Spectral Band Optical Analysis for Shape and Material of Terrestrial Imaging by Using Remote Sensing Technique

Safaa Mustafa Hameed, and Abdulrazak A. S. Mohammed

***Abstract*—Photogrammetric grid is the generation of processing system (which is one of the remote sensing techniques) with efficiency developed based on imaging and computer cluster parallel processing; the new application of photogrammetric technique has been applied on the Castel-Gate of Erbil city. It is a way of analyzing the objects especially for a traditional one "the castle in the ancient city of Erbil". This paper got the analysis of Erbil Castel-Gate structure using visible & IR spectral band analysis for transmission and absorption energy (E_λ) based on civil study, as well as the analyzing of chemical & physical test. On other hand the Satellite image of castle has been analyzed by using photogrammetric & GIS techniques. The result calculated the reflected energy values.**

***Index Terms*—Spectral Band; Castel-Gate; Erbil City; GIS Techniques.**

I. Introduction

There are many ways for traditional object analysis (such as Erbil's Castle). It has been claimed that Erbil is one of the oldest continuously inhabited cities in the history; sometimes it called (Citadel of Erbil, Kurdistan _Iraq). The present paper worked on a sample of the gate (real brick) of Erbil castle, a civil study [3] and analyzing with different methods for its structure, dimensions and materials of the contains has been done. The sample that has been taken is a brick of the Gate's wall and an old photographic image of it has been analyzed.

II. Material Analysis

Material analysis of the sample is an important step because the analysis has been done for the contains (components) of the sample {brick which it's dimension (19-20) cm x (8-10) cm x (4-5) cm}. Usually the brick is made of mixture materials belong to the ground (land) roundabout of the Castel; there are different types of materials oxides.

Therefore, the sample was analyzed by chemical and physical laboratory tests.

The results of chemical test show the types of materials and their percentages in the sample. Physical test results give the density of the sample (that calculated for dry and wet cases), and the percentage of the water with the color of the sample were recorded and measured.

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The analysis includes the spectral band of the materials for absorption and transmission of the light energy [1]. The incident light follows the conservation law of energy which is:

$$E_I = E_T + E_R + E_A = 1 \quad (1)$$

Where E_I is the Incident energy, E_T is the Transmission energy, E_R is the Reflection energy, and E_A is Absorption energy. Each energy is relative to the wave length of the material, that means: $E_{\lambda I}$ for incident energy, $E_{\lambda T}$ for Transmission, $E_{\lambda R}$ for Reflection, $E_{\lambda A}$ for Absorption.

III. Spectral Band

The visible light spectral band is from $\lambda = 0.4\mu m$ to $\lambda = 0.7\mu m$ [2], [4], according to the data tables, which represent the values of absorption & transmission wavelength have been subtracted in normal brick sample. If we subtracted values of absorption & transmission wavelengths from the incident value, we will get the reflected wavelength (which caused the photograph). Table III represents the reflected spectral band (wavelength) for each material of brick sample. This test has been done by λ -9 system, which uses white light (white light usually contains visible and IR wavelengths). In the present research we concentrate on the visible part only because our photograph is visible one, even the procedure is the same for NIR and VISIBLE, as shown in Fig. 6 and 7.

IV. Sampling & Testing

The Properties of the tested sample are: thickness (2mm), weight (6gm). The sample is made by compressing it under 5 tons' pressure.

The analysis of the subject sample (gate bricks of Erbil citadel) contains two parts [3]:

1. Material testing, which is: -
   - *a.* Chemical analysis (as shown in Table I).
   - *b.* Physical analysis (as shown in Table II).
   - *c.* Optical spectral band analysis (as shown in Fig. 1 and 2).
2. Image analysis (image processing) by:
   - *a.* photogrammetric technique which is done by restricting the images [5]-[7] of gate Fig. 3(a) and getting a new image of the gate with construct all the damaged part as shown in the Fig. 3(b) The procedure is done as following:
     - i. Finding the Scale

$$Scale = \frac{\text{distance of an object on the image}}{\text{the distance of the same object on the earth (real)}} \quad (2)$$

ii. Measuring the relief displacement of the object (that has been chosen in the image of the gate), as shown in Fig. 5 and establishing the corresponding transformations.

iii. Then convert the input to the desired output.

b. GIS system where the image analysis was carried out on the Gate image, after feeding the image data in the GIS system [8] we get the shape layer Fig. 4(a) and the gray level picture for the gate Fig. 4(b) has been also found, of course we used to 8-bit system.

V. Conclusion

1. Analyzing the sample for an ancient object (building) it should be done by three methods Physical, chemical (material sample) and spectral band (sample image) in order to get all the information.
2. The difference between the incident energy (radiance) and the absorbed or transmitted energy will give us the reflected energy value.
3. From the reflected energy value, we can forecast the important properties of the material sample.
4. The results of this research can be applied on any old image (or the old data of imaging) to study the important properties of the sample.

VI. Figures and Tables

TABLE I: Chemical analysis of Erbil-Citadel bricks

Sq.	Oxides	Percentage
1	SiO_2	41%
2	AL_2O_3	7.52%
3	Fe_2O_3	2.8%
4	CaO	20.7%
5	MgO	3.8%
6	SO_3	0.5%
7	Loss on Ignition	16.98%

TABLE II: Result of Physical Properties of Erbil-Citadel bricks

Color of bricks	Dry density gm/cm^3	Wet density gm/cm^3	Water absorption% 24 hours immersion
Red	1.943	22.69	84.12 used for the walls
Yellow	1.91	24.512	198.68 used for the walls

TABLE III: Reflection intensity from the Sample(from 400-800µm)

479	585	619	642	658	674	698	735
479	586	621	643	659	676	700	736
515	587	622	644	660	678	701	738
564	588	625	645	661	679	704	742
565	690	626	646	662	680	706	746
567	592	628	647	663	682	708	760
568	593	630	648	664	684	709	761
571	594	633	649	665	685	711	764
572	596	634	650	666	687	713	767
573	599	635	651	667	688	715	769
575	611	636	652	668	691	717	770
576	613	637	653	669	692	720	771
578	615	638	654	670	693	721	777
579	616	639	655	671	694	722	780
580	617	640	656	672	695	725	788
582	618	641	657	673	696	729	791

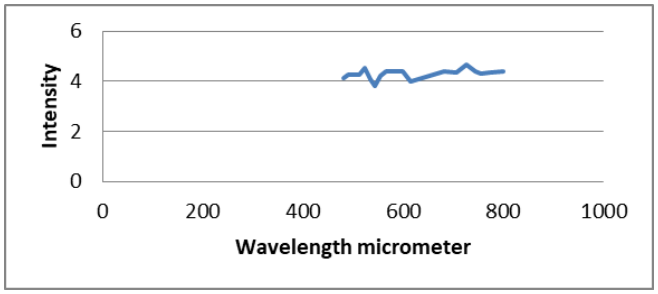

Fig. 1. The absorbed intensity values of a sample from 400 to 800µm

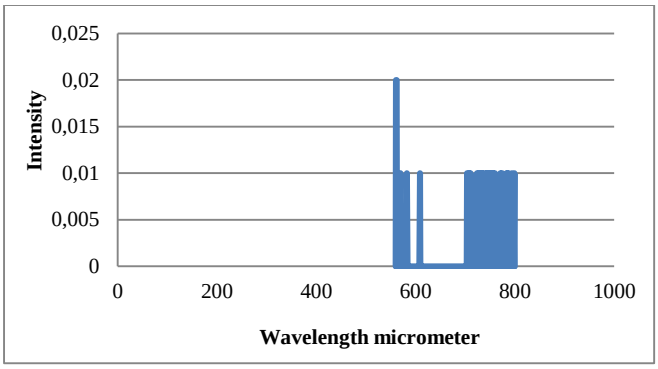

Fig. 2 The transmission intensity values of a sample from 400 to 800µm

(a)

(b)

Fig. 3. Photos of Erbil citadel-Gate (a) Original one year1927, (b) Construct image

(a)

255	204	178	152	127	101	76	51	25	0

(b)

Fig. 4. GIS Syste
(a): shape-Layer of the Citadel Gate,
(b) Gray level distribution Sample and it's equivalent Value of DN (for 8-bit system)

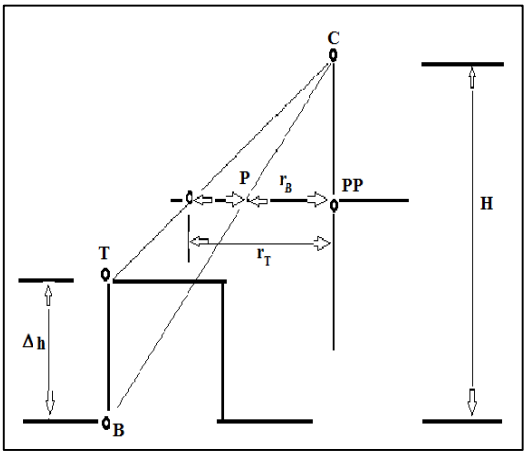

Fig. 5. Relief displacement.

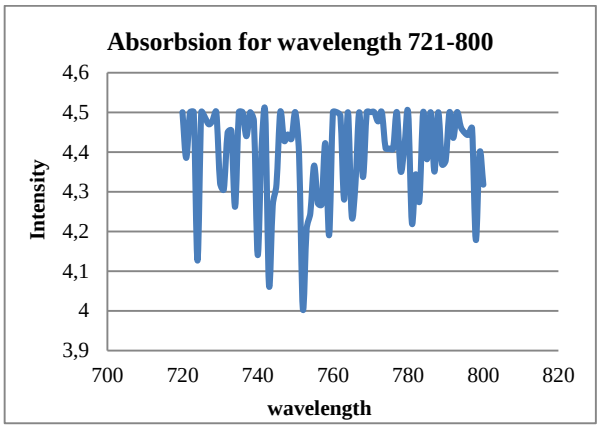

Fig. 6. Absorbsion Intensity for band(λ) (721-800μm)

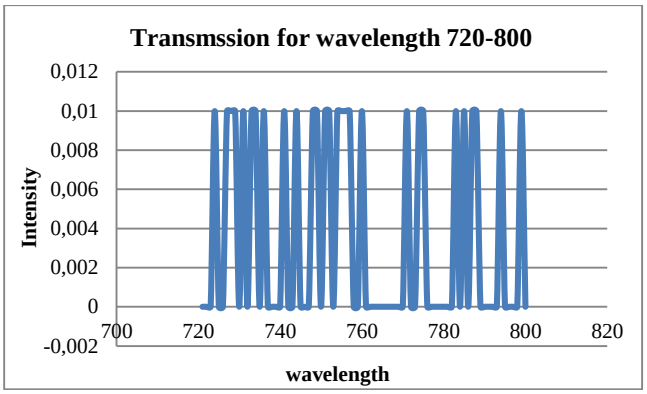

Fig. 7. Transmission Intensity for band(λ) (720-800μm)

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