Abood et al. *Iraqi Journal of Science, 2025, Vol. 66, No. 5, pp: 2139-2152*
DOI: 10.24996/ijs.2025.66.5.29

ISSN: 0067-2904

Determining the Soil Elements Distribution of a Google Earth Image Using a New Processing Method: A Case Study in Iraq

Khaleel Ibrahim Abood, Ahmed Asaad Zaeen, Faleh Hassan Mahmood
Remote Sensing Unit, College of Science, University of Baghdad, Iraq

Received: 6/ 9 /2023 Accepted: 26 / 6 /2024 Published: 30 / 5 /2025

Abstract
The study uses the photometric method, which depends on the intensity of color scale levels in the image pixels. The work is based on converting color into a wavelength in each pixel; in the beginning, the work has been verified by measuring the monochromatic wavelengths of rays, such as lasers. The Matlab program (image processing) calculated the number of lasers as 325 nm, 473 nm, 477 nm, 535 nm, 603, and 785 nm, where the results were very good and had a low error rate. The elements had distinctive colors, which indicated wavelengths in the visible range. The work was done for the sulfur element found in specific Iraqi locations, such as Al-Mashraq field in Mosul province. The image processing techniques by Matlab software, with the assistance of the Google Earth tool, zoomed the land from a scale of about 700 km to 5m, as shown in the research results. The result showed that the sulfur element locations on the map revealed that Iraq contains significant quantities of the element in western and southwestern regions, which essentially concentrate in referred locations compared to some fields in northern Iraq. This study and its results can help companies identify specific sulfur fields.

Keywords: Google Earth Image, Soil Elements, Sulfur, Remote Sensing.

تحديد توزيع عناصر التربة لصورة Google Earth باستخدام طريقة معالجة جديدة، دراسة حالة في العراق

خليل ابراهيم عبود، احمد اسعد زعين، فالح حسن محمود
وحدة الاستشعار عن بعد، كلية العلوم، جامعة بغداد، العراق

الخلاصة
الدراسة أستخدمت طريقة القياس الضوئي الذي يعتمد على مستويات شدة اللون في بكسلات الصورة. فالعمل يستند على تحويل اللون الى طول موجي لكل بكسل , ففي البدء فأن العمل قد تم التحقق منه بواسطة قياس الاطوال الموجية الاحادية الطول الموجي للاشعة, كما هو الحال في الليزرات. أن عدد الليزرات التي تم حسابها بواسطة برنامج الماتلاب (المعالجة الصورية) كليزر 325 نانومتر , 473 نانومتر, 477 نانومتر, 535 نانومتر , 603 نانومتر وأخيرا 785 نانومتر , حيث أن النتائج كانت جيدة جدا ونسبة خطأ قليلة. العناصر لديها الوان مميزة والتي تشير الى الاطوال الموجية ضمن المدى البصري. تم العمل على عنصر الكبريت الموجود في مواقع محددة في العراق، مثل حقل المشراق في محافظة الموصل. تكنلوجيا المعالجة

*Email: ahmed.asaad@sc.uobaghdad.edu.iq

الصورية في برنامج الماتلاب وبمساعدة الاداة كوكل ايرث مع تكبير الاراضي على مقياس 700 كم طوليا للوصول الى 5 متر كما في نتائج البحث .أظهرت النتائج أن مواقع عنصر الكبريت على الخارطة كشفت أن العراق يحتوي على كميات كبيرة من ذلك العنصر في المناطق الغربية والجنوبية الغربية والتي تتركز بشكل أساسي في المواقع المشار اليها مقارنة ببعض حقول شمال العراق.

1.Introduction

The earth's soil contains many elements in salt forms and oxides, bonded together by molecular and atom bonds, giving them different colors. Copper, iron, gold, silver, and other materials have particular colors that distinguish each element. Most of the time, human eyes cannot distinguish the subtle differences in these colors among the elements because they are bonded together. Therefore, image processing technology can be used to distinguish these elements from each other by photographing and digitally processing them using current CCD cameras, where the study is a mix of three technique branches: photometry, spectroscopy, and image processing, treating each pixel in the image based on its color (Matlab program), where the color means a specific wavelength on the RGB. Therefore, any image has many wavelengths from all its pixels within spectrum lines, such as the spectrum of any object in the sky. The image processing and its photometry are converted to spectroscopy. So, any image of the soils or rocks or any clear land image will have many indicators of the presence of the elements from their colors [1] [**2**].

The photometric processing method includes several features to obtain distinctive features and essential information from digital images and their colors [1]. The CCD camera gives any image an RGB color system, which has a linear function with the photon's intensity that strikes the CCD camera's internal materials [3] [4]. The colors in each pixel are proportional to the wavelength [5] with the incident number of the photons (intensity of the photons). Three bands of photons are in the visible range, and the method is based on red, green, and blue colors. The color in each pixel is a mix of three colors with values ranging from zero to 256. There is a different probability of mixing these colors with their respective intensities; it is possible to achieve up to 16,777,215 different colors from 256 to the power of 3 [6]. Ultimately, each pixel in the image will have one color along the visible wavelength spectrum that is derived from mixing three (RGB) colors [7], where each color has a peak and band of many wavelengths [8]. Each band has intensity levels from 0-256, for example, the blue has a range that starts from 400 nm to 550 nm with a peak at 450 nm [9]. Figure (1) shows three essential nature bands of color spectra in the visible range: red, green, and blue, which generate all other colors by mixing their intensities. Some physicists may consider it incorrect, as the density and photon intensity do not affect the changed wavelength [10]. However, the truth is that the wavelength will change with the variation in photon intensity [11] because the electric current energy in the internal materials of the CCD camera will increase with the number of incident photons [12].

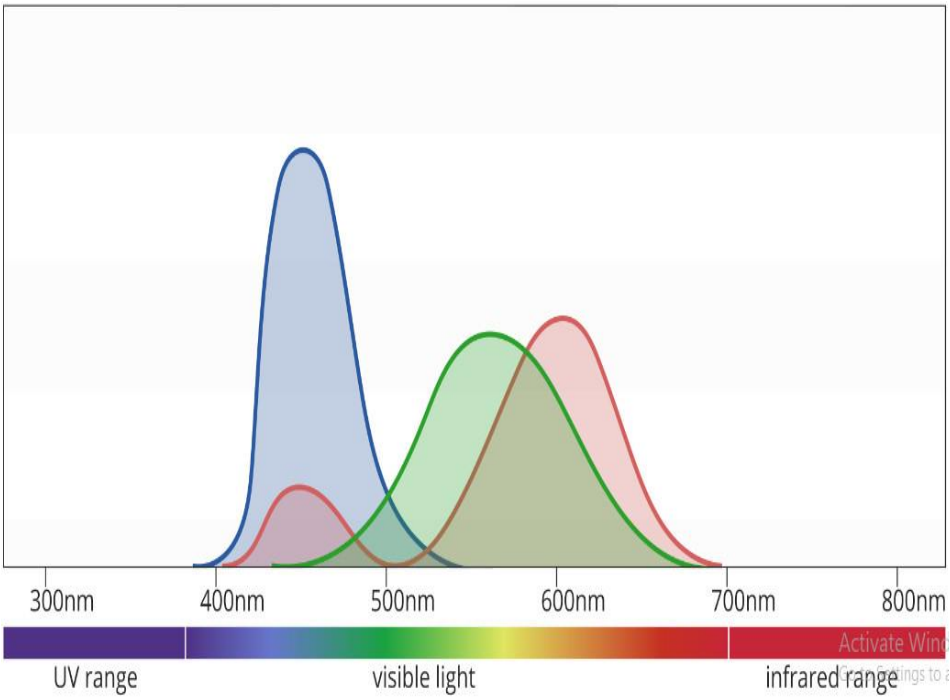

Figure 1: RGB represents the wavelength line [11]

Ultimately, each pixel will have a single color that can be translated into vision range frequency [14], while every element in nature has many strong emission lines in the human optical range, which are sensed by the human eye and perceived as a single color in the end [15].

The result is that observing any object with mixed elements will produce many wavelengths from that target [16]; each wavelength represents a specific element from each image pixel, and then the target has distributions of many elements on its surface. The study aims to identify the locations of sulfur field clusters in Iraq.

Literature review

Image processing studies conducted in Mosul, Iraq, focused on AL-Khoser River pollution. In this study, image processing was used to calculate the increase in pollution levels over the years in the river. Extracting sulfur near the Tigris River causes a significant amount of pollution in the water of the Tigris, which is considered hazardous [17]. Some studies in Iraq can potentially be conducted using image processing, and they are mainly related to our current study on soil analysis with image processing techniques. These studies involve analyzing soil samples containing pollutants such as lead and cadmium elements, toxic substances that can enter the human food chain. In a research conducted at the University of Baghdad [18], direct analysis of soil samples near petroleum fields was performed to study the adverse side effects of manufacturing the concentration of elements, which can be easily and quickly achieved through image processing techniques.

The work of Ekunayo-Oluwabami Babalola, Muhammad Hamza Asad, and Abdul Bais in 2023 involved soil image analysis by a series of steps to improve the image, where the non-soil pixels were removed by segmenting the image and preparing it for further processing. Next, the segmentation was processed by dividing it into smaller tiles to isolate soil pixels. Then, high-frequency filtering would improve the image [19].

2. Materials and Methodology

In the first step, the study calculates the best wavelength of monochromatic laser waves using the photometric method with the assistance of image processing techniques, while those applications use spectroscopy processes, such as prisms and diffraction grating. The first application was on a green laser with a wavelength equal to 556 nm. The spotlight emitted by a laser was captured using a regular mobile phone camera (just an ordinary photo), as shown in Figure 2. This image was analyzed using a custom program to obtain the visible spectrum, Figure 3.

Figure 2: A spot of green laser with a wavelength of 556 nm.

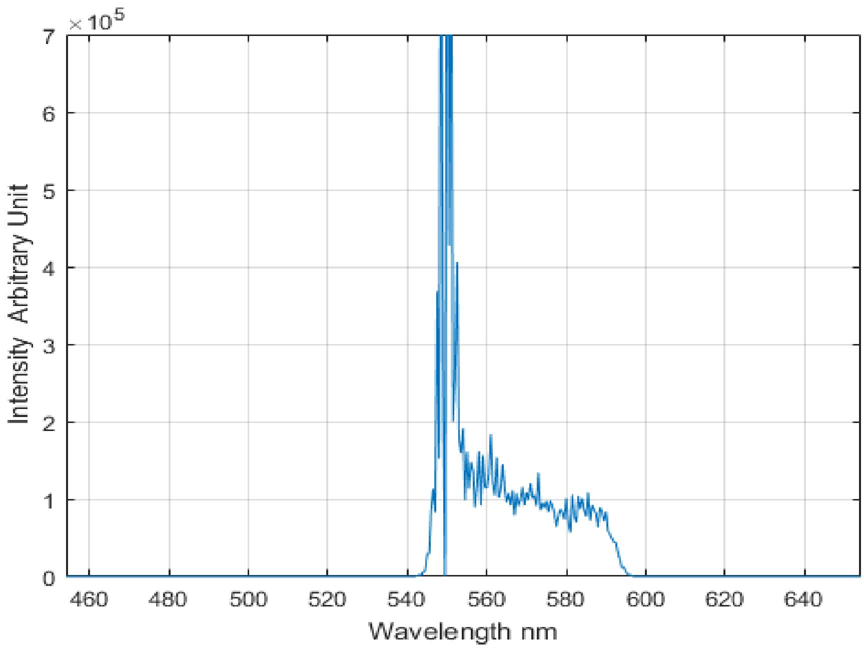

Figure 3: Laser-spectrum of 556 nm was extracted by the Matlab program.

The Matlab program analyzed laser spots to give an average wavelength of 561.5 nm with an error rate of 1%, which was an excellent result. Additionally, the program showed all spectral lines around the average value. The program was used on several laser spots and successfully passed all of these tests, (Figure 4). It provided 3.5% error rate for the laser with a wavelength of 473 nm, while the laser 477 nm showed <1% error rate, the laser 603 nm showed 4% error rate, the laser 535 nm had an error rate of 2.4 %, the laser 785 nm had 6 % error rate, and the laser 325 nm showed 10 % error rate.

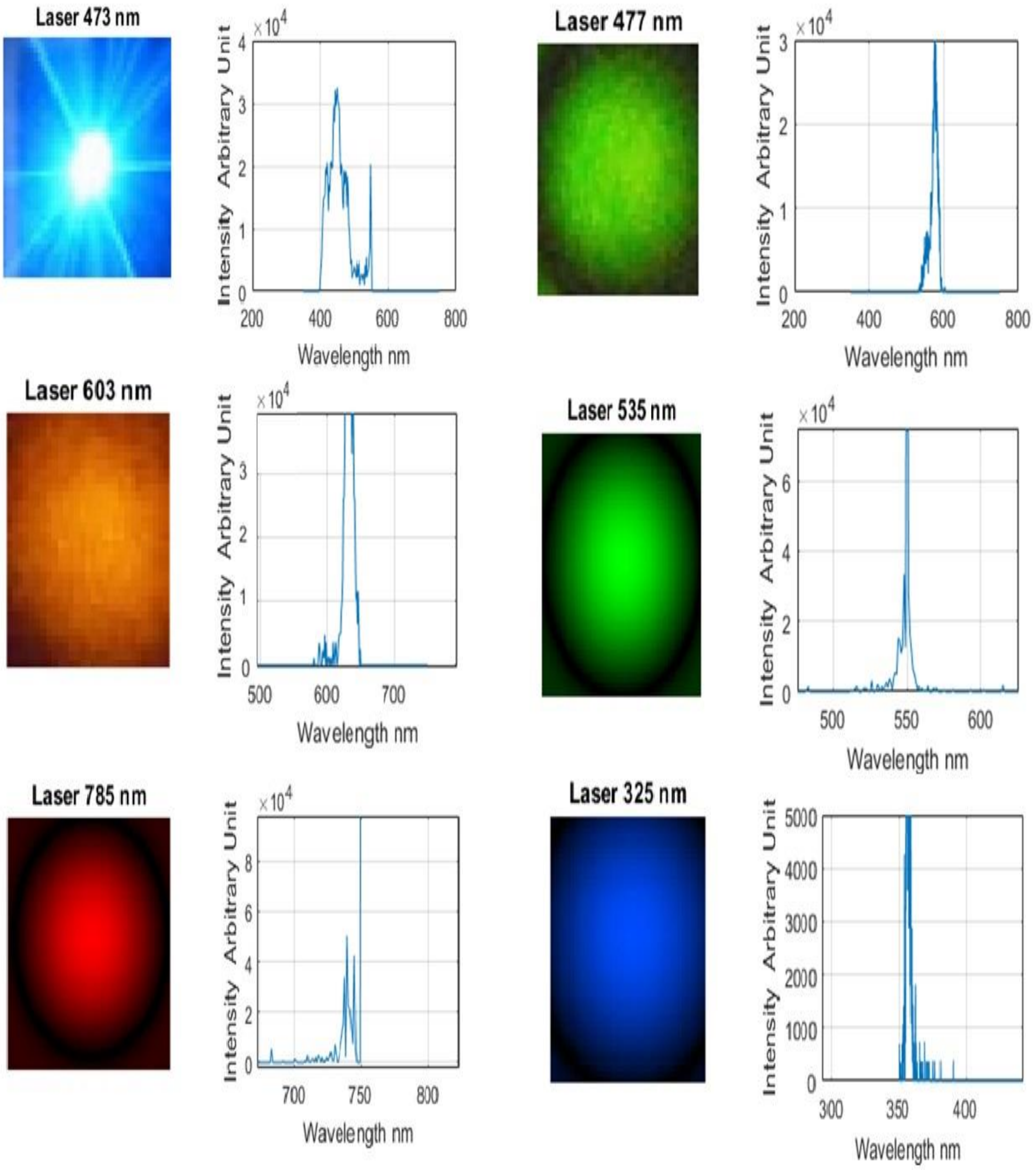

Figure 4: Six spots of the lasers with different wavelengths [20].

Note: The previous figures of the applications only referenced laser spots, not their spectra. The laser applications were experiments conducted via the program with few errors; the highest error rate was only 10% for one laser. Therefore, the program provided excellent results in the visible range. The program can detect elements in any natural environment, such as soil, rocks, etc. This is because each element has many strong emission lines in the visible range, corresponding to absorption lines. Therefore, the colors of any element in the visible spectrum are optical reflections, not emission lines [21].

Finding the elements

The elements have distinctive colors, such as metallic color, which have been detected in the digital image, where the CCD camera has the linear function of the photons quantities with scale level in each pixel, at range 0 - 255; therefore, here the intensity of any color means the color itself and some photons, thus, the color means the wavelength that is indicated to the element itself, and the number of photons represents the scale of intensity of these photons. The gold element has emissions; a rock contains some gold elements, as shown in Figure 6.

Figure 6: The photometry method detects gold elements in some rocks [22].

The rock in Figure 6 has some quantities of the gold element, which is known by just looking at it with the naked eye, but the difficulty lies in recognizing and analyzing it through software using only image processing; therefore, with more complex steps, experimentation, and utilizing some of the physical relationships specific to identifying elements, we are able to find a way to identify elements in images using Matlab program, as in Figures 7 and 8.

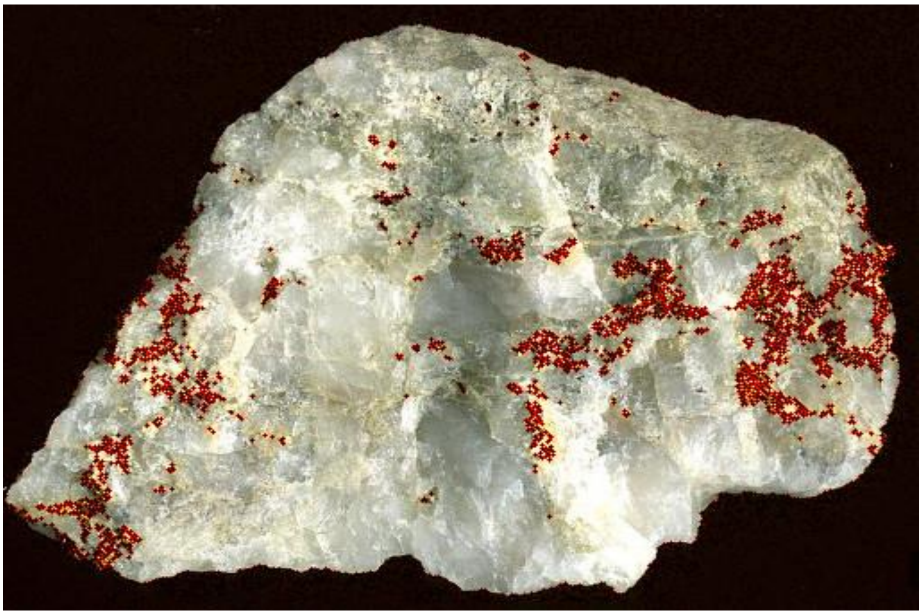

Figure 7: Matlab program specifies the gold element by Red color [22].

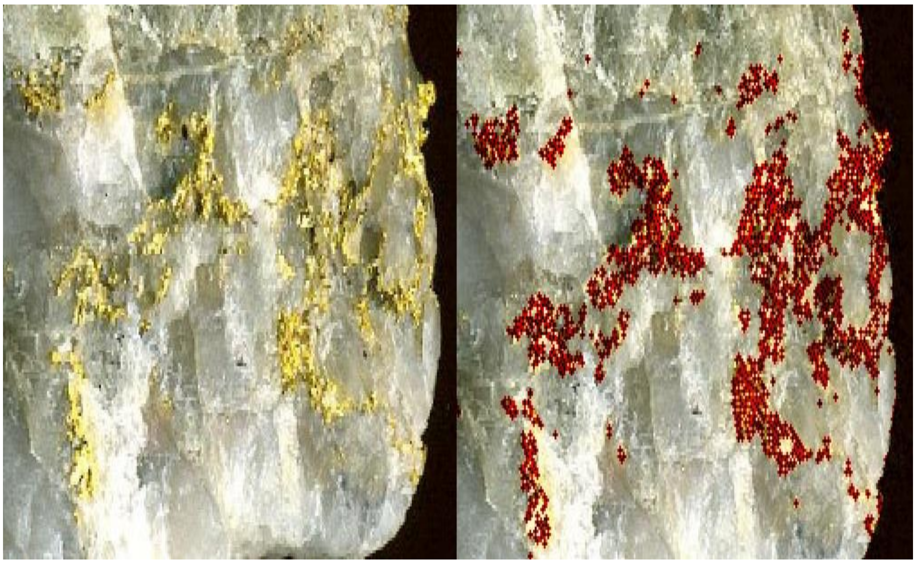

Figure 8: Zooming of the right part of Figures 6 and 7.

The applications show promising results for specific gold elements by processing this image; therefore, it can be said confidently that the rest of the elements will be similar to this case.

Determining Soil Elements

The colors in nature are a mixture of many colors that emanate from various elements, whether from rocks, soils, or even from vegetation cover itself; therefore, it is possible to detect elements in the high-resolution image and also to re-process old images again to extract some information about their compounds and elements [23].

A natural sulfur field appeared, was extracted, and was depicted in yellow color. Upon image processing, the sulfur element was identified and colored with black dots, as observed in Figure 9. The black dots above some areas that did not contain this element represented visual reflections of the wavelengths emitted from the same element.

Figure 9: The sulfur element appears yellow (left image) [24], and after processing, it appears black (black dots).

The black dots above some areas that did not contain this element represented just visual reflections of the sulfur element itself. The maps of Google Earth include a wide field of this work, where the work has taken the map of Iraq to the study, where the sulfur element was chosen to determine its locations. The concentrations of the element fields exist in several locations in Iraq, where the study showed a very high abundance of these fields in western Iraq, with a notable presence of two essential sites in Mosul province, Al-Mashraq (1) and Al-Mashraq (2) fields, Figure 10.

Figure 10: Sulfur fields in northern Iraq were determined through image processing, scale drawing of $1.9/10^7$

The sulfur field that is known as Al-Mashraq (1) near Al-Lazakah village is located 15 km away from Mosul province, and Al-Mashraq (2) sulfur field is located 45 km away from Mosul province, where the two fields are currently being operated, and their distances mentioned were confirmed using Google Earth. The map in Figure 10 can be zoomed in to reveal new features of the urban area being researched; therefore, zooming in on Figure 10, the image pixels separate from each other to give new colors that indicate new features of the sulfur field's presence, Figure 11.

Figure 11: Al-Lazakah field with a red circle above the image with four new undisclosed fields, marked with a white plus sign, scale drawing along the height figure $1/10^5$

3. Results and discussions

Many new landmarks become apparent with increased zooming in various land areas. As a focus solely on the major cluster, the land contains numerous minerals. Therefore, it indicates the presence of one mineral or another, albeit in small amounts, and cannot be considered fields that can be explored. Hence, relying on concentrations and large clusters provides an idea of significant quantities in this area. In this case, the focus should be on the cluster element concentrations on the map rather than individual points, Figure 12.

Figure 12: Red Circles indicate cluster concentrations of the sulfur element, but the other white points scattered on the map do not necessarily represent real fields, scale drawing along the height figure $3.3/10^5$

There are more scattered points on the map; zooming in on the map shows more scattered points because the soils and rocks are a mixture of many elements, and the colors of pixels will overlap at each step of zooming in the image. Therefore, each pixel in the image with the same color and optical wavelength has three possibilities, which have been discussed in the conclusions.

The study determines that the most important and most abundant sulfur fields in Iraq are located in Anbar province, west of Iraq, but not in Mosul province, whereas the lands of Anbar contain wide areas of this element, Figure 13.

Figure 13: The white points indicate a sulfur element in the west of Iraq, scale drawing $1/10^5$

The map of Iraq in Figure 13 contains numerous white dots in the western and southwestern parts of Iraq, indicating the presence of sulfur in that area. In addition, the widespread presence of many dots indicates the existence of numerous fields, whereby zooming in on one of these areas, new distribution features appear, Figure 14.

Figure 14: Sulfur concentrations are measured at 18.1 mi scale at $30^{o}\,39'56''$ N, $43^{O}22'1.38''$ E.

The focal points refer to the areas of interest or attention points that may change when the image is zoomed in due to the separation of pixels and the appearance of new pixels with different colors. As a result, the location of those points may shift as a previously intertwined pixel color becomes distinguishable after zooming. Increasing magnification could reveal new details with new pixels (colors) in slightly different colors. Zooming in on a specific area in Figure 14 produces Figure 15 and then Figure 16.

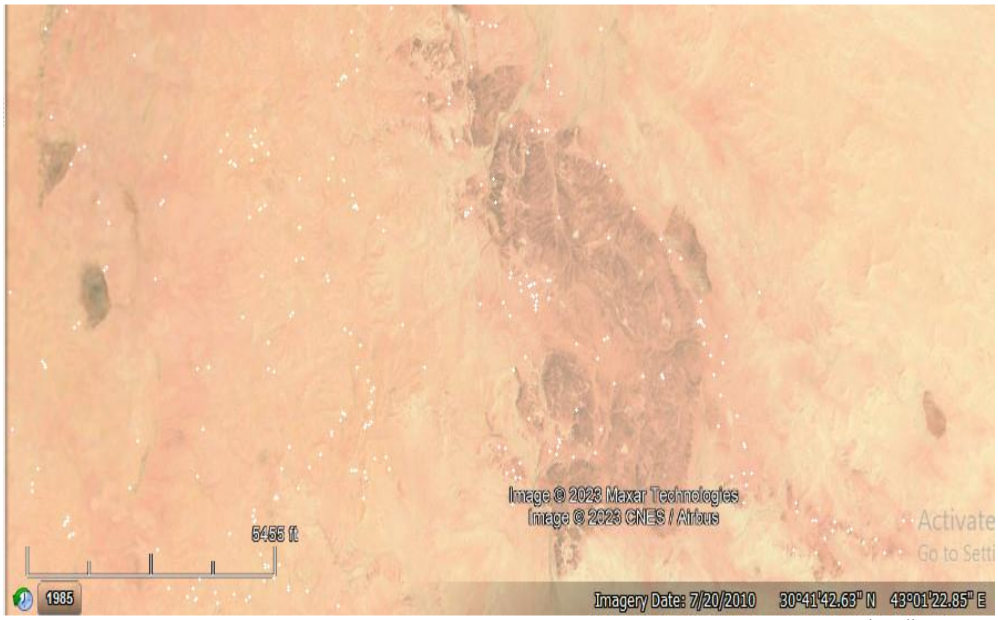

Figure 15: Sulfur concentrations were measured at a 5456 ft scale at $30^{o}\,41'42''$ N, $43^{O}01'22.8''$ E

Figure 16: The minimum distance between the points is limited to the length of the yellow line, which is only 5m.

Good results with the appearance of concentration focal points in a small area as a clear group.

4. Conclusion

Conclusion of the new working method for the program. The first steps of the program were to find the average wavelength of any mono-wavelength light by using image processing without using the prisms or diffraction gratings in the laboratory and trying to find the spectrum of the lasers from just a spot in the image, where, the errors in wavelength were as shown in Table 1.

Table 1: The percent errors by image processing to find the average wavelength of laser spots.

Laser wavelength (nm)	Laser wavelength (nm) after image process	The error
325	357.5	10 %
473	456.4	3.5 %
477	481.7	1 %
535	547.8	2.4 %
603	627.1	4 %
785	737.9	6 %

This study's results indicated the ability to explore elements accurately based on the maps' colors and determined the locations of these elements on the ground by assessing the concentrations. This was done through numerous marked points that indicated the presence of quantities of the elements in specific locations and layers. The structure of a map at a large scale gave the wavelength of the visible color that was a mixture of (RGB) colors, but each pixel in the image that had the same color with the optical wavelength could have three possibilities:

1-The pixel's color may be derived from the blending of colors of the adjacent pixels.

2- The pixel's color may originate from the dispersed element in the soil, but they only represent scattered individual particles on the soil's surface and do not indicate the presence of an actual field that contains quantities of this substance.
3-The pixel's color may indicate the presence of large quantities of the element, specifically in the soil at a particular location, considering the presence of multiple other surrounding pixels that also indicate the presence of this element-suggesting the accumulation of this element in this location, specifically, as opposed to elsewhere.

B-Conclusion of the study results

Concentration locations of the sulfur element deposits in Iraq reveal that the country contains significant quantities of this element in its western and southwestern regions, Figure 13, where they gather in large amounts instead of some fields in northern Iraq.

Google Earth can follow up on the changes in the locations of these concentrations on the maps to access the maximum zoom and reduce the distance to the minimum achievable range, Figure 16.

5. Recommendation

The focus of this study was on only sulfur elements since the study is a new work using optical range to search for elements in the soil, with a secondary focus on verifying the accuracy of the program's results. In future work, the search for other elements would focus on the calcium element and point to maps of the presence of calcium fields, which help fertilizer companies operate quickly in these locations with less efforts. In the future, I will search for other elements in any desired places after contracting with some companies.

6. Acknowledgements

The authors thank everyone at the Remote Sensing Unit, College of Sciences, University of Baghdad, for each piece of advice, idea, and data supporting this article's ideal shape.

References

[1] X. Jin, J. Hou, S.-J. Lee, and D. Zhou, "Recent advances in artificial neural networks and embedded systems for multi-source image fusion," *Frontiers in Neurorobotics*, vol. 16, p. 7, 2022. https://doi.org/10.3389/fnbot.2022.962170

[2] A. Zaeen and G. Hadi, "Remote Sensing Monitoring of Changes in Soil Pollution a Case Study in a Region in Baghdad, Iraq," *Iraqi Journal of Science*, vol. 53, no. 1, pp. 200-208, 2012.

[3] H. Henderson, "*Encyclopedia of computer science and technology*". Infobase Publishing, Pp.371, 2017. https://corp.credoreference.com/component/booktracker/edition/14681.html

[4] S. H. Ali and M. S. Shafeq, "Photometric Investigations of Peculiar spiral galaxy NGC 2608 Using Multiband CCD Camera," *Iraqi Journal of Science*, pp. 1853-1859, 2016.

[5] O. Gervasi, B. Murgante, A. M. A. Rocha, C. Garau, F. Scorza, Y. Karaca, and C. M. Torre, "*Computational Science and Its Applications–ICCSA." Workshops: Athens, Greece, July 4–7, 2022, Proceedings, Part VII*. Springer Nature, Pp.423, 2022. https://link.springer.com/book/10.1007/978-3-031-10450-3

[6] G. Sluder and D. E. Wolf, "*Digital microscopy."* Academic Press, Pp.172, 2013. https://shop.elsevier.com/books/digital-microscopy/sluder/978-0-12-407761-4

[7] L. Ross, "The Image Processing Handbook," ed: Cambridge University Press, Pp.424, 2016. https://www.routledge.com/The-Image-Processing-Handbook/Russ-Neal/p/book/9781138747494

[8] J. A. Richards and J. A. Richards, "*Remote sensing digital image analysis."* Springer, Pp.156, 2022. https://link.springer.com/book/10.1007/978-3-030-82327-6

[9] D. Salomon, G. Motta. "*Handbook of data compression*". Springer, Pp.145, 2010. https://link.springer.com/book/10.1007/978-1-84882-903-9

[10] V. Jain, "*Chapterwise Topicwise Solved Papers Physics for Engineering Entrances,*" 9th, Kindle Edition, Pp703. 2020. https://www.amazon.com/Chapterwise-Topicwise-Physics-Engineering-Entrances-ebook/dp/B08BGBKV4V

[11] S.-W. Zhang, H. He, C. He, and M. Booth, "*Advances in nano-scale systems with optics (nano-chemical, nanomaterial, and nano-biomedicine),*" vol. 10, ed: Frontiers Media SA, p.44-43, 2022. doi: 10.3389/978-2-83250-035-4

[12] G. Healy, S. Shafer, and L. Wolff, *"Physics-Based Vision: Principles and Practice, COLOR*," ed: Boston: Jones and Bartlett, Pp.315, 1992. https://doi.org/10.1201/9781439865880

[13] D. Zhang, "*Fundamentals of image data mining*". Springer, Pp.51, 2021. DOI:10.1007/978-3-030-69251-3

[14] R. Radvan, J. F. Asmus, M. Castillejo, P. Pouli, and A. Nevin, "*Lasers in the Conservation of Artworks VIII.*" CRC Press, Pp.100, 2011. https://doi.org/10.1201/b10567

[15] A. R. Jha, "*Rare earth materials: properties and applications.*" CRC Press, 1st Ed. Pp. 371, 2014. https://doi.org/10.1201/b17045

[16] M. N. Favorskaya and L. C. Jain, "*Computer Vision in Control Systems-3: Aerial and Satellite Image Processing*". Springer, Pp. 100, 2017. http://tk.ulstu.ru/stu/sbr2018.pdf

[17] F. A. Mustafa, A. A. Khaleel, and T. A. Khaleel, *"Image Processing Approaches as a Diagnostic Parameter to Determine Pollution by Using Satellite Imagery, Northern Iraq,"* Iraqi Journal of Science, pp. 1555-1565, 2023. https://doi.org/10.24996/ijs.2023.64.3.43

[18] H. M. Kamil and F. M. Abdulhussein, "*Distribution and Evaluation of Lead and Cadmium in Some Soils Surrounding East Baghdad Oil Field*," Iraqi Journal of Science, pp. 4902-4917, 2023. https://doi.org/10.24996/ijs.2023.64.8.25

[19] E.-o. Babalola, M. H. Asad, and A. Bais, "Soil surface texture classification using RGB images acquired under uncontrolled field conditions," *IEEe Access,* vol. 11, pp. 67140-67155.2023

[20] E. Instruments. (2023). "*How to Choose Your Lasers for Raman Microscopy.*" Available: https://www.edinst.com/blog/lasers-for-raman-spectroscopy/

[21] J. Bennett, S. Shostak, N. Schneider, and M. MacGregor, "*Life in the Universe.*" Princeton University Press, Pp. 71, 2022. https://www.perlego.com/book/3251678/life-in-the-universe-5th-edition-pdf

[22] Convering wavelengths to RGB color values. [Online]. Available: https://www.en.silicann.com/blog/post/wavelength-color/, [Accessed: 10- Mar.- 2024].

[23] R. Hanash, S. Khalaf, and K. Abood, "Photometry technique to map elements' distribution on comets' nuclei surfaces by using the new method," *Iraqi Journal of Physics,* vol. 21, pp. 77-91.09/01 2023

[24] M. Daniel, G. Rodolfo, D. Arthur, "*Dead End Approaches For High-Sulfur Fuels.*" [Online]. Available: https://www.adlittle.com/en/insights/viewpoints/dead-end-approaches-high-sulfur-fuels, [Accessed: 10- Jul.- 2023].