increased year by year in China, the old mode of census need to be improved, which based on the household registration system. Dividing the statistic zone into small areas hierarchically according to some principle is the international conventional method. With the development of RS, GIS and GPS in recent year, dividing census area into small pieces is possible. By the advantage of quick update, full coverage and better visualization of the buildings, the remote sensing image is the most important data source to be based on to divide the census area.

Census areas comprise 6 hierarchical levels, namely province, district, county, township, census district and enumeration district. Each level of areas has different requirement in dividing census area. The lower the level, the higher the image resolution needed. Different region type (city, suburban, village etc) has different requirement too. The higher image resolution is needed in city, the lower in village.

APPROACH AND METHODS

The optimal spatial resolution of remote sensing image related to the size of researched object. The optimal spatial resolution of remote sensing image should meet two conditions: the researched objects appear in the image by pure pixel; the other objects appear in the image by mixed pixel. The higher the resolution, the easier the condition one to be met while the lower the resolution, the easier the condition two to be met. The rule mentioned above can be abstracted as: The optimal spatial resolution is the lowest resolution that the probability of the researched objects appear in pure pixel get maximum value.

Hypothesis:

The researched objects size is L , the resolution of remote sensing image is S , the probability of the researched objects appear in pure pixel is $P(S, L)$, it is a function of S , and L .

$$P(S, L) = \begin{cases} 1 & S \leq L/2 \\ 2(L - S) / L & L/2 < S \leq L \\ 0 & S > L \end{cases} \quad \text{----- Formula 1}$$

In the range from $L/2$ to L , the partial derivative of P with respect to S and L are respectively:

$$\frac{\partial P}{\partial S} = -\frac{2}{L} \quad \text{----- Formula 2}$$

$$\frac{\partial P}{\partial L} = 2S * L^{-2} \quad \text{----- Formula 3}$$

According to formula 1,2,3: P is an increasing function of L and a decreasing function of S . when $S=L/2$, P gets maximum value. So the optimal resolution equal to half of the size of researched object.

Different level of census area and type of region has different requirement in dividing census area. Because of the high population density and the high building density in city, the optimal resolution of remote sensing image is higher than in rural section at the same level of census area.

In village, rural roads were chosen as the reference. According to the criterion of road line design, the width of rural road is about 11.5m, so the optimal resolution of remote sensing image is about 6m.

Because the census areas in city are usually divided by all kinds of city roads, city roads chose as the reference. Different level of census area based on different grade city road. The higher level the census

area is, the higher grade road needed. Township is divided by higher grade city roads. Township is usually divided by express way and main road in big and middling scale city, and trunk road in small scale city. Census district is divided by lower grade city roads. Census district is divided by sub main road and branch in big and middling scale city, and branch road in small scale city Enumeration district is divided by the lowest grade city roads and inner residential road. According to the correlation criterion about city road in

Level	Scale	Resolution	Area
City	1:50,000	5m	City
Suburb	1:25,000	5m	Suburb
Rural	1:10,000	10m	Rural

China, the optimal resolution of remote sensing image in city is:

Table 1: the Optimal Resolution of Remote Sensing Image in City

EXPERIMENTS AND RESULTS

An experiment has been taken to verify the rule. Panjin in Liaoning province and Hefei in Anhui province were chosen as the experimental area. The resolution of the image used in the experiment ranged from 0.61m to 30m. As the result of the experiment, the true resolution of remote sensing image in rural area is lower than the theoretical value. The reason is the reference object chose is too fine. The farmland, hill and river which are used usually as the sign object in rural area. The size of these kinds of object is bigger than the width of rural road. The true resolution of remote sensing image in city area is higher than the theoretical value. It is because of the resolution lost during the dividing process (for example in the printing process).

	city(m)	suburban(m)	Rural (m)
Township	<5	<10	<15
Census district	<5	<5	<15
Enumeration district	<2.5	<5	<10

Table 2: The Result of Experiment

CONCLUSION

Concluded from the experiment is that the optimal resolution of remote sensing image is related to the census area type and level. 2.5m or higher spatial resolution remote sensing image should be used in the city, and 5m in the outskirts, 10m in the rural area correspondingly.

KEYWORDS

Census, Remote Sensing image, spatial resolution