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Remote sensing and its importance in detecting traces
الاستشعار عن بعد وأهميته فى الكشف عن الآثار

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المستخلص:

يعد الاستشعار عن بعد من العلوم الحديثة التي استطاعت في فترة وجيزة أن تؤدي دوراً مهماً في مجالات مختلفة، كالزراعة والجيولوجيا وغيرها من العلوم. كما أدت دورًا مهمًا نظرًا للتطور الذي أحدثته في مجال البحث والتوثيق الأثري. يتناول هذا البحث في جزئه الأول تعريف الاستشعار عن بعد وأهم اللحظات التاريخية المميزة لأصل هذا العلم. كما يستعرض المراحل الرئيسية لتطور هذا العلم ومنهجيته، وأدواته وأجهزته الرئيسية المتاحة. كما يحلل البحث أهم تطبيقات الاستشعار عن بعد في بعض العلوم الأخرى. أما الجزء الثاني فيتناول ارتباط الاستشعار عن بعد وتطبيقاته في مجال الآثار، إلى جانب أهم التقنيات المستخدمة في البحث الأثري. وأخيرا يتناول هذا البحث تطبيقات الاستشعار عن بعد في مجال نظم المعلومات الجغرافية الأثرية ودورها في حماية وصيانة المواقع الأثرية.

Abstract

Remote sensing is one of the modern sciences, which managed in a short period to play an important role in various areas, such as agriculture and geology, and other sciences; it has also played an important role due to the development it brought to the field of archaeological research and documentation. This search deals with in its first part with the definition of remote sensing and the most important historical defining moments of the origin of this science. It also introduces the main stages of the development and methodology of this science, and its main available tools and devices. The research analyzes also the most important remote sensing application in some other sciences. The second part deals with the connection of remote sensing and its application in the field of archaeology, along with the most important techniques used in the archaeological search. Finally, this search deals with the

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remote sensing application in the field of the archaeological GIS, and its role in the protection and maintenance of archaeological sites.

The introduction

Remote sensing is a relatively recent science, which has not received sufficient knowledge The interest is only recently, as remote sensing has begun to prove itself as an assistant science, in many areas Other sciences and today it has become an independent branch of science with researchers and specialists in it.

The development of remote sensing has been closely linked to scientific progress in the fields of communications Technological technologies are advanced, as the size of remote sensing devices is constantly decreasing.

In this research, we discussed the importance of remote sensing as an independent science, and we tried to clarify its principles And the main stages of the sensing process, as we briefly touched on the most important applications of Remote sensing and its applications in other fields of science, including the relationship of remote sensing and its applications in The field of archeology, which is the subject of research, in an attempt to clarify the importance of this science in Detecting archaeological sites and saving a lot of effort, time and money required by operations Excavation, as well as the role of remote sensing in the documentation and preservation processes of archaeological sites, in An attempt to reach an answer to the question posed was the entry of remote sensing technologies, In the field of archeology, a turning point in the history of archaeological research and exploration, or not?

1-Remote sensing and its beginnings:

- Remote sensing is the science of studying targets and phenomena on the Earth's surface without Direct contact or physical contact with the studied targets, and this is done by By sensing and recording electromagnetic radiation reflected or emitted by targets studied, and then processed, and analyzed in order to obtain the characteristics of the objectives studied, using a range of means, such as aircraft, satellites, or balloons,Data capture devices, receiving stations, and a set of processing software Received data that allows to understand substances and phenomena by means of their spectral properties. The emergence of remote sensing science was linked to the invention of the camera in 1839 The French (Nadar) was the first to take a photograph of the village of Petit Bicctre from a height of 80 metres. Then I took a picture of the American city of Boston in 1860 from a 360-meter-high balloon Then I took a

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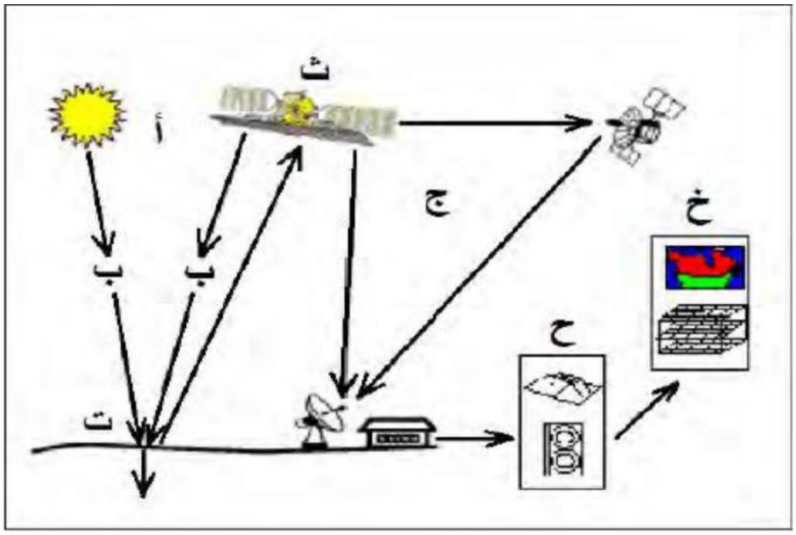
picture for weather purposes from a kite It is radiation consisting of two compatible vibrational motions moving in two perpendicular planes, the source of the first motion Then came the invention of the brothers (Wright) the plane in 1903, which in turn contributed to the development of Imaging methods, and in 1915 he made a special camera for aircraft that he designed Officer in the British Air Force for the purposes of military espionage , Where was the filming? Aerial is the first form of remote sensing. With the beginning of the space age, the United States The United States in 1946 launched a rocket for the purpose of space exploration at an altitude of 120 kilometers, and in 1957 the Soviet Union launched the first satellite, the command Which greatly contributed to the development of remote sensing technologies It is noteworthy that the first use of the term remote sensing was in the year 1960

2- The main stages of the sensing process:

Remote sensing depends mainly on the interaction between rays
Incident (sunlight or any other rays) and the studied targets, and then simplify the process sensor,
as shown in Figure (1).



Remote sens

A- Source of rays of light:

The first thing that the sensing process requires is the presence of a light source or a power source, The sun is the source of energy in most types of remote

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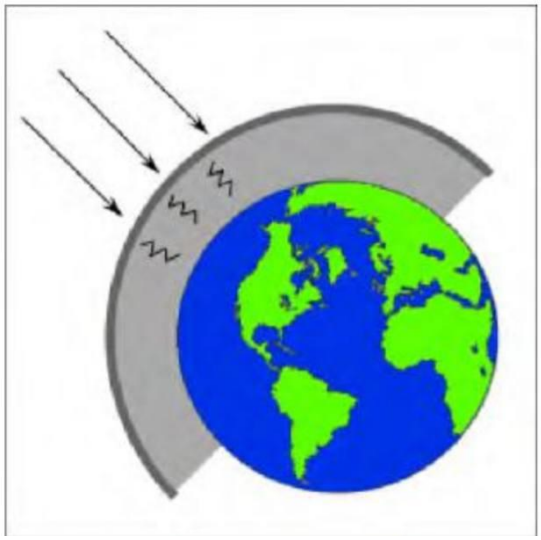
sensing other sources; The purpose of the energy source is to supply energy to the studied targetElectromagnetic

b- Rays and atmosphere

When the rays travel from their source to the studied target, they directly rub against the coverAtmosphere and interfere with it in an interaction that leads to a change in the nature of the rays, and the same is true whenReflection from the target and passing through the atmosphere again.The interaction between the reflected rays and the atmosphere can lead todistort itThis distortion is divided into what is known as scattering or absorptionScattering occurs when there are large particles of gases in the atmosphere?

This causes the electromagnetic radiation to be deflected or scattered from its original path, depending on the size ofThis scattering depends on several factors, including the wavelength of the radiation, the abundance of gas molecules, and the distanceThe radiation travels through the atmosphere, as shown in Figure 2.



- **Interact with the target:**

Radiation that is not absorbed or scattered in the atmosphere can reach and interact with The targets on the Earth's surface, and there are three images of the interaction of the incident radiation They are: absorption, penetration, and reflection:

- **Absorption**: Occurs when the target absorbs the incident radiation.

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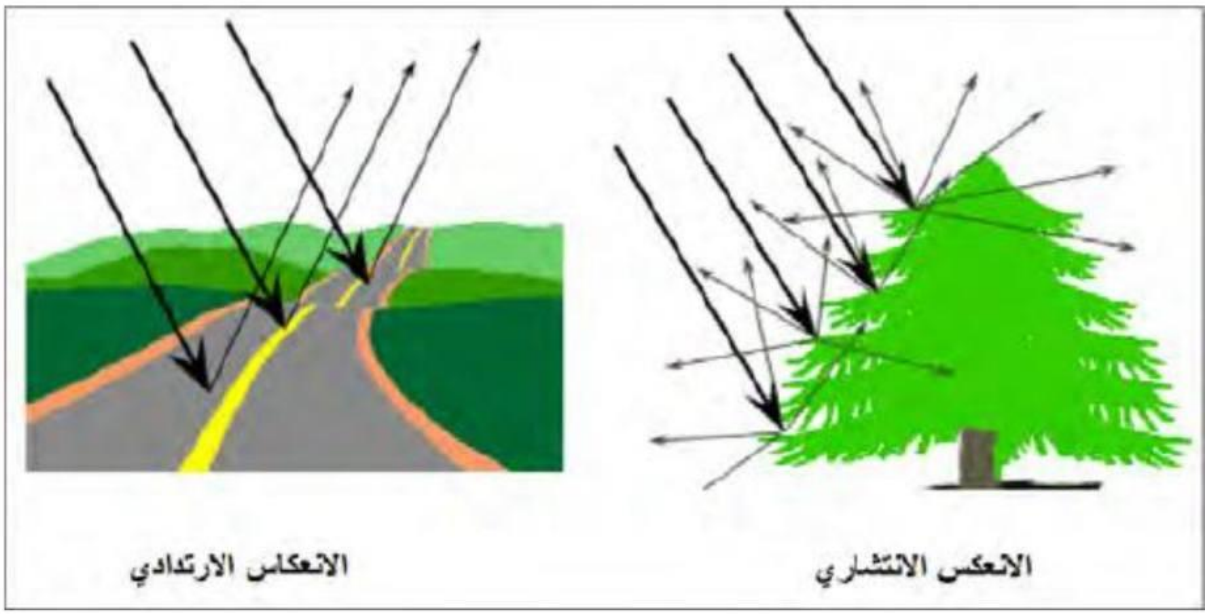
- **Transmittance**: Occurs when radiation passes through the target.
- **Reflection**: occurs when a target reflects and redirects radiation.

The targets are interacted with in one or more of these images depending on the length the radiation wave and the characteristics of the targets themselves.

In remote sensing, we are interested in measuring radiation Turn on two types:

Backscatter: When the target is smooth or soft, the reflection occurs Recoil, or what might be called a quasi-reflection, where all the incident energy is reflected or mostly away the target surface in one direction.

Diffuse reflection: When the surface of the target is rough, the energy is reflected almost uniformly In all directions, see Figure (3). To reverse the spread Backscattering Figure 3: Types of Reflection



C- Recording the rays emitted by the sensors

Where it accepts the rays reflected from the studied target by a sensor to collect the rays Electromagnetic recording and recording (remote sensing), which are of several types, including:

Ordinary cameras.

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A- Multispectral cameras.
B- Thermal infrared spectrophotometer.
C- Radar
D- Multispectral receiver.
E- Other imaging machines such as X-ray machines, gamma rays, and lasersAnd the microwave.

C-Analysis and Interpretation:

Trace and document the images received visually and automatically to obtain relevant informationWith the objective studied and to show its characteristics.

3- Remote sensing applications:

Good and sustainable management of various natural resources is one of the most important foundations for the development of Rich and poor countries alike, and to serve this end, the science of remote sensing was introducedGreat services in various fields such as natural resource statistics, disaster and crisis managementnatural, ecological and civic; Such as overpopulation, and the following is an explanation of the sensor applicationsRemotely in the most important areas:

A- Agricultural applications:

Agriculture plays a major role in the economies of both developed and developing countries. Production in its economic form is the goal of farms and agricultural institutions alike; And from There is an urgent need to know the quantity and quality of the expected crop in order to control the price. and trade requirements (import, export). Aerial and satellite images are used as technical tools for the development of special maps to determine Types of crops, checking their health and quality, and monitoring agricultural operations, and applications include agricultural remote sensing:

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A. Determine the types of crops.
B. Crop case assessment.
C. Estimate production.
D. Monitoring aquaculture erosion soil condition maps.
E. Education Department Maps.
F. Follow the steps of cultivation

B- Deforestation Monitoring Applications:

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Deforestation is a major global problem with multiple impacts on wildlife Drinking water as well as agricultural production, as remote sensing helps in better analysis, The problem is deforestation. Multiscale images provide a good way to analyze changes where Photos from previous years are combined with recent photos, so the differences are confirmed space, And the extension of forests, identifying the areas most vulnerable to this problem, and determining its causes.

C- Geological Applications:

Geology is concerned with the study of the Earth's surface structures, types, and subsurfaces. Geology includes the study of natural hazards such as volcanoes and earthquakes, as well as their image In the traditional exploration and extraction of minerals and petroleum, remote sensing provides a means Good for extracting information on Earth's surface structures and subsurfaces; Which leads to Determining the potential locations of oil and gas

d- Hydrological Applications:

Hydrology is concerned with the study of water on Earth, whether it is underground, surface or Usually rain or snow, most of these studies require frequent monitoring, which is what Allow remote sensing to play an effective role in this field in terms of the possibility of monitoring

Required goals periodically, and at the lowest material costs, and important examples ofApplication of Remote Sensing in Hydrology (Flood Monitoring):

The floods are a natural phenomenon, but on the other hand, the floods may be red and cause deaths and significant damage to infrastructure, and applications are used Remote sensing in monitoring and measuring the spatial boundaries of flooded areas, Then defining the modalities for evacuation, rescue, and assessment of flood risk and damage.

E- Developing maps:

Aerial and satellite images help to develop maps and update old ones with high accuracy. Giving it multiple information more accurately about terrain, elevations, and more.

4- Types of remote sensing:

Remote sensing is classified according to the type of received data into:

A- Positive remote sensing: the data received in it is a reflection Electromagnetic waves sent by remote sensors to targets when studying it, it is

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reflected from it to be received by sensors, which in turn send it to stations Terrestrial receivers for analysis and interpretation. This type of sensor is characterized by the fact that it works at any time of the day and in the seasons of the year All of them, and they provide wavelengths that cannot be found in the energy of the sun, such as waves short or microwave.

The sun's energy from the surfaces of the studied targets, as in the case of visible light, or that Absorbed and then emitted again as in the case of thermal infrared rays.

B-Passive sensors only measure reflected energy during the day, there is no reflected energy At night, as for the emitted energy, it can be measured and felt during the day and at night as long as it lasts its quantity was sufficient to allow sensitization.

5- Types of archaeological manifestations:

The types of archaeological manifestations are divided into two main types, namely: the superficial archaeological manifestations that Be visible on the surface of the earth, and the archaeological manifestations under the surface that are buried Underground. Despite some archaeological sites, such as the city of Petra in Jordan or the city of Palmyra in Syria, It has not been completely destroyed, as the majority of archaeological sites and finds are buried under the surface of the earth. The first reason that comes to our mind when talking about archaeological finds is that the people who They lived at that stage who buried them like graves, or buried some things as supplies Like money and jewelry, that was the only way back then to protect and hide money For the absence of sinks and locks, it is worth noting that some of these cases were They are sacrifices or sacrifices, meaning that there was no intention to take them back. There are also other examples of unintentionally buried monuments and archaeological sites, such as the city of Roman Pompeii in Italy, as the eruption of the volcano Vesuvius in 79 AD buried this city Completely under volcanic ash, volcanoes, along with sandstorms and avalanches, are The soil is one of the natural phenomena that can lead to the complete destruction of archaeological sites The process of removing and demolishing old buildings in preparation for the construction of newer buildings is also ongoing Mental leads with time to raise the level of the ground level of the archaeological site, and forms mounds

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Earthy known as the hills, which contain in its interior the layers of the oldest settlement One of the most common causes is a series of natural processes of decay and re-growth The disappearance of archaeological sites where they are buried, these sites, over the years under layers of dirt And the seeds that are scattered by the wind

6- Remote sensing techniques used to detect traces:

A- Traditional aerial photography:

Aerial photography means photography that takes place by private aircraft Equipped with special cameras. It makes clear to archaeologists at the end of the twentieth century the value of information that can be inferred from

Aerial photos of archaeological sites, as these photos can give valuable information that cannot be Observed with the naked eye from the surface of the earth, while it appears clearly and clearly when Looking at the site from above Figure (4)

The oldest aerial photograph of an archaeological site was taken in 1906 for the Aston Heng siteBritain, but aircraft were not used in particular as a platform for aerial photography until the year1909 As we mentioned earlier, there are many details about the Earth that can be clearly seen From the air for several reasons

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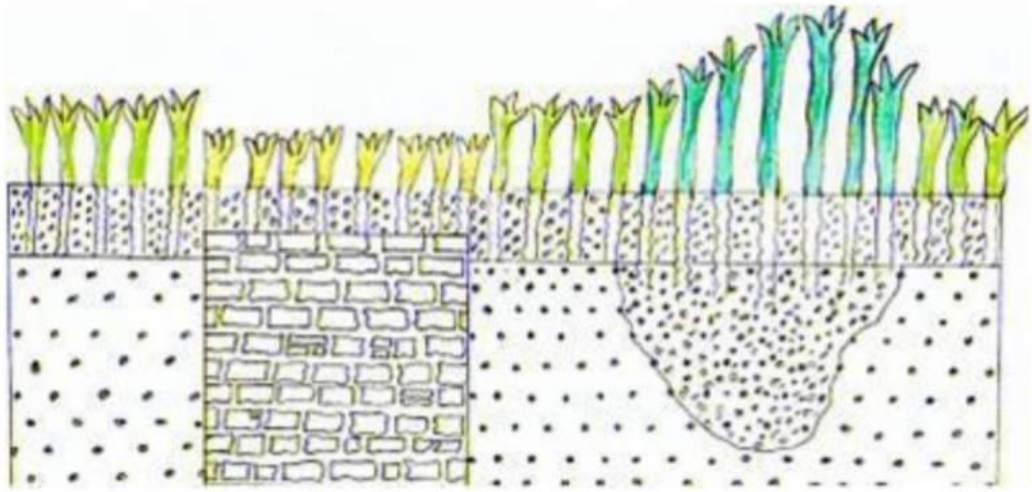
A. The difference in ground level reflects the shadow of the heights; So it reflects the color shade that is different from what's around it.

B. The walls located below the surface of the ground in the cultivated areas give plants over which it grows a different color and shape from the rest of the plants due to the fact that the growth of plants is based on for the nature of the land under it, see Figure (5)



C.the difference in the color of the soil is clearly visible in the aerial photos, as the color of the soil

D.the natural environment differs from the color of the transported soil that resulted from the accumulation of archaeological remains, as

The organic acids that are present in the organic waste in archaeological sites Give a different color to the soil.

• Through aerial photographs taken in the early morning or after snowfall, Detection of underground foundations, or buried walls that do not absorb Moisture to the extent absorbed by the soil, as it appears on the surface of the earth in the form of lines Wet with water, and the degree of clarity of these lines depends on the degree of cold or temperature of the ground

The day the pictures were taken also depends on how deep these foundations and walls are And then from the surface of the soil Aerial photographs, in turn, are divided into two types: vertical aerial photographs, and aerial photographs

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tilted, and vertical aerial photographs are more commonly used than slanted photographs as they take photographs

Perpendicular to the site and the scale shows real, so this type of image is preferred in If we want to obtain accurate measurements of archaeological phenomena, they can be used to prepare Maps, and tilted aerial photographs are taken at a tilt degree, so they can cover Larger areas than those covered by vertical images, and they give shapes familiar to the eye. Human beings are more than vertical images, as well as tilted images can clarify Phenomena that are not shown by vertical aerial photographs, such as archaeological caves and rock shelters. It is located below the edges of the hills, but is not suitable for taking accurate measurements or making maps

There are several deaf conditions for taking aerial photographs, and they are:

• Airplanes are preferred over flying balloons (airships), due to the possibility of controlling movement

The plane is directed to the place to be photographed, unlike airships, which often move according to the direction of the wind.

• The archaeologist locates the sites after one or more sorties with an average altitude ranging between500 to 1000 meters.

• You must also photograph locations that One at a low altitude ranging from 150 to 300 meters.

• The adoption of distorted aerial photographs as a result of aircraft vibrations should be avoided.

• Aircraft must fly in a circular motion around the location to be photographed, what Allows taking pictures of different heights, angles and degrees of light.

Then he atomized the images in search of signs of the archaeological sites we mentioned earlier and as evidence of the effectiveness of aerial photography technology in discovering archaeological sites, Nord North France is an example where he discovered the sites of more than a thousand Roman houses (villas) based on Analyzing the images and noting the difference in the growth of plants above these circuits from the rest of the plants. see illustration (6) Figure (6)

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It should be noted that not all visual shapes and differences appear in the images Atmospheric represents archaeological sites, soil marks and plant growth team can be caused by landmarks and the geological differences of the soil itself.
It is worth noting that the French R. A. Poidebard was a pioneer of aerial archeology In Syria, who was the first to capture a number of archaeological sites from the air, for example, Tell Brak and Qasr al-Hayr al-Gharbi

b- space photography

Although aerial photography has a long history, space photography is a method recent used detection Cartography, and archaeological analysis. Space photography. An important way to explore archaeological sites, especially as it covers vast geographical areas. By examining satellite images, it is possible to discover the locations of archaeological sites through Observe its phenomena on images such as tone, pattern, shape, size, and shade, as it is the case for conventional aerial photographs24. Satellite images also help in answering questions that exploration alone may be unable to answer The answer to it is, as space imaging sometimes reveals the courses of rivers and valleys and old wells, and thus can help in predicting the likely locations of archaeological sites, as It happened in the case of the Libyan desert, where valleys and rivers

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appeared in satellite images It was ancient, and plant and animal residues were found in it when digging, which led to the belief that there were Human activity, in turn, prompted excavations at several sites selected based on the images. The space station, where stone tools dating back to the late Acheulean period dating back to the period extending from 250 - 100 thousand years ago.

C- Infrared imaging and thermal scanning devices:

The growth of plants over archaeological sites buried in the soil is affected, as mentioned earlier, positively or Negative, of course, for the type and nature of the buried effects, but these changes and effects may be in Some cases are so accurate that they are difficult to notice with the naked eye, and here imaging leads Infrared radiation plays an important role in observing these changes, as we can easily observe Differences in plant health within the studied area 2, as in Figure (7) . Good growth plants appear red 28 As for thermal scanning, it is by means of thermal field measurement devices These devices are designed to detect antiquities and are installed on satellites It distinguishes the thermal differences of the surface and subsurface archaeological manifestations, as the degree of The temperature in archaeological areas is greater than those without them, and these devices can _ in our time Current - Measures temperature differences with an accuracy of up to 0.1 degrees. 2

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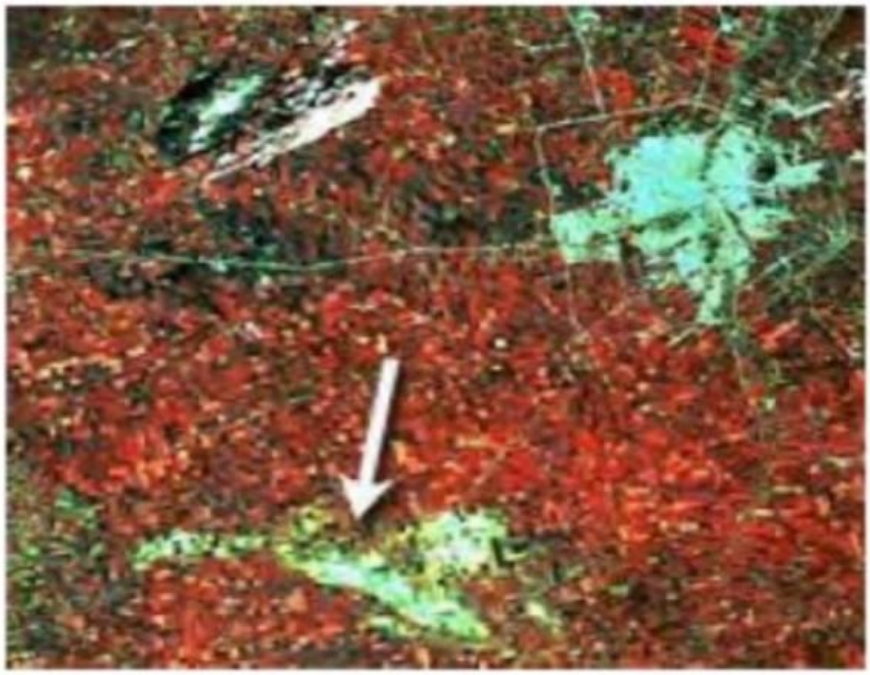

W- Radar sensors:

He developed radar sensors in the period between 1950 - 1960, The idea of this technology relies on sending electromagnetic waves into the ground, where These waves are reflected when they collide with the components of the soil and what it contains to varying degrees depending on The degree of hardness of these components, and they bounce back in the form of waves that the device receives, drawing Maps of buildings, and materials buried in the ground, meaning that the radar distinguishes the differences underground structuralism depends on the structure of the material buried in it.

Among the types of radar used in detecting impacts are the side aperture radar, and point radar. The radar sensors are characterized as:

It can be used at all times and in different circumstances and is an effective method in Archaeological discovery and documentation. It has a high sensitivity to different shapes of the earth's surface and terrain Water in its various forms,

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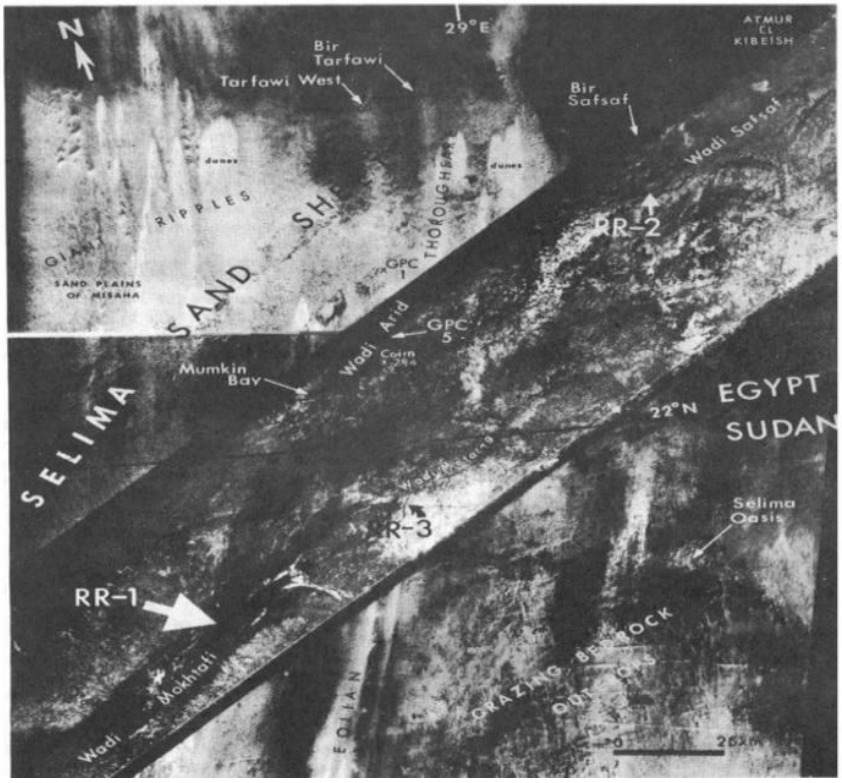
soil moisture, vegetation, ice, and filled earth.swamps, as well as sea waves and oceans.

Radar scanning can penetrate soil and soft rocks sometimes tens of meters In the case of point radar, and to determine the paleogeographic forms of the geological ages Modern and ancient riverbeds and others 31, see Figure (8).



C- Geomagnetic rays:

The application of this technology began in the field of antiquities detection in Britain in 1958, and is based on This technique is based on the principle of measuring the intensity of the magnetic field inside the soil; As the soil monolithic structure without foundations, walls or archaeological remains will give a magnetic intensity reading one, In case at If the reading differs in the studied area, this indicates the presence of me Materials with a different magnetic field are likely to be relics.33 Examples of materials that can be detected by this technique are: Walls built from Milk, or burnt milk, ancient tombs, ancient kilns, trenches, and metal tools 4 See Figure (9).

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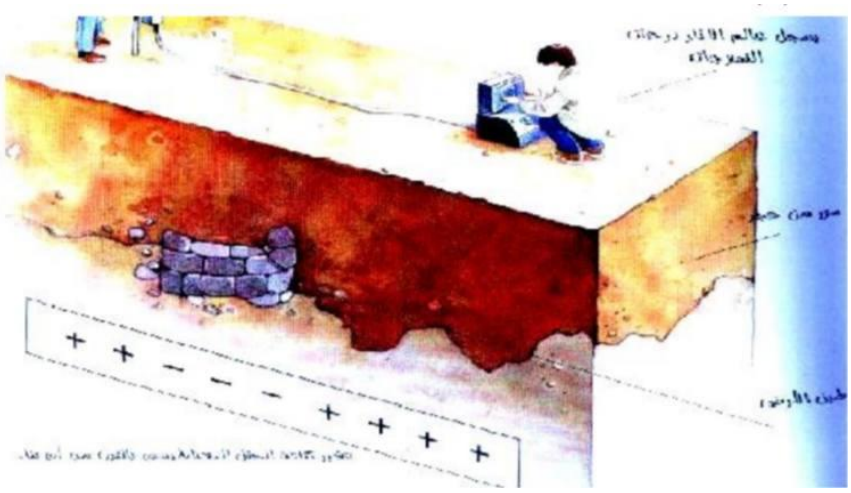

This technique was used in Syria to prepare a map of the surface of the site of Tell Jindires in Syria northwest of the country, where it revealed the Roman city located under the surface of the hill

She gave a plan that clearly shows the buildings and the perpendicular streets according to the chess plan Which was prevalent in the Roman cities at the time.

H- Electrical resistance:

This technology is based on the idea that all types of soil are conductors of electric current due to The presence of salt and brick in it, and in the event that there are traces under the surface of the earth at the site where It is checked by this technique that the electrical resistance will be different, which The scanner will detect it.

This technique is applied by passing an electric current in the ground through two electrodes that are implanted in the ground, and then calculate the electrical resistance of that soil through two other electrodes at the surface.

To explain the principle of operation of this technique, for example: The archaeological wall buried under the The surface of the soil will exhibit great electrical resistance, as the stones that make up the fence are characterized by that it retains moisture to a lesser degree than the surrounding soil; Which means that the current The electrode will pass more easily into the soil and cavities; Because it will be wetter than The wall, and this can be detected by the ultrasound scanning device.

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An example of this technique is the research that took place in the Wadi al-Baqa'a region northwest The city of Amman in Jordan, where he identified many places that contain remnants of archaeological buildings.38

g- Transmission method:

The use of geophysical sciences in the detection of antiquities has spread in recent years Significantly in many archaeological sites, including the transmission methods that are used to determine the The voids under the earth's surface in a way with high accuracy in determining the dimensions of these

Three-dimensional spaces. An applied study was conducted for the Valley of the Kings and Deir el-Bahari region in Luxor, Egypt

Due to the many subsurface effects it contains, it was possible through this study to determine the The true dimensions of the known tombs, and the discovery of a number of voids under the surface of the earth; Which indicates the presence of other undiscovered tombs.

research results :

- From the above it is clear to us the principle of the work of remote sensing techniques, and the main stages that are

The sensing process goes through and the types of rays used in the sensing process, and the types of

The reflection of these rays, as well as the types of sensors used in remote sensing,

Such as ordinary cameras, multispectral cameras, or radar.

- As it becomes clear to us the importance of remote sensing and its techniques in various fields

And the great and auxiliary role that it can play if it is in the field of agricultural applications,Such as determining the types and quality of crops or estimating production quantities, or if it is in the field ofThe study of the earth's surface structures and exploration of oil, gas and groundwater reservoirs, as well as

The great advances made by remote sensing in the field of cartography.

- As it becomes clear to us from the foregoing, the types of archaeological manifestations of both types, the superficial whose effects areclear on the surface of the earth, and the archaeological manifestations that are buried in the layers of the soil,As well as clarifying the reasons for the burial and

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disappearance of these archaeological manifestations, and the factors that helped toThese archaeological features have been hidden from view for hundreds of years

- As it turns out to us, the great development achieved by remote sensing in the field of archeology

Specifically, as it offers us archaeologists a wide range of sensing techniques that can

Its use in archaeological detection and documentation, starting with traditional aerial photography and photography

Space-based, not ending with radar sensors, or sensors that rely

The transmission method that helps to discover the voids under the earth's surface, as

It happened in the case of Deir el-Bahari in Luxor, Egypt

- Perhaps the most important of all of the above is what remote sensing provides to archaeologists from

Great effort, wasted time and large material costs, for example became

It is possible to deduce in advance the areas that are likely to contain archaeological sites, and provide

The hassle of carrying out test probes and the trouble and effort it entails for workers and archaeologists alike

Both, as well as the large time we need to complete these probes and material costs

The large volumes required by traditional soundings and excavations, as happened in the case of the desert

Libya, for example, as it was inferred by satellite images that

places of valleys and ancient riverbeds,

- It is also possible through the aerial photographs taken to determine the extension of the ancient archaeological city

And its expansion through the divisions of agricultural land, as we saw from the study of the city of Homs, which

By the General Directorate of Antiquities and Museums in Syria.

- In the end, we cannot deny that remote sensing technologies have entered the field of

Archeology was a turning point in the history of this science in the field of archaeological research and documentation.

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In the field of conservation and the preparation of archaeological maps as well, even some universities today
This established a separate branch of what became known as space archaeology.

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