International Journal of Information, Control and Computer Sciences
ISSN: 2517-9942
Vol:10, No:5, 2016

Best Timing for Capturing Satellite Thermal Images, Asphalt, and Concrete Objects

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***Abstract*—**The asphalt object represents the asphalted areas like roads, and the concrete object represents the concrete areas like concrete buildings. The efficient extraction of asphalt and concrete objects from one satellite thermal image occurred at a specific time, by preventing the gaps in times which give the close and same brightness values between asphalt and concrete, and among other objects. So that to achieve efficient extraction and then better analysis. Seven sample objects were used un this study, asphalt, concrete, metal, rock, dry soil, vegetation, and water. It has been found that, the best timing for capturing satellite thermal images to extract the two objects asphalt and concrete from one satellite thermal image, saving time and money, occurred at a specific time in different months. A table is deduced shows the optimal timing for capturing satellite thermal images to extract effectively these two objects.

***Keywords*—**Asphalt, concrete, satellite thermal images, timing.

I. Introduction

HOW much energy any object radiates is, among other things, a function of the surface temperature of the object. This property is expressed by the Stefan-Boltzmann law (1) which states that:

$$M = \sigma T^4 \quad (1)$$

where M is the total radiant exitance from the surface of a material, watts (W) m^{-2}: σ is the Stefan-Boltzmann constant, 5.6697×10^{-8} W m^{-2} K^{-4}: T is the absolute temperature (K) of the emitting material.

The total energy emitted from an object varies with temperature as T^4 and therefore increases very rapidly with increases temperature [1]. The behavior of the radiant temperature of asphalt and concrete objects are shown in Table I. By expanding the range of brightness values between the asphalt and concrete objects and each of the other objects in one satellite thermal image, the lack and the limited availability of the best digital remote sensing data is prevented. The area of study exists in the temperate zone from latitude 23.5° to 66.5° where the weather generally changes with the seasons and the solar energy that does reach earth is distributed over an area 1.4 the one in the tropics zone [2]. The location of the study takes the role of a control thermal image point at that latitude. Field work is carried out for the objects round the clock for one year, from 9/10/2013 to 6/10/2014, using ground truth equipment compatible to the required wavelength in the region 8 to 14 microns. Data changes over time as information is inserted or deleted or updated [3]. Remote sensing and GIS have been the objects of considerable interest of all countries regarding emergency services and disaster management. Geospatial technology uniquely suited to collect information of disaster prevention, impact assessment and help to remediable damages [4]. The spatial analysis capability and the applicability to apply standards GIS functionalities such as thematic mapping, network-level analysis as well as the ability to interface with external problems and software for decision support, data management, and user-specific functions [5]. Development of a state is based on proper planning of its resources on a regional scale. It requires analyzing the forces that shape the growth and development of districts and regions, formulating plans and policies to meet the needs of the area's inhabitants, and coordinating programs and projects to implement these plans and policies. Application of geomatics is very effective in drawing clear picture of the status of resources in a state with the help various thematic maps, charts and tables [6].

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II. Results, Analysis, and Discussions

The mean values of radiant temperature with time of asphalt and concrete objects are shown in Table I.

TABLE I
Mean Radiant Temperature with Time of Asphalt and Concrete Objects

TIME	Mean (Asphalt)	Mean (Conc.)
12:00 AM	15.35957	17.352174
1:00 AM	14.97826	16.8
2:00 AM	14.65652	16.291304
3:00 AM	14.5	15.843478
4:00 AM	14.30652	15.456522
5:00 AM	14.1	15.078261
6:00 AM	13.94348	14.773913
7:00 AM	14.20435	14.934783
8:00 AM	17.78261	17.621739
9:00 AM	24.29565	21.13913
10:00 AM	32.93478	26.243478
11:00 AM	38.75652	30.830435
12:00 PM	43.59565	32.830435
1:00 PM	45.2	34.743478
2:00 PM	44.71304	35.552174
3:00 PM	43.06522	35.121739
4:00 PM	38.24783	32.056522
5:00 PM	32.24783	28.330435
6:00 PM	25.75217	24.434783
7:00 PM	21	22.265217
8:00 PM	19.01304	20.965217
9:00 PM	17.76087	19.986957
10:00 PM	16.83478	19
11:00 PM	16.06957	18.173913
12:00 AM	15.78261	17.669565

Table I is represented in Fig. 1, which shows the behavior of the asphalt and concrete objects with time per year by its mean radiant temperature. it is obvious that, from Fig. 1, the big differences in radiant temperature between asphalt and concrete objects occurred between 10:00 am and 4:00 pm. And the worth time is when the two curves are close to each other and intersect. The optimal and best timing for capturing satellite thermal image of asphalt object per year are shown in Table II. Table II shows the best time for capturing the satellite thermal image for asphalt object per year, the choice time per month, day, and hour, the number 1 is the best choice, the range of the minimum difference in radiant temperature between asphalt and other object. The best time for capturing the satellite thermal image for concrete object per year shown in Table III.

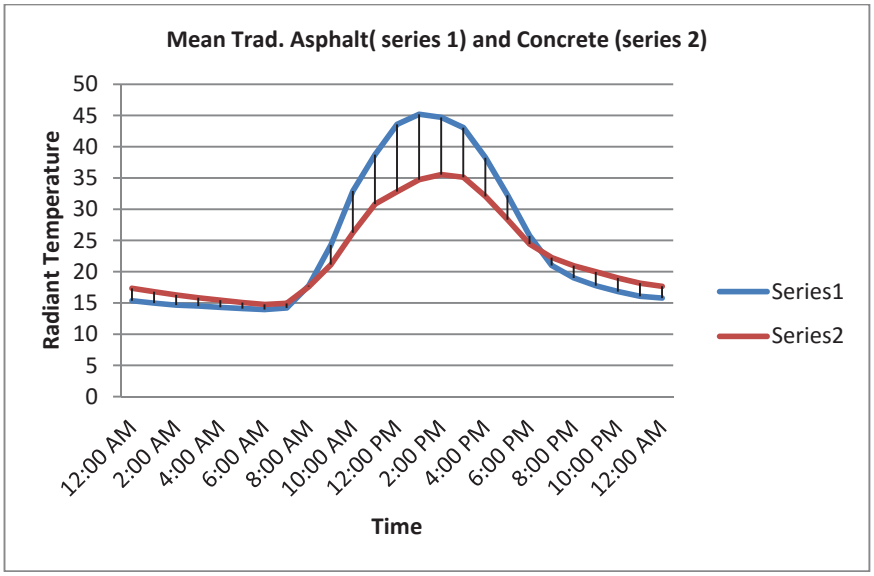

Fig. 1 Mean Trad. with Time of Asphalt and Concrete Object

TABLE II
BEST TIME FOR CAPTURING SATELLITE THERMAL IMAGE FOR ASPHALT OBJECT PER YEAR, CHOICE TIME PER MONTH, DAY, AND HOUR, WITH RANGE OF THE MINIMUM DIFFERENCE IN RADIANT TEMPERATURE

12:00 AM				12, c, 1	8, c, 1			
1:00 AM				11, nc, 1.4				
2:00 AM				10, c, 1.6				
3:00 AM				12, nc, 1				
9:00 AM				7, c, 3.4	6, c, 3	8, c, 1.4	5, c, 1-4.6	
10:00 AM		2, c, 1.8-4.8		3, c, 5.8	4, c, 3.4	9, c, 1.2	4, c, 1-4.8	
11:00 AM	2, c, 1.4-3.4		6, c, 1.8-4.6	9, c, 2.6		10, c, 1		
12:00 PM			5, c, 3-5.6	6, c, 3.6	5, c,3.2	9, c, 1.2		3, c, 1.2-1.8
1:00 PM	1, c, 1-3.8	1, c, 3-5.2	2, c, 4.6-8	4, c, 5.6	3, c, 3.8	4, c, 2.2	2, c, 1-5.2	1, c, 2-5.2
2:00 PM			3, c, 5.2-7.6	2, c, 7	4, c, 3.4	1, c, 3.4	1, c, 1- 11	
3:00 PM	3, nc, 1-3	4, nc, 1.8-3.2	1, nc, 6.4-7	1, nc, 8.8	2, nc, 6	2, nc, 3.2		
4:00 PM	4, nc, 1	3, nc, 1-4.6	4, nc, 4.4-6.4	5, nc, 5.2	1, nc, 7	5, nc,2		
5:00 PM				8, nc, 2.8	2, nc, 6	3, nc, 2.8	3, nc, 1.6-6	2, nc, 1.6-3.4
6:00 PM					7, c,1.4	6, c, 1.8		
10:00 PM						7, nc, 1.6		
11:00 PM					7, nc, 1.4			
12:00 AM				11, c,1	7, c, 1.4			
% / month	7.14 %	12.9 %	10 %	3.23 %	3.34 %	3.23 %	35.49 %	10 %
TIME	February	March	April	May	June	August	October	November
Days nb.	2 days/28	4 days/31	3 days/30	1 day/31	1day/30	1day/31	11days/31	3days/30
Date of day	(14-21)	(5-21-22-23)	(27-28-29)	1-May	29-Jun	24-Aug	5-11-12-15-16-17-22-24-27-28-29	(3-14-20)
	Asphalt	Asphalt	Asphalt	Asphalt	Asphalt	Asphalt	Asphalt	Asphalt

(4, nc, 1) = 4th choice for capturing satellite thermal image, not coincide, 1 minimum difference range in Radiant temperature

TABLE III
BEST TIME FOR CAPTURING SATELLITE THERMAL IMAGE FOR CONCRETE OBJECT PER YEAR, CHOICE TIME PER MONTH, DAY, AND HOUR, WITH RANGE OF THE MINIMUM DIFFERENCE IN RADIANT TEMPERATURE

12:00 AM	10, c, 1-1.6		10, c, 2.8	11, c,1	9, c, 1			
1:00 AM			11, c, 1.4-2.8					
2:00 AM			13, nc, 1-2.8					
3:00 AM				11, nc, 1		6, nc, 1.2		
4:00 AM			14, nc, 1-2.2	11, nc, 1		6, nc, 1.2		
5:00 AM		6, nc, 1.2-1.8				5, nc, 1.4		
6:00 AM						4, nc, 1.6		
7:00 AM				10, nc, 1.2				
8:00 AM				9, nc, 1.4		6, nc, 1.2		
9:00 AM				5, nc, 2.4	6, nc, 2.4			
10:00 AM		4, nc, 2-2.8	3, nc, 4.2-5	5, nc, 2.4	8, nc, 1.4	2, nc, 2.2		4, nc, 1.2-2.6
11:00 AM	2, c, 2.2-2.6		2, c. 3.8-7.2	3, c, 4	3, c, 3.6	4, c, 1.6	1, c, 1-5.6	
12:00 PM	5, c, 1-2	3, c, 2.4-2.6	1, c, 4.8-7.2	1, c, 5.8	6, c, 2.4	4, c, 1.6		2, c, 1.4-4.8
1:00 PM			4, c, 2.4-5.2	2, c, 4.8	2, c, 3.8	4, c, 1.6	2, c, 2-3.8	3, c, 1.2-3.8
2:00 PM	1, nc, 2.4-2.6	5, nc, 1.8-2.6	5, nc, 1.8-5.2	5, nc, 2.4	1, nc, 4.2	6, nc, 1.2		1, nc, 2.2-5
3:00 PM	3, nc, 1.2-2.2	2, nc, 2-4.6	8, nc, 1.8-4	7, nc, 2	6, nc, 2.4	3, nc, 2		
4:00 PM	9, c, 1-1.2	1, c, 1.8-5.6	6, c, 1.8-4.6	3, c, 4		5, c, 1.4	3, c, 1.4-3.2	6, c, 1.4-1.6
5:00 PM		c, 1-2.6		4, c, 2.8	7, c, 1.8	1, c, 3.2	4, c, 1.2-2.8	
6:00 PM	6, c, 1.2-1.8			11, c, 1	8, c, 1.4	4, c, 1.6		
7:00 PM		7, nc, 1-1.6		8, nc, 1.6				
8:00 PM	4, c, 1-2.4		9, c, 1.6-3.6	4, c, 2.8	5, c, 2.6			5, c, 1.2-1.8
9:00 PM			12, c, 1.6-2.6	4, c, 2.8	3, c, 3.6		5, c, 1-1.8	
10:00 PM	7, c, 1-1.8		7, c, 1.8-4.4	7, c, 2	4, c, 3.4	5, c, 1.4		
11:00 PM	8, c, 1.2-1.6			6, c, 2.2	6, c, 2.4	4, c, 1.6		
12:00 AM	10, c, 1-1.6			4, c, 2.8	9, c, 1			
% / month	7.14%	12.90%	10%	3.23%	3.33%	3.23%	29.03%	10%
TIME	February	MARCH	April	May	June	August	October	November
days nb.	2 days/28	4days/31	3 days/30	1day/31	1day/30	1day/31	concrete	3days/30
date of days	(14-21)	(5-21-22-23)	(27-28-29)	1-May	29-Jun	24-Aug	9days/31	(3-14-20)
							(5-11-12-15-16)	
							(17-22-23-26)	
	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	concrete	Concrete

(5, nc, 1.8-5.2) = 5th choice for capturing satellite thermal image, not coincide, 1.8-5.2 is the minimum difference range in Radiant temperature

A comparative study done between Table II and III shows the best time for capturing the satellite thermal images to extract efficiently both objects asphalt and concrete at same time from one satellite thermal image. This is shown in Tables IV A and B.

TABLE IV A
BEST TIME FOR CAPTURING SATELLITE THERMAL IMAGE FOR ASPHALT AND CONCRETE OBJECTS PER YEAR, CHOICE TIME PER MONTH, DAY, AND HOUR, WITH RANGE OF THE MINIMUM DIFFERENCE IN RADIANT TEMPERATURE

12:00 AM	10, c, 1-1.6				10, c, 2.8		11, c,1	11, c, 1
9:00 AM							5, nc, 2.4	7, c, 3.4
10:00 AM			4, nc, 2-2.8	2, c, 1.8-4.8	3, nc, 4.2-5		5, nc, 2.4	3, c, 5.8
11:00 AM	2, c, 2.2-2.6	2, c, 1.4-3.4			2, c. 3.8-7.2	6, c, 1.8-4.6	3, c, 4	c, 2.6
12:00 PM	5, c, 1-2		3, c, 2.4-2.6		1, c, 4.8-7.2	5, c, 3-5.6	1, c, 5.8	6, c, 3.6
1:00 PM		1, c, 1-3.8		1, c, 3-5.2	4, c, 2.4-5.2	2, c, 4.6-8	2, c, 4.8	4, c, 5.6
2:00 PM	1, nc, 2.4-2.6		5, nc, 1.8-2.6		5, nc, 1.8-5.2	3, c, 5.2-7.6	5, nc, 2.4	2, c, 7
3:00 PM	3, nc, 1.2-2.2	3, nc, 1-3	2, nc, 2-4.6	4, nc, 1.8-3.2	8, nc, 1.8-4	1, nc, 6.4-7	7, nc, 2	1, nc, 8.8
4:00 PM	9, c, 1-1.2	4, nc, 1	1, c, 1.8-5.6	3, nc, 1-4.6	6, c, 1.8-4.6	4, nc, 4.4-6.4	3, c, 4	5, nc, 5.2
5:00 PM			c, 1-2.6				4, c, 2.8	8, nc, 2.8
6:00 PM	6, c, 1.2-1.8						11, c, 1	
10:00 PM	7, c, 1-1.8				7, c, 1.8-4.4		7, c, 2	
11:00 PM	8, c, 1.2-1.6						6, c, 2.2	
12:00 AM	10, c, 1-1.6						4, c, 2.8	11, c,1
% / month	7.14%		12.90%		10%		3.23%	
TIME	February	February	MARCH	MARCH	April	April	May	May
days nb.	2 days/28	2 days/28	4days/31	4days/31	3 days/30	3 days/30	1day/31	1day/31
date of days	(14-21)	(14-21)	(5-21-22-23)	(5-21-22-23)	(27-28-29)	(27-28-29)	1-May	1-May
	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt

TABLE IV B
BEST TIME FOR CAPTURING SATELLITE THERMAL IMAGE FOR ASPHALT AND CONCRETE OBJECTS PER YEAR, CHOICE TIME PER MONTH, DAY, AND HOUR, WITH RANGE OF THE MINIMUM DIFFERENCE IN RADIANT TEMPERATURE

12:00 AM	9, c, 1							
9:00 AM	6, nc, 2.4	6, c, 3		8, c, 1.4		5, c, 1-4.6		
10:00 AM	8, nc, 1.4	4, c, 3.4	2, nc, 2.2	9, c, 1.2		4, c, 1-4.8	4, nc, 1.2-2.6	
11:00 AM	3, c, 3.6		4, c, 1.6	10, c, 1	1, c, 1-5.6			
12:00 PM	6, c, 2.4	5, c,3.2	4, c, 1.6	9, c, 1.2			2, c, 1.4-4.8	3, c, 1.2-1.8
1:00 PM	2, c, 3.8	3, c, 3.8	4, c, 1.6	4, c, 2.2	2, c, 2-3.8	2, c, 1-5.2	3, c, 1.2-3.8	1, c, 2-5.2
2:00 PM	1, nc, 4.2	4, c, 3.4	6, nc, 1.2	1, c, 3.4		1, c, 1- 11	1, nc, 2.2-5	
3:00 PM	6, nc, 2.4	2, nc, 6	3, nc, 2	2, nc, 3.2				
4:00 PM		1, nc, 7	5, c, 1.4	5, nc,2	3, c, 1.4-3.2		6, c, 1.4-1.6	
5:00 PM	7, c, 1.8	2, nc, 6	1, c, 3.2	3, nc, 2.8	4, c, 1.2-2.8	3, nc, 1.6-6		2, nc, 1.6-3.4
6:00 PM	8, c, 1.4	7, c,1.4	4, c, 1.6	6, c, 1.8				
10:00 PM	4, c, 3.4		5, c, 1.4	7, nc, 1.6				
11:00 PM	6, c, 2.4	7, nc, 1.4	4, c, 1.6					
12:00 AM	9, c, 1	7, c, 1.4						
% / month	3.33%		3.23%		29.03%		10%	
TIME	June	June	August	August	October	october	November	November
days nb.	1day/30	1day/30	1day/31	1day/31	9days/31	9days/31	3days/30	3days/30
date of days	29-Jun	29-Jun	24-Aug	24-Aug	(5-11-12-15-16)		(3-14-20)	(3-14-20)
	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete	Asphalt
					(17-22-23-26)			

III. CONCLUSION

It can be noticed from Tables IV A and B that, in May month only, the satellite thermal images can be captured at 12:00 am. At 9:00 am in May and June. At 10:00 am in March, May, June, and August. At 11:00 am in February, April, May, and August. At 12:00 pm in April, May, June, August, and November. At 1:00 pm in April, May, June, August, October, and November. At 2:00 pm in April, May, June, and August. At 3:00 pm in February, March, April, May, June, and August. At 4:00 pm in February, March, April, May, and August. At 5:00 pm in May, June, August, and October. At 6:00 pm in June and August. At 10:00 pm in August. At 11:00 pm in June. The time mentioned above is related to Greenwich Mean Time GMT+3hrs. Table IV shows, in colored areas, the optimal timing for capturing satellite thermal images to extract the two objects asphalt and concrete from one satellite thermal image effectively, saving time and money.

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