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Establish of the Image Color Extraction Algorism for Selective Classification of LiDAR Point Cloud

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Abstract
LIDAR survey has been widely used for establishment of three dimensional spatial information and territory monitoring by intuitionally obtaining high density point cloud on features. As point cloud possesses a characteristic of massively high density, there is a limitation on storing and processing. Thus, it necessarily requires reclassification work for point cloud of specific targets to fit the purposes of users. In this context, it suggests a new concept of classification method that is based on ortho-image to selectively classify point cloud of specific targets from high density point cloud by using color information of ortho-image. In this study, the attribute value that is used to classify point cloud is constructed to utilize the color information extracted from ortho-image and color extraction algorism is set and materialized. Furthermore, point cloud of specific targets is classified by putting color information as an attribute value of point cloud.

Keywords: Ortho-Image, Point Cloud, Color information, Classification

1. Introduction
People-centered spatial information service such as a system improvement method regarding the spatial industry for the recent government 3. 0 materialization has been provided in various platforms. Establishment accuracy of spatial information depends on geo-spatial data. To establish spatial information, aerial LiDAR survey method that makes it possible to quickly and accurately obtain three dimensional location data of all features in target areas has been utilized. For high density point cloud, which is obtained from this, horizontal and vertical information on the features that exist on spaces is basically measured. It is a data that includes information such as altitude and reflection intensity and has various and massive information such as buildings, roads and trees. However, classification process is needed for certain purposes as the use of high density point cloud, which has such massive data, has a limitation based on operation systems. Thus, various methods on classification of point cloud have been suggested.
Generally, tile-based topography classification method, which classifies point cloud in tile-unit, has been used to classify point cloud. Tile-based topography classification method is a method that classifies the types of surfaces by dividing aerial LiDAR data into certain size of quadrangle shaped tile and extracting the characteristics such as dot distribution patterns, average altitude and reflection degree. Tile-based topography classification method has a benefit that calculation velocity increases because the size of area is limited within a tile and classification is conducted with a tile as a basic unit compared to dot-based method[1, 2, 3, 4]. However, for the complex topography that mixes with various types of topography in a narrow area, the classification class increases because many complex classes need to be included. In this case, there is a weakness that the accuracy of topography classification decreases. To precisely classify buildings or road objects after topography classification, it needs a revised step that fixes wrong classification by reviewing the accuracy of topography classification based on tile-unit. This will cause a problem of decreasing the efficiency improvement effect of running time.
This study suggests a method that selectively classifies specific targets among high density point cloud to improve a problem of filtering process by the current batch process[5]. It suggests a new concept of classification method to only extract point cloud of specific targets by blending ortho-image, granting color information of specific targets as an attribute value of point cloud and using it as a search factor. This study constructs to utilize color information extracted from ortho-image as a search factor that uses for classification of point cloud and color extraction algorism is materialized[6]. Furthermore, it reviews the classification possibility of certain point cloud and applicability of this algorism through tests [Figure 1].

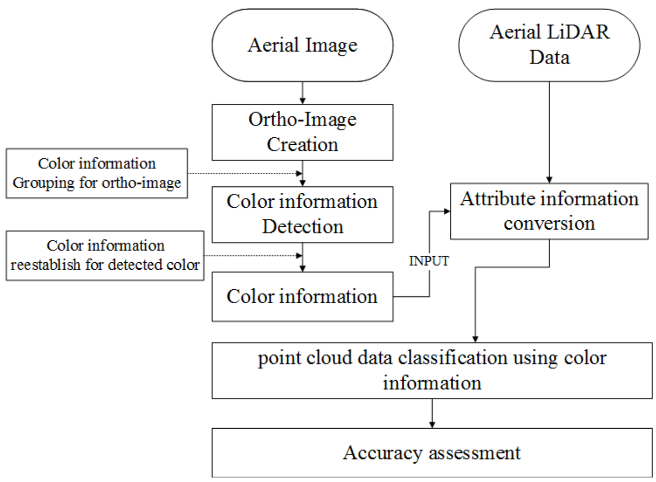


Figure 1: Study flow

2. Materialization for Color Information Extraction Algorism

To reclassify point cloud obtained from aerial LiDAR survey using ortho-image color information, color information for target objects is required. This study establishes an algorism to extract color information from ortho-image and extracts color information of ortho-image through single programming.

2. 1. Object Establishment for Classification Target

It contains color information of produced ortho-image. Generally, color information is composed of R, G, B. For 8 bit image, each color has brightness value of 256(0~225) and the color information is 24 bit data per pixel and has 16, 777, 216 color information[7, 8, 9]. It may cause a problem that the same object can be recognized as a different object when the object is discolored due to time difference. To group the colors, the objects that are included in study target areas are categorized accordingly by six types [Table 1].

Table 1: Object establishment

No.	object
1	building
2	road
3	terrain
4	vegetation
5	farmland
6	river

2. 2. Algorism Establishment for Color Information Extraction

To extract color information that will be given to point cloud by using color information from ortho-image, coding and programming for single process needs to be constructed. Thus, this study extracts color of ortho-image by using C language that is suitable for image process. Flow chart of algorism for color extraction is shown as Figure 2.

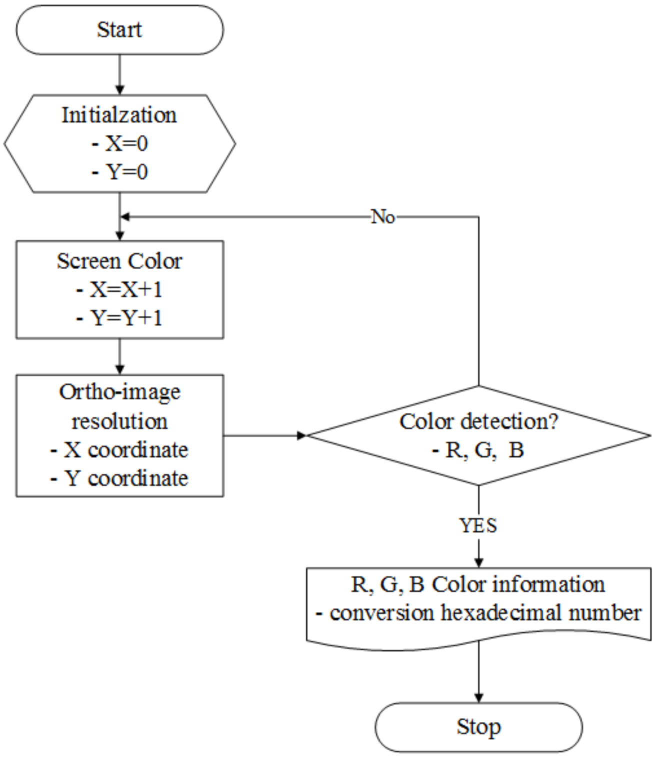


Figure 2: Flowchart of color information detection algorithm

Based on the flow chart of algorism from Figure 2, code was written by using visual studio2010 from Microsoft. Visual studio 2010 includes various C languages and dot net 4. 0 which supports many libraries. In this study, code was written with C# that uses open CV which is object-oriented and is suitable for image process[10, 11].

First, images were added by writing basic forms and labels by using C#'s window form. At this time, the resolution of image was set as the resolution of image itself [Figure 3].

```
{
string openstrFilename;
openFileDialog1. Title = "image load"
openFileDialog1. Filter = "All Files(*. *)|*. *|Bitmap File(*. bmp)|*. bmp|JPEG File(*. jpg)|*. jpg"
if (openFileDialog1. ShowDialog() == DialogResult. OK)
{openstrFilename = penFileDialog1. FileName;
image= Image. FromFile(openstrFilename); this. pictureBox1. Image = image;
gBitmap = new Bitmap(image);}
}
```

Figure 3: Code for image load

Code was written by using a method that increases a coordinate because color information has to cognize and output within a maximum resolution of ortho-images to recognize color information from input ortho-images and output characters[12]. At this time, to extract color in a detailed way, the movement of coordinate was set as 1 pixel [Figure 4]. R, G, B color information was extracted by increasing 1 pixel of coordinate and a code that saves text file was written[13]. Figure 5 shows the codes that extract R, G, B color information

```
private Color ScreenColor(int x, int y)
{
Size sz = new Size(1, 1);
Bitmap bmp = new Bitmap(1, 1);
Graphics g = Graphics. FromImage(bmp); g.
CopyFromScreen(x, y, 0, 0, sz);
return bmp. GetPixel(0, 0);
}
```

Figure 4: Code for pixel increase

```
{
buf = "X coordinate : " + Control. Resolution. X. ToString() +
"\r\n"
buf += "Y coordinate : " + Control. Resolution. Y. ToString()
+ "\r\n"
colorbuf = ScreenColor(Control. Resolution. X, Control.
Resolution. Y);
buf+="R : "+colorbuf. R. ToString()+"\r\n"
buf+="G:" + colorbuf. G. ToString() + "\r\n"
buf+="B: " + colorbuf. B. ToString() + "\r\n“
}
```

Figure 5: Code for color extract

3. Reclassification of Point Cloud for Specific Objects

3. 1. Setting the Target Area for Study

Chung-ju, Chungcheongbuk-do was established as the spatial scope to perform this study [Figure 6].

Figure 6: Study area

3. 2. Acquisition of Point Cloud

Point cloud, aerial LiDAR data, which includes the target area for study was acquired. Data acquisition was completed by asking the data from National Geographic Information Institute. After checking the attribute materials, it was identified that it was DEM data, which basically includes locations and topographic data. Figure 7 shows the floor plan (a) and 3D viewer (b) that include the target area for study.

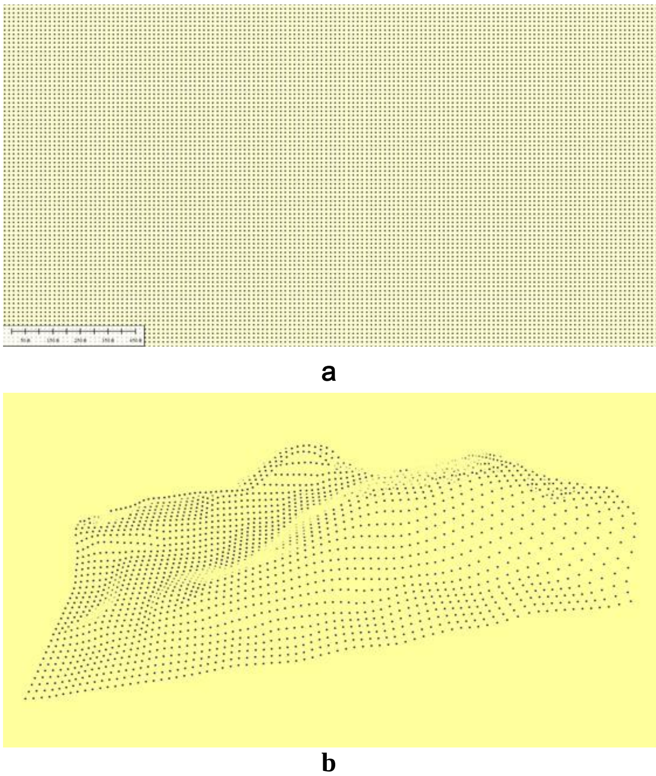


Figure 7: Point Cloud (a) drawing of plane, (b) 3D view

3. 3. Aerial Image Acquisition and Ortho-image Production

Aerial image that include the target area for study was acquired. To extract color information from aerial images and input it to point cloud, the location data between aerial images and point cloud should be exactly identical[14]. Then, acquired aerial images were produced as ortho-images. Ortho-image was produced by using an existing method that referred to "Work Regulation for Image Map Production" and was based on "Chapter 3 Clause 2 of Ortho-images Production". Image station from Intergraph was used as a program[15, 16]. Figure 8 shows the production process.

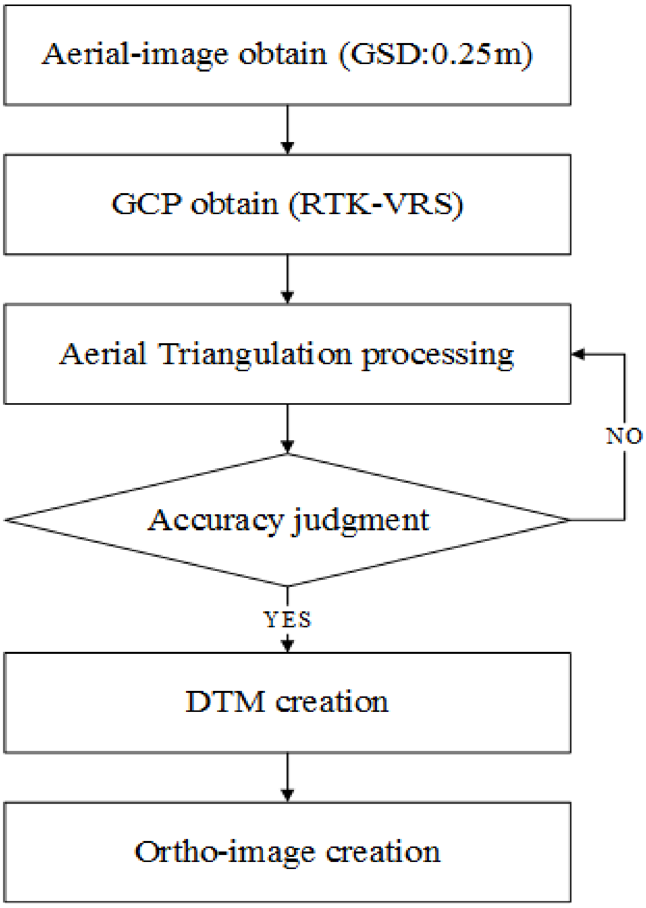


Figure 8: Ortho-image creation process

To produce ortho-image, a ground coordinate of spot was decided by conducing A. T(Aerial Triangulation) after acquiring GCP(Ground Control Point) through RTK-VRS survey. Furthermore, ortho-image was finally produced by producing it as DTM. Figure 9 shows the produced ortho-image.

Figure 9: Ortho-image

3. 4. Matching Ortho-images and Point Cloud

To input color information that was extracted from point cloud, the location value of point cloud and ortho-images should be the same[17]. For this, matching on point cloud and ortho-images was conducted. Figure 10 shows the result of matching.

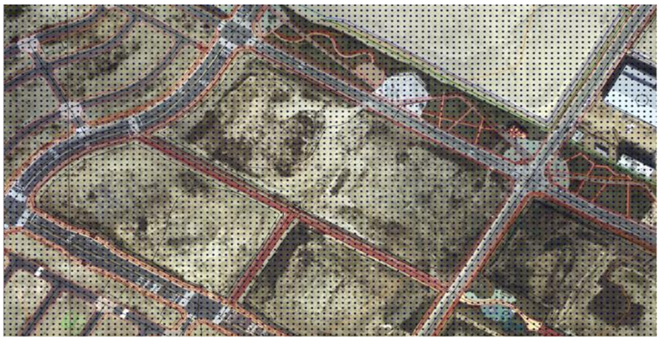


Figure 10: Ortho-image & point cloud mapping

3. 5. Color Information Extraction and Color Coding

Color information was extracted by using the algorism established from produced ortho-images of the target area for study in this study. Extracted color information was saved as a text file. When it is applied to point cloud, recognition error may occur due to discolor of specific objects. To avoid this, R, G, B color information on the objects from table 1 was reorganized and grouped. For this, R, G, B values were directly obtained from ortho-images per object and color information per object was reestablished [Table 2]. Based on this, color information value per pixel of extracted ortho-images was grouped as the values that are included in the scope of reestablished color information. To input it to the attribute information of point cloud, color information value, which is divided by R, G, B, was coded by averaging the maximum and minimum values and transforming it to a hexadecimal digit [Table 3].

Table 2: Color information establishment & grouping

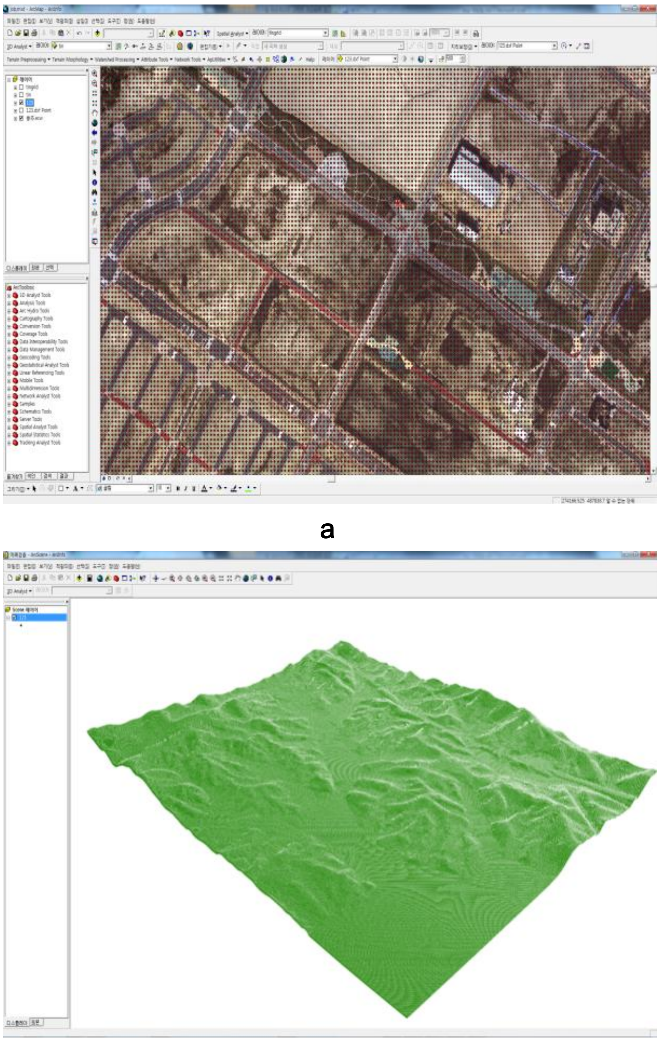
No.	object	Color information		
		R	G	B
1	building	143~161	155~173	108~169
2	road	103~121	107~124	108~122
3	terrain	103~221	107~214	108~178
4	vegetation	41~57	42~54	31~47
5	farmland	141~165	130~156	98~111
6	river	41~52	66~73	50~56

Table 3: Color information coding

No	Object	Code
1	building	98a4b3
2	road	585d61
3	terrain	a2a18f
4	vegetation	313027
5	farmland	998f69
6	river	2f4635

3. 6. Format Conversion of Attribute Information of Point Cloud

To input color information extracted from the attribute information of point cloud and conduct reclassification, this study used Arcmap program from ESRI. Initially obtained attribute information of point cloud was changed to texts and was transformed as a format that is compatible with ArcMap program[18, 19]. Figure 11 shows the point cloud transformed by ArcMap.



a

b

Figure 11: Point Cloud format conversion for ArcMap, (a) drawing of plane, (b) 3D view

3. 7. Input and Reclassification for Color Information of Point Cloud

Reclassification that uses the attribute value from coded color information value of point cloud was conducted. In this study codes were input and point cloud was reclassified with the road objects as targets. Classification was conducted by using a reclassification function after searching codes of road objects from attribute labels of ArcMap. Figure 12 shows the screen that codes of roads were input to the attribute information of point cloud. Figure 13 shows the result of the classified codes of roads from attribute data at ArcMap.

FID	Shape	X	Y	Z	CODE
0	포인트	273388,695	488042,808	106,038	#585D61
1	포인트	273388,695	488047,804	105,475	#585D61
2	포인트	273388,695	488052,8	104,485	#585D61
3	포인트	273393,699	488052,8	104,147	#585D61
4	포인트	273398,703	488052,8	103,514	#585D61
5	포인트	273388,695	488057,797	103,252	#585D61
6	포인트	273393,699	488057,797	102,975	#585D61
7	포인트	273398,703	488057,797	102,476	#585D61
8	포인트	273403,707	488057,797	101,753	#585D61
9	포인트	273408,711	488057,797	101,296	#585D61
10	포인트	273388,695	488062,793	102,202	#585D61
11	포인트	273393,699	488062,793	101,779	#585D61
12	포인트	273398,703	488062,793	101,332	#585D61
13	포인트	273403,707	488062,793	100,79	#585D61
14	포인트	273408,711	488062,793	100,463	#585D61
15	포인트	273388,695	488067,789	101,714	#585D61
16	포인트	273393,699	488067,789	101,018	#585D61
17	포인트	273398,703	488067,789	100,475	#585D61
18	포인트	273403,707	488067,789	100,134	#585D61
19	포인트	273408,711	488067,789	100,03	#585D61
20	포인트	273413,715	488067,789	100,036	#585D61
21	포인트	273393,699	488072,786	100,883	#585D61
22	포인트	273398,703	488072,786	100,234	#585D61
23	포인트	273403,707	488072,786	100,012	#585D61
24	포인트	273408,711	488072,786	100	#585D61
25	포인트	273413,715	488072,786	100,001	#585D61
26	포인트	273393,699	488077,782	100,82	#585D61
27	포인트	273398,703	488077,782	100,2	#585D61
28	포인트	273403,707	488077,782	100,005	#585D61
29	포인트	273408,711	488077,782	100	#585D61
30	포인트	273393,699	488082,778	100,757	#585D61
31	포인트	273398,703	488082,778	100,178	#585D61
32	포인트	273403,707	488082,778	100,005	#585D61
33	포인트	273408,711	488082,778	100	#585D61
34	포인트	273398,703	488087,774	100,157	#585D61
35	포인트	273403,707	488087,774	100,004	#585D61
36	포인트	273408,711	488087,774	100	#585D61
37	포인트	273413,715	488087,774	100	#585D61
38	포인트	273403,707	488092,771	100,004	#585D61

Figure 12: Input color information data

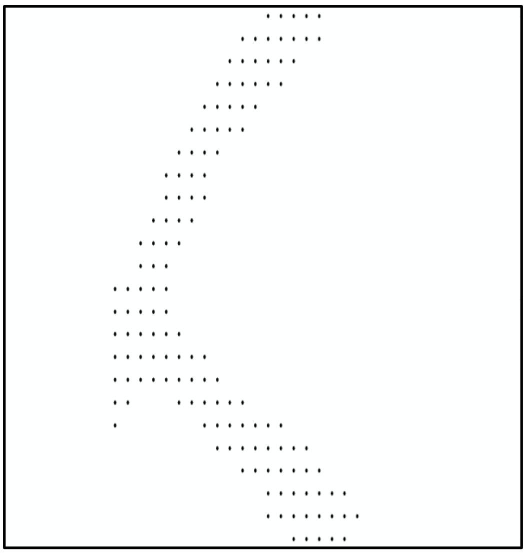
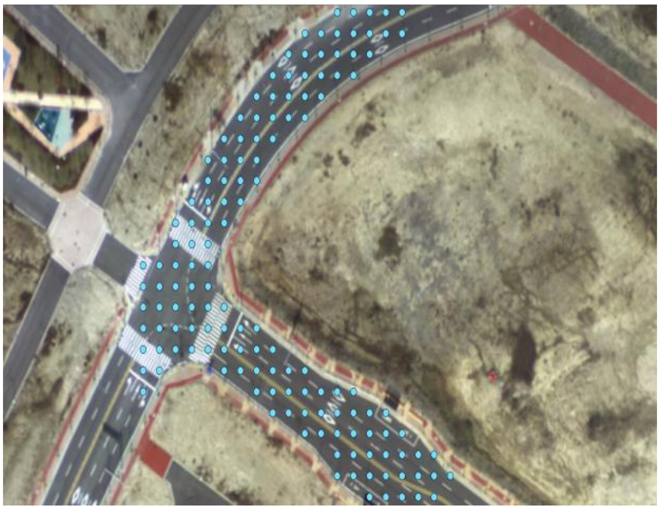


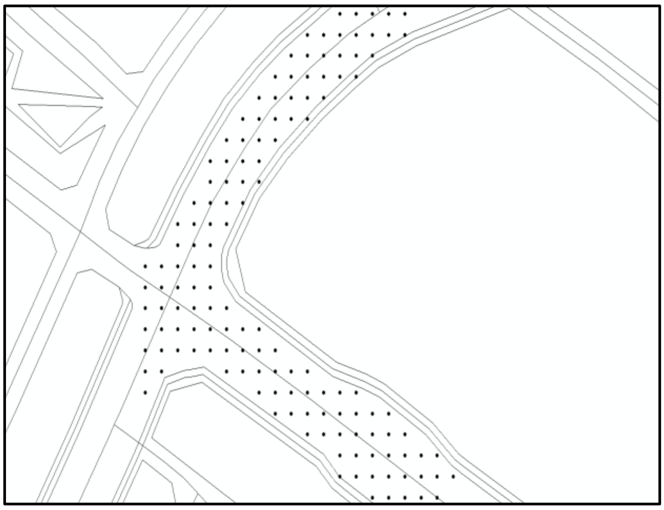
Figure 13: Classification result(road)

3. 8. Reclassification Accuracy Analysis of Point Cloud

This study reclassified point cloud of road objects by using color information extraction algorism and by utilizing extracted color information as a search factor. To analyze the classification accuracy, it compared the location shapes of ortho-images and road shapes [Figure 14(a)]. As a result, it was identifies that the point cloud which was located within road shapes of ortho-images was only accurately classified. Also, after comparing and analyzing classified point cloud, shapes and boundaries that are extracted from road layers of 1:5, 000 digital map [Figure 14(b)], it was identified that reclassified point cloud was located within the road boundaries of digital map. Thus, the point cloud of specific objects was accurately reclassified. It is expected that algorism that was set for reclassification of point cloud and the reclassification method will be utilized to effectively classify the point cloud of specific objects that users require.



a



b

Figure 14: Classification accuracy Analysis, (a) classified point cloud & ortho-image, (b) classified point cloud & digital-map

4. Conclusion

In this study, it established to use color information as a search factor of classification to selectively classify the point cloud of specific objects from high density LiDAR point cloud. For this, algorism that extracts color information from ortho-images was constructed. Furthermore, it reclassifies point cloud of specific objects by using color information extracted from it. The results of study are as the follows.

First, it designed an algorism that effectively extracts color information from ortho-images to classify point cloud. The color information extracted from this was used as attribute information to classify point cloud.

Second, codes were written to search and extract color information of R, G, B per pixel within the resolution scope of ortho-images. For solo processing, color information per pixel was extracted through programming of comfiler and execution file. Extracted color information was reestablished or grouped per object of established six types of target objects. Color information which was grouped per object was coded not as the value of R, G, B but as one factor by transforming it to a hexadecimal digit.

Third, color information that was coded by editing the attribute information of point cloud was input. Furthermore, based on this, point cloud of road objects was classified. To analyze the accuracy, comparison analysis on road shapes of ortho-images and digital map was conducted. As a result, each road shape and the road shape classified from point cloud was very similar. Thus, point cloud of specific objects from high density and bulk point cloud were selectively classified by extracting color information from ortho-images and using it as an attribute value.

The algorism that was designed in this study needs to be continuously supplemented for automation of process for selective classification of point cloud. Also, further studies need to focus on reviewing the classification accuracy of point cloud of specific objects and improving the accuracy by applying it to various objects.

Acknowledgments

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