A STUDY ON THE DEVELOPMENT OF EVALUATION TECHNOLOGIES FOR THE RESOURCE AMOUNT OF SOLAR ENERGY BY USING THE SPATIAL INFORMATION TECHNOLOGY

*Sung Jae Kim [a] *, Yun Won Jo [a], Myung Hee Jo[b]*
Kwangdeuk Kim[c], Chang Yeol Yun[c]
a Institute of Spatial Information Technology Research, GEO C&I Co., Ltd,
Gyeongsan-si, Gyeongsangbuk-do, Korea ;Tel: +82-53-857-7312;
E-mail: Syungjaekim97@hanmaill.net, sorabol00@hanmail.net

b Dept. of Satellite Geoinformatics Engineering, Kyungil University,
Gyeongsan-si, Gyeongsangbuk-do, Korea; Tel: +82-53-850-7312
E-mail: mhjo@kiu.ac.kr

c Dept. of Renewable Energy Research, Korea Institute of Energy Research,
Dae Jeon, Korea; Tel: +82-42-860-3731
E-mail: kdkim@kier.re.kr, yuncy@kier.re.kr

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ABSTRACT This study has focused on the LiDAR data and the GIS technology for the examination of possible utilization in such highlighted fields as the spatial information technology and the new renewable energy (solar energy). First of all, by using the LiDAR data, a 1m-class contour has been produced. Through the pre- and post-processing processes, DEM (Digital Elevation Model) and DSM (Digital Surface Model) have been established in regard to such data. For the identification of the incidence range for sunlight based on the elevation and azimuth of the sun, the DEM data has been used. Also, for the execution of simulations regarding the solar access for each time period, the DSM data has been used. The simulations regarding the solar access for the evaluation of the resource amount of solar energy have been classified into the confirmation of the amount of sunlight and the amount for surrounding buildings. In regard to the confirmation of the amount of sunlight at selected points, subject points have been selected for the analysis of the amount of sunlight in order to execute the simulations regarding the solar access. Also, the amount of sunlight and the path of the sun can be confirmed at the subject points. The amount of sunlight for surrounding buildings has been calculated with the amount of sunlight received by all the surrounding buildings influenced by the subject building between sunrise and sunset for each time period. The evaluation technologies for the resource amount of new renewable energy based on the utilization of the spatial information technology evaluate the amount of energy based on the 3-dimensional environment which is similar to the real world. By using such technologies, it is possible to secure the basic data which can be used to reflect more realistic contents and suggest scientific and reasonable evaluation methods.

1. INTRODUCTION

A new era has drawn near and had gotten us to be more aware of ways to save energy. Due to climate changes, we are recognizing the importance of making prudent decisions of fossil fuel purification, proper usage and conservation of fossil fuel, and conservation of energy. Many countries became more involved in research for renewable resources that United States supported with strong policy and it is a relief that we are heading towards developing an

alternative resource of energy. In 2008, Korea has announced a strategy to develop into a green energy society. An energy research institute introduced the GIS, a system created as a web based analysis of energy to provide any information regarding renewable energy. In order to select the best place for a spatial, eco-friendly environment, it is imperative that we have an accurate and secure standard based on scientific method. Energy- related facilities must have accurate research reflected upon exact geographical factors to decipher the truth behind alternative resources.
Korea has been recently utilizing LiDAR data and aerial photographs to produce three- dimensional topographic information. A study done in 2008 used aerial photography and LiDAR data to estimate the forest biomass of Janganjin, and in 2004, David P conducted a research monitoring forest carbon sequestration with remote sensing and carbon cycle modeling. Moreover, space information technology has helped advance renewable energy researches. In Yi-insu in 2007, a study has been made to extract the 3D boundary of a building using terrestrial laser scanner. Through these studies, space information technology and solar energy proved themselves as a possible future technology.

2. 3D TERRAIN DATA GENERATED UTILIZING LIDAR DATA

During June 4 to 6 in 2011, pictures were taken four times throughout the three days in KeyungSangBukDo OolLeungGoon using Optech ALTM 30/70 and a laser pointer density of 1M and 2- 3 points per unit. LiDAR data is computed using injected laser data in proportion to time of return of the ground terrain, planimetic features, and vegetation to calculate the distance from the surface to the height of the laser. In addition, strength of reflection and echo are classified in parallel manners and is separated by layers. The data of altitude of all layers are calculated as DSM (Digital Surface Model) which illustrates an actual terrain layer which is then created as a visual model using DEM (Digital Elevation Model).
Primarily, the first classification was carried out automatically. The automatic classification alone can produce a reasonably accurate terrain data, but equipment malfunctions or incorrectly classified data can occur. Therefore, it is necessary to include a secondary visual classification to remove any error. Through filtering operation, terrain models are produced using the simplest linear filter similar to the median, maximum, and minimum filtering technique to calculate the arithmetic mean of each and using the filter to average the central pixel.

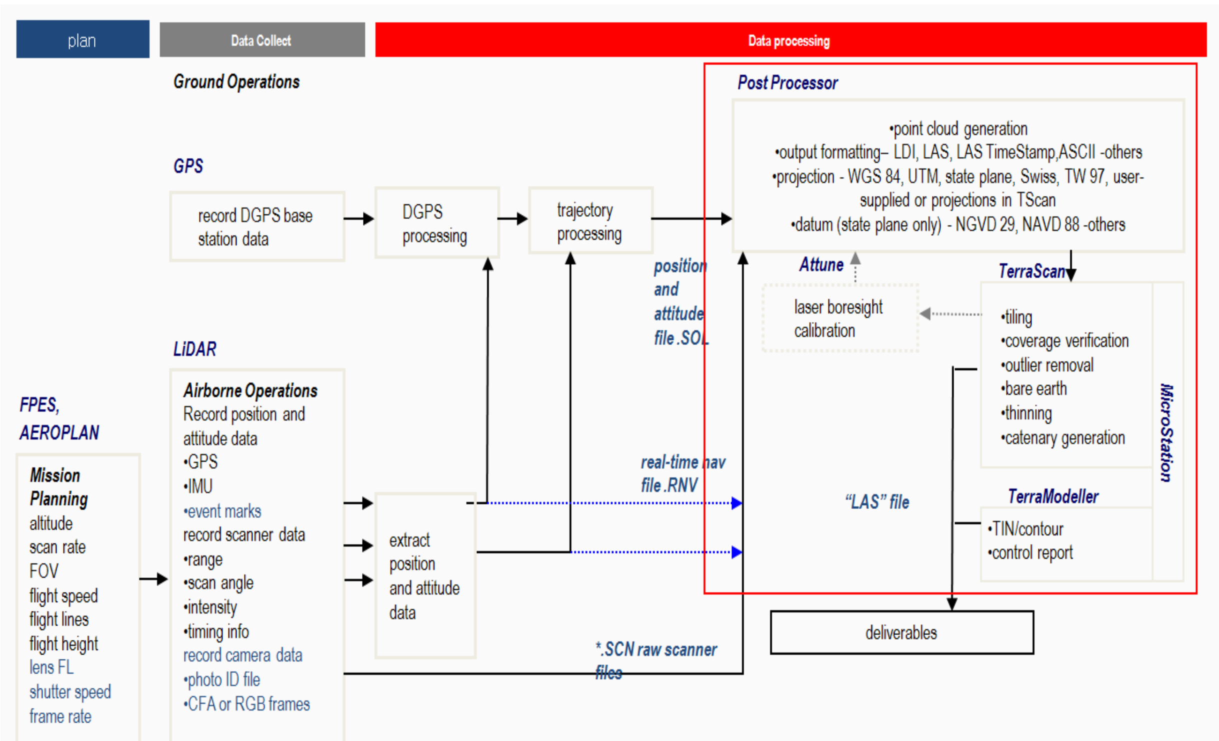

Fig.1. LiDAR Data processing

3. ESTIMATING THE AREA OF SOLAR LIGHT ENTRANCE THROUGH THE USAGE OF SOLAR ALTITUDE AZIMUTH

In order to estimate the area of solar light entrance for the location of interest for this research, OolLeungGoon OolLeungEup DoDongLi area was chosen as the representative region. The monthly average values of the azimuth and solar altitude were calculated using the region stated previously starting from January to December of the year 2010. To calculate the average value, the hourly values of the latitude and longitude coordinates, altitude, ascension, and declination had to be taken into account primarily. These values were then calculated into a daily average. With this, the monthly average was recalculated. Table 1 shows the values of latitude and longitude coordinates, altitude, ascension, and declination of the region of Lat/Lng: (37.49255400286561, 130.8943998474122) on December 1, 2010. In addition, to eliminate the night period when solar light entrance is not available, the data with negative altitude values were not used.

Tab. 1. Calculation of the average daily values of solar altitude and azimuth

Time	Azimuth			Elevation			Right Ascension			Declination		
	Degree	Minute	Second	Degree	Minute	Second	Degree	Minute	Second	Degree	Minute	Second
00:00	355	40	42.90	-74	09	34.5	16	26	10.70	-21	41	20.2
01:00	040	43	55.00	-70	15	02.3	16	26	21.60	-21	41	44.3
02:00	065	36	12.60	-60	38	25.4	16	26	32.50	-21	42	08.4
03:00	079	49	43.20	-49	16	50.8	16	26	43.37	-21	42	32.7
04:00	089	59	44.30	-37	26	40.8	16	26	54.23	-21	42	57.0
05:00	098	36	48.20	-25	35	44.0	16	27	05.05	-21	43	21.4
06:00	106	50	01.40	-14	00	10.3	16	27	15.85	-21	43	45.7
07:00	115	21	39.40	-2	54	44.3	16	27	26.61	-21	44	10.0
08:00	124	45	33.60	07	22	47.6	16	27	37.34	-21	44	34.2
09:00	135	32	56.80	16	28	26.7	16	27	48.04	-21	44	58.3
10:00	148	09	23.80	23	49	48.0	16	27	58.71	-21	45	22.3
11:00	162	41	07.40	28	47	17.0	16	28	09.37	-21	45	46.1
12:00	178	34	48.00	30	43	34.7	16	28	20.02	-21	46	09.8
13:00	194	35	45.90	29	20	55.5	16	28	30.67	-21	46	33.2
14:00	209	25	06.40	24	52	09.3	16	28	41.33	-21	46	56.5
15:00	222	21	29.60	17	52	32.1	16	28	52.01	-21	47	19.6
16:00	233	25	42.10	09	02	12.5	16	29	02.71	-21	47	42.6
17:00	243	01	14.80	-1	04	56.4	16	29	13.45	-21	48	05.5
18:00	251	38	47.10	-12	03	36.7	16	29	24.21	-21	48	28.3
19:00	259	51	25.40	-23	35	12.9	16	29	35.02	-21	48	51.0
20:00	268	18	56.00	-35	24	48.5	16	29	45.86	-21	49	13.7

21:00	278	03	04.60	-47	17	03.9	16	29	56.73	-21	49	36.5
22:00	291	12	26.00	-58	47	52.3	16	30	07.63	-21	49	59.3
23:00	313	22	08.50	-68	55	30.3	16	30	18.54	-21	50	22.2

By entering the recalculated average monthly values of the average azimuth and altitude values into the Arc GIS, the Hillshade was created. The Hillshade is a map designed to effectively show the shades based on the elevations in the topography. The Hillshade has values between 0 to 254. The closer to 254 the region, the brighter the region. The brighter the region, the greater the amount of solar light entrance. In this research, the regions with the top 5% monthly values out of the whole pixel were extracted first (Figure 3).

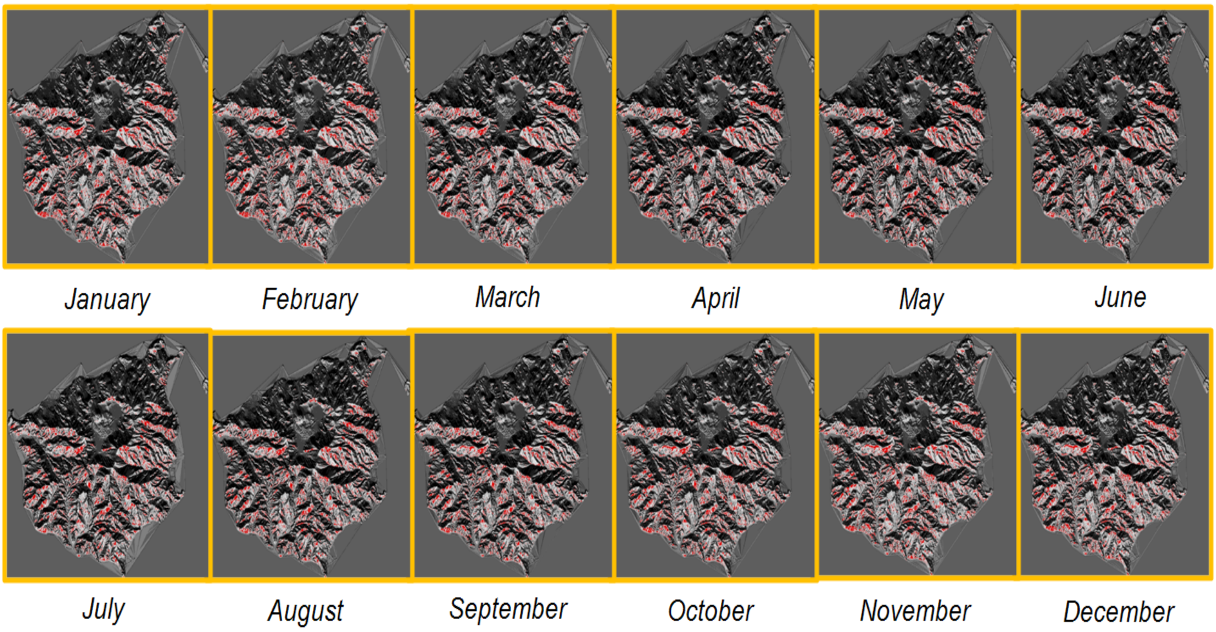

Fig.2. The extraction of region with greater amount of solar light entrance

4. TO EVALUATE THE AMOUNT OF ENERGY RESOURCES OF THE SOLAR LIGHT, THE REGIONS WITH GREATER AMOUNT OF SOLAR LIGHT ENTRANCE WAS EXTRACTED AND CALCULATED

In order to extract the region with the highest amount of solar light entrance in the area of interest, the A-L layers of the top 5% regions in each class had an overlay analysis performed. By performing the overlay analysis, only the regions within the top 5% of each class were extracted and only the regions that were common were extracted using the Arc GIS Analysis Map Query. The result of the extraction showed that out of the whole OolLeungDo area 72.56 km^2 to 5.2km^2 were corresponding regions. Seo-myeon with 2.6km^2 was occupying the most space, while OolLeungGun with 2.0km^2 and Buk-myeon with 0.6km^2 came next in places.

Tab. 2. To evaluate the amount of energy resources of the solar light

Month	Class	Azimuth Average	Elevation Average	DN Average	High Lank 5%
JAN	A	180.5702317	19.78542751	85.23669639	203
FEB	B	179.8824718	24.76986353	100.8256061	213
MAR	C	181.3066847	30.33584894	118.2189975	224
APR	D	183.2601895	35.76470063	135.0369857	232
MAY	E	184.2095374	38.90746048	144.2568118	235
JUN	F	183.265501	39.57076062	146.0540342	236
JUL	G	181.9374691	40.61251626	148.8210777	237
AUG	H	182.340356	36.98976444	138.5116306	233
SEP	I	184.5379144	32.2498639	124.4077129	227
OCT	J	186.814528	27.32803289	109.1986797	218
NOV	K	185.0611958	20.37658194	86.92567914	204
DEC	L	186.5619316	18.6755151	81.56204907	200

5. RESULT

This research used the space information technology to evaluate the amount of renewable energy resource by using the three dimensional (3-D) LiDAR data. The 3-D LiDAR data was used because it was decided to be a better way to obtain evidence of a more realistic reflection and better scientific and rational evaluation method to be presented.

In order to do this, the data from the LiDAR was primarily used to generate a contour of 1M level and with these data the DEM (Digital Elevation Model) and the DSM (Digital Surface Model) were built. And with the usage of DEM data, the range of the solar light entrance was determined based on solar altitude and azimuth. In addition, with the usage of DSM data, one trillion simulations were performed hourly. To evaluate the amount of solar light energy resources, the one trillion simulations were divided into verification of the amount of sunshine and verification of the amount of sunshine of the surrounding buildings. The verification of the amount of sunshine of the chosen location was performed by choosing the area of interest for the evaluation of the amount of sunshine and carrying out a trillion simulations. The amount of sunshine of the measurement point and the trajectory of the sun from the corresponding area were then verified. The verification of the amount of sunshine of the surrounding buildings was performed by calculating the amount of sunshine of all the surrounding buildings that might be affected by the building of interest from sunrise to sunset. Through these treatments the regions with a high amount of solar light energy resources were accurately calculated and with these calculations an accurate evaluations of the amount of solar light energy resources were able to be made. Also, this information can be used to aid in the domestic energy supply and demand analysis, as well as for the overall national energy policy planning. In addition, by securing energy resources and the qualitative and quantitative information system for the evaluation, they can be used as the nation’s energy resource economy indicator.

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