

Remote Sensing and Image Understanding as Reflected in Poetical Literature of Iran

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¹**Abstract.** Some modern sciences have root in classic art, literature and culture. Remote sensing as a science, art and technology of obtaining information about objects and areas from far distance has been started from the launch of the first Landsat on July 23, 1972. Remote sensing that is getting more and more importance in several domains of humankind's life has a key role for obtaining information about the Earth. The success of image processing and interpretation requires understanding deep knowledge of the basic elements of remote sensing science, systems, art context and a broad disciplinary of human knowledge of the world. Therefore, the processes of visualization, image and photo interpretation bring to bear not only scientific knowledge but also all of the experiences that a person has obtained through his lifetime. Such learning cannot be exactly measured, precisely programmed or completely understood. In this paper, in order to develop the synergisms of combination scientific knowledge regarding the physical world, art and even literature, different aspects of remote sensing were firstly defined. The way of thinking about some image problems, forming the hypothesis, observing and experimenting, data interpretation, and finally artistically producing attractive images and maps were discussed. Moreover, we attempted to deal with analyzing and interpretation of some remote sensing key words such as colour, heat sensation and visualization. Although a great number of papers and books have addressed the implication of the remote sensing applications for studying the physical aspects of the earth but not noticeable research work on the history and literature of remote sensing has been published and discussed. In this paper, beside the investigation of heat sensation as a source of information by satellite sensors, the quality of human sensors regarding this matter, as reflected in poetical literature of Iran will be discussed. Moreover we have analyzed the ideas of Iranian poets in interpretation and discovering some important scientific and artistic concepts of remote sensing. This research can help to explore the history of primary ideas related to this new branch of science and technology in ancient days and show the role of poetry in better expression and understanding of remote sensing concepts.

Keywords: Remote sensing, cultural heritage, image understanding, heat sensation, art, interpretation, literature.

Introduction

In remote sensing advances are often focused on technological innovations in imaging equipment and computational techniques that enable human to automatically interpret images (Hodgosen and L. Loyd, 1986). In this paper we discuss the importance of human interpreter which is reflected in the Iranian poets works. Therefore we will draw on literature from remote sensing, cognitive, psychology and vision of Iranian poets.

Remote sensing images are obtaining increasingly important roles in environmental and planetary sciences. It is also becoming salient in the culture at large (Holze, 1985). Today's interpreters of archived satellite imagery face some difficulties. Many of the original interpretations depend not only on the imagery itself but also on the skill and experiences of the interpreters' vision, psychology, age,

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etc. Many critical interpretations depend on the experiences of the interpreters with an extensive knowledge in image analysis that is not readily available to today’s analysts. There are many ways, where the human contributes of the analysis of remote sensing images. Some more pertinent psychological research such as concept formations, graphic perception, expert, novice difference, and perceptual learning are needed. There has been little work in understanding the human perception or cognition of remotely sensed imagery. Despite the lack of research, we often design automated measures of the image cues, such as texture or pattern, with an implicit assumption that we are emulating visual cues or at least matching human performance. But how do we know that such measures emulate visual cues of human processes without studying the human processes (Hodgson, 1994).

1. Schematic overview of the remote sensing history

The same as other modern sciences, remote sensing has roots in ancient and classic days; in the thoughts, dreams, ideas and efforts of the people of the old days, who tried to explore and understand the real world. The following schema (Figure 1) shows a chronicle brief history of Remote Sensing and the evolution of its ideas from the myth to reality (Figure 2):

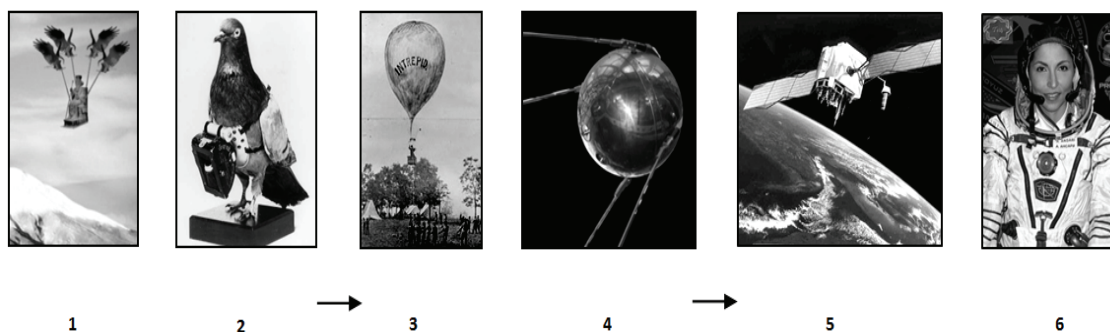


Figure 1. The manifestation of primary ideas of human flight to see and evaluate the surrounding world in the legend of Keykavous, the king of Keyani dynasty in the Shahnameh (the epic book from 10th and 11th centuries belongs to Ferdowsi, the classic Iranian poet); 2. A squadron of pigeons equipped with lightweights (approximately 2.5 oz) 70-mm aerial cameras; 3. The intrepid balloon being tethered by Union troops at the battle of Fair Oaks on June 1, 1862; 4. Launching the first meteorological satellite i.e. SPOTNIK into the space by the former USSR in April 1960; 5. Today, various satellites are receiving data and obtaining images from the surface of the earth, sky and even other planets in each moment; 6. The first space female tourist, i.e., Anoushe Ansari in international space station.



Figure 2. The story of flight, from myth to reality

2. Definition of some key concepts of remote sensing (via Iranian poems)

Remote sensing is the science, technology, and art (Figure 3) of obtaining information about an object, area, or phenomenon by analyzing data acquired by a device that is not in physical direct contact with the object, area or phenomenon under investigation (Lillesand, et al., 2004).

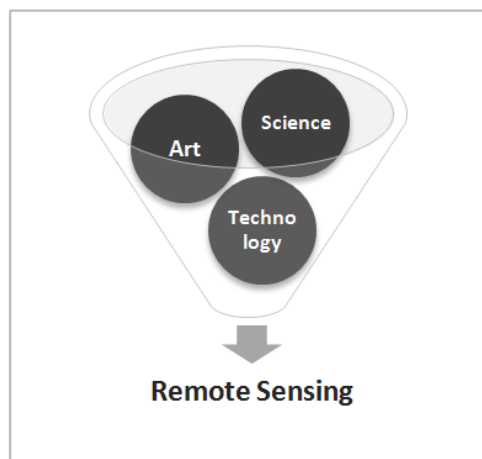


Figure 3. Three main dimensions of remote sensing

2.1. Flight or desire to fly

Employing pigeons in 1903 by Julius to acquire more information about the earth was an important and primary point for the development of Remote Sensing. This issue should not be considered just as the flight of a bird, but it should be considered as the flight of the idea that tries to lay down a new science in this field (Alavipanah, 2009). Therefore, it should be emphasized that the real remote sensing has a root in flight. The study of the manifestations of the desire to fly in fanciful legends and stories in learning the evolutionary course of Remote Sensing is of great significance, because this issue shows the efforts made by human from the very beginning to know the phenomena and the surrounding environment through seeing and sensing them from a long distance. The oldest and most famous legend of flight among the Iranian people has taken place at the time of Keykavous, the King of Key-ani dynasty² based on the leftover Pahlavi texts of Sassanid period³ and the Shahnameh of Fredowsi. In a book entitled “Dinker”⁴, it is mentioned that “Keykavous prepared to dominate the sky and in his flight, he reached to a place which was the limit between light and darkness.”⁵ In the tale of Kaykavous in the Shahnameh, also, the same incident is mentioned and although we cannot demand that Ferdowsi was aware of some of Remote Sensing concepts, but his statements indicates the attention towards several concepts of Remote Sensing.

- Then he chose out four eagles strong of wing, and bound them unto the corners of this chariot.
- And when it was done, Kai Kaous seated himself in the midst thereof with much pomp.
- And the eagles, when they smelt the flesh, desired after it, and they flapped their wings and raised themselves, and raised the framework with them.

² The Keyanian (or Kaianids) are a semi-mythological dynasty of Greater Iranian tradition and folklore. Considered collectively, the Keyanian kings are the heroes of the Avesta, the sacred texts of Zoroastrianism, and of the Shahnameh, Iranians national epic.

³ It was the last pre-Islamic Persian Empire, ruled from 224 to 651 AD.

⁴ Dinkard is a ninth century encyclopedia of the Zoroastrian religion, but with extensive quotes from materials thousands of years older, including (otherwise) lost Avestan texts. It is the single most valuable source of information on this religion aside from the Avesta (the holy book of Zoroastrians).

⁵ West, (1897), Dinkard, book 9, chapter 22: 7

- And they struggled sore, but they could not attain unto the meat; but ever as they struggled they bore aloft with them Kai Kaous and the throne whereon he sat.
- And so long as their hunger lasted, they strove after the prey.

Ferdowsi believes that the ambition of Keykavoos was to find out the right answers to the following questions. Of course it is more than his elementary interests to observe his own land over the sky:

- Kai Kaous's mind was dimmed that how far is from here (Earth) to the moon?
- What is the nature of the sun and moon, how is the day(light) and night(dark)?, nor wherefore the planets roll. Who is art master of all the earth!?
- What's the secret of sun and how is the roll and motion of the sun?
- I heard that Kai Kaous up to sky and went to find the secret of heaven
- and visit the sun and moon, and count the stars one by one...⁶

Beside the written ancient texts and manuscripts, in several inscriptions belong to Achaemenid (ca. 550-330 BC) and Sasanid (224-651 CE) times the desire of humans to fly has been drawn and engraved (Figure 4).

As can be seen, in the ancient inscriptions and coins of Iran, many images and statues of winged humans (Figure 4 (4)) animals like lion and bull are remarkable clues regarding to the flight (Figure 4 (2 and 3)). Moreover, the symbol of Zoroastrian religion, the ancient religion of Iranians⁷, i.e. the 'Fravahar' (Figure 4 (1)) is the winged disc with a man's upper body.⁸ All of these images could be count as documents that human beings from the beginning have had a fascination with human flight.



Figure 4. The ancient inscriptions and coins of Iran in relation to flight

2.2. Vision

As it is mentioned in the definition of Remote Sensing, it is to observe objects and phenomena but from a far distance. So, seeing is the first condition for the materialization of Remote Sensing action. The results of the seeing, receiving and interpreting which formed in eyes and brain are linked with visual system and the physical stimulants are their most simple part (Nassau, 1983).

Our eyes are able to make a direct vision only within the narrow limit of electromagnetic spectrum (visible light: 400-700 nm) (Alavipanah, 2006). In fact, of the total spectrum range of electromagnetic, only we can see it in the ratio of one to thousands thousand billionth. In the following

⁶ In Greek legend also this kind of desire to fly can be found. It is mention that Bellerophon the Valiant, son of the King of Corinth, captured Pegasus, a winged horse. Pegasus took him to a battle with the triple headed monster, Chimera. In another legend belong to Greek ancient times it has been mention that Daedalus was an engineer who was imprisoned by King Minos. With his son, Icarus, he made wings of wax and feathers. Daedalus flew successfully from Crete to Naples, but Icarus, tired to fly too high and flew too near to the sun. The wings of wax melted and Icarus fell to his death in the ocean.

⁷ Zoroastrianism is a religion and philosophy based on the teachings of Prophet Zoroaster, probably founded some time before the6th century BC in Iran.

⁸ Beside Iran, this symbol has a long history in the art and culture of the ancient Near and Middle East.

couplet, Sanaee, an Iranian classic poet, describes the limits of the vision of the human eyes vis-à-vis the total spectrum of electromagnetic radiated from sun like a particle:

- I cannot know the fountain of the sun through a particle
It is likely that there is not a particle of vision in my eye ⁹

The considerable point is that “seeing” is different from “viewing” (insight). By seeing, we mean the apparent seeing and physiology of the thing and include the physical and optic dimension, but viewing is the deep understanding and deep sight of things. In fact, it is a seeing based on vision. Since each field and profession demands its prerequisites, in remote sensing and in particular the interpretation of photos and images, in addition to the health of visual system, there is a need to a deep talent, vision and deep view. In the following couplet, Hafiz says that even observing the whole world (which is displayed in Jam-e Jam) will be useless without having a vision and knowledge of the perception of what we see:

- When you are not capable to be seen, do not seek link, the Jam-e-Jam will not help with that when someone is in lack of insight ¹⁰

In the following verse, Molavi (Rumi) states the result of the physical observance combined with knowledge and vision as follows:

- (Whit which) you may behold colours other than these, and may behold pearls instead of stones. ¹¹

2.3. Light

Displaying the surrounding world, the light provides us with knowledge about phenomena, distance and colour. It is with the help of light that we can see. In fact as Iraqi, the Iranian poet says:

- I see the entire universe as you and this is not surprising
To whom else should I see when you have given vision to my eye? ¹²

2.3.1. Electromagnetic wave's production

- Each atom of your tender heart you bore, You will see a sun smiling within the core. ¹³

The concept of the above couplet can be compatible with the issue of the production of electromagnetic waves as a result of electron movement round the core of atom or proton. In this manner, the movement of electrons from the orbits near to core to farther orbits associated with energy absorption and the opposite of this action leads to discharging Photon and electromagnetic waves. Therefore, the sun in the second hemistich can mean the production of electromagnetic waves as a result of the nuclear fusion in sun. Different parts of the electromagnetic spectrum radiating from sun have become the base of diverse sensors which are active in different parts of it.

2.3.2. Light and colour

It is an accepted and recognized scientific principle that human does not see the phenomena but sees its images. Seeing an image is the process of the light reflection and colour is emerging out of light. In simple words, colour is the visual effect produced by EM radiation on the retina of the human eye. The average human eye is sensitive to radiations from approximately 0.4-0.7 μ m. which is called the visible region: in exceptional individuals, visibility may extend to a slightly shorter and longer wave-

⁹ Sanaei (11th-century)

¹⁰ Hafez (14th-century)

¹¹ Molavi Rumi (13th-century)

¹² Iraqi (14th-century)

¹³ Hatif Isfahani (19th-century)

length. The visual effect is related to the wavelengths of the incident radiation, and this leads to the colour effect. Rumi clearly defines those three primary colours of “Red, Green, Blue”. Rumi expresses the provability of colourous in relationship to light through hidden state of colour at night (the lack of light). In another couplet, he states the existence of the source of light, its reflection and also the visual perception of colour amazingly.

- You will be unable to see green, red and light-coloured / until you could see more than these three lights
- As these lights are hidden at night/ so you observe that the seeing of colour is from the light
- It is not possible to see the colour without the external light/ also the same applies to the colour of inner imagination. ¹⁴

2.4. Thermal remote sensing and heat sensation

An intuitive understanding of temperature, associated with the sensation of hot and cold, has been recognized since ancient times (Zhumin M. Zhang and Graham Machin, 2010). Every object emits thermal radiation when it is at a temperature above absolute zero. Thermal Remote Sensing data can be used for extracting some information about phenomena that is impossible in optical Remote Sensing data. In the following poem, Molana (Rumi) expresses the importance of heat and considers it as a factor to percept the entity, which without any need to light, helps to perform the seeing process:

- Whoever is clear-sighted observes its light/ The blind also enjoys its hotness
- So the blind eye can understand based on hotness / that a weak sunray rose
- But this hotness will open up the eye/to see the exact things being heard

3. Image Understanding

Interpreting remotely sensed images is an open-ended task (Hoffman, 2001). The perception of image in the part of the interpretation of aerial photos and satellite images are the most outstanding and artistic parts of Remote Sensing (Figure 5). Human is created such that he will be able to percept the realities of the entity. In other words, human is equipped with intellect by which he can percept his surrounding world.

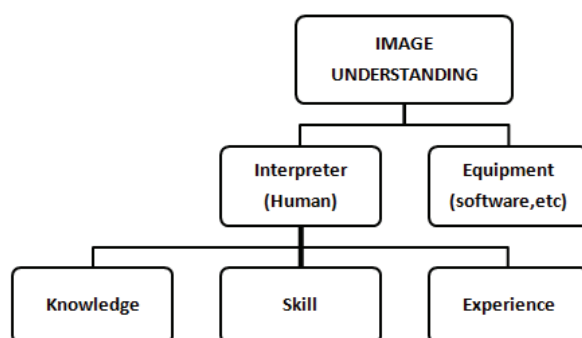


Figure 5: Image understanding, the main elements

Automatic image processing techniques remain inadequate (Friedl, 1988). The human must “be in the loop”, since the human, unlike the computer, can perceive and can form and reform concepts (Hoffman, 2001). Human interpreter could derive very little information using in a point-by-point approach. Many of original interpretations depended not only on the imagery itself but also on the

¹⁴ Molavi Rumi (13th-century)

skill and experience of interpreter (Campbell, 1996). So in this work we focus on the background knowledge, Experiences and skills obtained from many years ago by humans in this regard.

3.1. *The perception and proper interpretation of image*

Human senses are limited and are not sufficient to percept the complex and immense world. Some of Iranian poets e.g. Molavi (Rumi) expresses this limited capacity of mankind senses as follow:

- The eye of sense-perceptions only likes the palm of the hand: the palm that not power to do everything

Sometimes the sensational limitations do not let humans to have his perceptions abilities to their functions properly. In fact, by making amendments in the perception powers, understanding the facts in human can be changed. According to Molavi (Rumi), the smallest factor can disturb the understanding and perception of human:

- He said) "When thou layest one finger on an eye, thou seest the world empty of the sun".
- So that the (whole) world may be covered (hidden from view) by a single point and the sun be eclipsed by a splinter.

According to Molana (Rumi), these apparent senses are not sufficient to percept the universe and the basic matters are human's intellect, knowledge and heart:

- My heart hath five sense other (than the physical): both the worlds (external and spiritual) are the stage (theatre) for the senses of the heart.

The process of visual photo or image interpretation brings to bear not only scientific knowledge but all the backgrounds that a person has obtained through his lifetime. Such learning cannot be measured, programmed or completely understood. The synergism of combining scientific knowledge with real world analyst experience allows the interpreter to develop heuristic rules of thumbs to extract valuable information from the imagery. Therefore some image analysts are better than other image analyses, due to the following reasons:

- They can synthesize scientific rules and real word experiences to reach logical and correct conclusions.
- Understand the scientific rules better.
- Have seen many geographical landscapes.
- Understand thermal properties of materials. Thus we may conclude remote sensing is both, art and science.

An amateur subject can look at aerial photo or other remote sensor data and extract some useful information from it. Generally, he/she does not interpret the image with any particular plan or hypothesis to test. Unfortunately, it is likely that he/she may makes serious false interpretations because he/she does not understand the nature of remote sensing system which is used to acquire the data or appreciate the vertical or oblique perspective of the terrain recorded in the imagery.

For the purpose of the perception of image in interpretation of aerial photos and satellite images, the necessity of using artistic outcomes and in particular applied arts become more prominent. Having ability to make an eye interpretation along with "visual knowledge", beautiful selection and the efficiency of colours by considering the principles of compatibility and lack of compatibility of colour, increase of idea fertilization and ability to have a specific observance with the help of imagination and mental creativity and order are among the consequences which make possible utilization this issue and having access to that will increase the ability to interpret (Figure 6). Since the visual interpretation of satellite images and aerial photos are mostly accompanied with individual judgment, so a commentator should know how to employ the scientific and proper methods to reach the goal. In most of cases, the conditions of the earth which appear in the image are complex. Sometimes, a commentator is not able to make a link between the phenomena of the earth and the information content of an image fully based on his/her knowledge and experience.

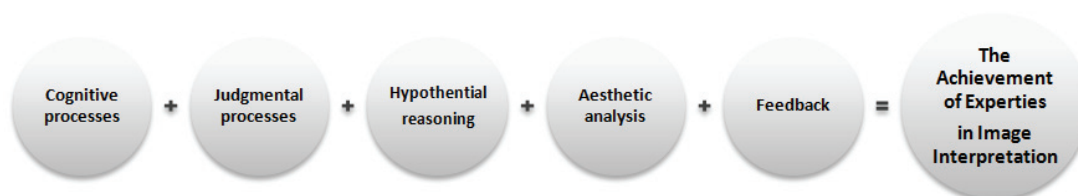


Figure 6: The processes for achievement in image interpretation

The light reaching our eye is a function of surface reflectance. The dependency due to illuminant colour is removed through colour constancy computation. We have a good solution to colour constancy: the white page of this paper looks white whether viewed under blue sky, or under a yellow artificial light. However, the processes through which colour constancy is achieved are not well understood and also the mechanisms of human visual colour constancy processing are not known (Graham .D. Inlayson). This is the same motif, which is referred to in this couplet by Molavi (Rumi):

- You held a blue glass before your eye: for that reason the world seemed to you to be blue.¹⁵

3.2. *The importance of light, colour and visual perception in Remote Sensing*

Today, it is a proven fact that objects, materials and different phenomena have different spectral behaviours in relation with electromagnetic energy or with their own inner molecular conditions. The perception of the reflection or radiation of objects, with regard to their physical, chemical and biological features is very different. In fact, in science, art and the technology of Remote Sensing, it is based on this intensity and weakness of energy and light interactions that it will be possible to identify and distinguish objects and phenomena from each other. If it is not possible to distinguish different objects from each other in a certain spectrum, then it will be possible to identify them in other spectrums. This subject is the base of multi-spectrum and trans-spectrum Remote Sensing (Richards and Zewing, 2006, Alavipanah et al, 2007).

As for the importance of colour, John Rasking says: "Whatever you see in your surrounding world, it is displayed to your eye in form of a combination of different colour levels". The sensitivity of human's eye towards colour changes is so high, whereas the human's eye can distinguish gray levels between 20 to 25 tons (Alavipanah, 2006). Remote sending tries to look at objects with regard to the structure of eye, the phenomenon of seeing and perception of colour through light reflections of objects. So, in this science, the relation of objects, phenomena and images taken from them are considered. The experts of Remote Sensing should be well aware of the nature of colour, combinational methods and colour processing techniques. The selection of various colours in images to detect the changes of phenomena and help with their redetection is in need of a proper understanding of the principles of colours and their dominating rules. These rules along with artistic creativity and literary interpretations will be useful. In this regard, in the Persian literature, there are many deep poems which indicate the awareness of their poets of these concepts.

3.3. *The description of beauty and the beauty of image*

One of the most innate and natural requirement of human is his adoration to elegance. It cause that he creates images and pictures in a very beautiful and attractive way. Such an attractive image could even go further than its initial purpose and it can be practical for other functions. Therefore, although pay attention to beauty of images should not damage their contents, the attraction and beauty of images could be counted as an advantage. For a deep comprehend of image, the visual artifice and affection toward swell showing and production are useful. By help of this beauty endowment

¹⁵ Molavi Rumi (13th-century)

i.e. image humans can create elegance, because image is the reflection of light and a world that light govern over it, is full of beauties.

4. Conclusion

In this paper, we investigated the conceptual elements of remote sensing and aerial photo interpretation from the perspective of the literature of Iran. Here, we have deliberated some of the most famous poets of Iran, like Sanaee, Hafez, and Rumi, which their thoughts provide some clues regarding new and modern concepts of remote sensing. The most important considered aspects are flight, human sensation, light, electromagnetic spectrum, vision, colour, heat sensation, etc. As long as we continued our research, more and more facts were appeared that the poetical literature of the mentioned scientific facts have been discussed by these poets. In conclusion, the following are the most remarkable that have been traced from the works of these poets: 1) The remote sensing has a root in flight and the flight has its roots in human dreams, 2) The observation or seeing is the first condition for the materialization of Remote Sensing action, 3) For displaying the surrounding world, the light provides us with knowledge about phenomena, distance and colour, 4) Seeing an image is the process of the light reflection and colour is emerging out of light, 5) An intuitive understanding of temperature, associated with the sensation of hot and cold, has been recognized since ancient times, therefore, every object emits thermal radiation when it is at a temperature above absolute zero, 6) Materials and different phenomena have different spectral behaviours in relation with electromagnetic energy or with their own inner molecular conditions, 7) The perception of the reflection or radiation of objects, with regard to their physical, chemical and biological features is very different. Of course the language of poetry is different from the language of science and needs more sophisticated skills to find the real relationship between these two languages. Therefore, this work is an open discussion and any kinds of contribution are welcomed.

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