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The near infrared reflective materials surfaces : dimensions and angles.

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Abstract: The near infra-red signals reflected by different surfaces are studied. The transmitted signals are reflected by different surface obstacles for varied distances among the receiver, reflector and remote controller. The infra-red transmitter transmits the operating signals indirect to the remote sensor. This provides guidelines for another proper way. The proper adjustment and installation positions, of reflecting surfaces display the signal on the screen of user as a flash. The experimental results indicate that the limiting distances of the remote controller and the reflecting surfaces depending upon types, colors the reflecting surfaces ,besides incident angle on these surfaces. By using transmission indicator ,we can decide if the signal is bad or good. It was noted that the increasing distances above the limit interrupt with the reception. Also the sensing ranges of IR or invisible laser radiation are decreasing when the reflected areas & reflectivity of obstacles decrease, but the maximum incident angles decrease when the surface have high reflectivity. The research benefits for purposes of limitation of targets and types of directional reflectors to download, natural sites of user activator and guidance, to determine the sites of system like space channels or video image.

Keywords:: remote control, surface, reflectance, infra-red, , receiver, sensor, transmitter, signal, distance, invisible Laser, incident angle.

Introduction

The images of infrared signals are function of surface characteristics and imaging system. If the imagery is corrected for sensor effects, it can be assumed that the image is made of external factors. The use of multiple independent response parameters could yields multiple indicators, such as reflectivity. The increases of infrared reflectivity gave estimates geometric sites, moderate and kind of surfaces. A solution is to use reflectance enhancement, tailored to the study scene. Gausman, H. at al.(1970) (1) study NIR reflectance to number of intercellular airspace in cotton leaf mesophylls. As increase in leaf mesophyll airspace's increase reflectance. Croft,E.C.(1982) (2) provides detailed radiometric data for every pixel comprising a digital image. The data in FIR (1200- 2400 nm) were used to study the spectral expression of metamorphic minerals in the Ruby mountains of southwestern .Best ,R.G. et al.(1985) (3) study the spectral response of turbid water using (450-1000nm) wavelengths. They show a linear relationship between turbidity and percentage reflectance. Cierniewski,J.(1987) (4) study examines a mathematical model dealing with influence of soil surface roughness on soil reflectance in the visible and infrared ranges. TH (Thematic Mapper) is an efficient way to produce images of consisting high quality by using new blue and short wave IR bands[Ahern,1989] (5).

Everitt,J.D. et al.(1989) (6) were used multi-spectral video imagery to determine water content and surface features of soil. They were used five conditions, smooth wet and dry, disked wet and dry, crusted dry smooth surfaces, by indoor plots for a real video collection. Barton, Ian, J. et al.(1989) (7) used five channels in the visible and infrared regions to view the earth surface with resolution of (1km).The channels are used to measure surface observation cloud

temperature. It is observed that the red (high absorption) and NIR(high reflectance) are excellent for vegetation classification due to their contrast[Major,1990] (8).

The features describing the object may be spectral reflectance or emittance value for optical or infrared imagery, this from satellite and international geosciences in modern cartography [Morse,1991] (9). David R.P.(2000) (10) used visual and NIR imagery using NVIS for study mapping and classification algorithms. The NVIS data was converted from radiance to reflectance in two different ways, empirical line method and internal average relative reflectance. It reviews reconnaissance disciplines and limitations and acts as a step– by– step guide for requesting reconnaissance information. Sensor specific capabilities are classified and outside the scope of this publication that provide more specific information on reconnaissance system, sensors, or platforms[Marine,2000](11). In small rooms, the transferred of signal is easy and fast in any position of guide remote sensor. A new resource provides different positions to transmit signal from the specific surface to the selected targets[Davide,2000] (10). It is due to the features describing the object that may be spectral reflectance or remittance values from optical or infrared imagery which secondary measurements derived from the image[Brandt,2001] (12) . It provides general guidance and specific techniques for characterizing, monitoring and maintaining of methods[Lyon,2001] (13) .

It is explained to design engineers, system analysts and predict their performance based on design attributes and operating parameters[John,2001] (14) . The researchers use remote sensing to support the response and recovery operations at the world trade center. They concluded that the availability of aerial and high-resolution satellite imaginary should practically helpful to efforts aimed at improving the nation's security from terrorist attack[Ray,et al.2002] (15) . The study of infrared reflection spectroscopy of thin films on highly oriented pyrolytic graphite was from[Thomas, et al.2003] (16) . The development of attenuated total reflection based compression modulation step-scan Fourier transform infrared spectroscopy and its application to Rheo-spectral characterizations of polymer films was studied by [Yuji, 2004] (17) . Donald, at el.,(2005) (18) study Fourier transform infrared attenuated total reflection analysis of human hair. They compared the hair and breast cancer patients with hair from healthy subjects. The study of synoptic maps of water-column integrated primary production in May and September were derived using a primary production algorithm applied to ocean satellite data from Yellow Sea from 1998 to 2003 were from[Son, et al. 2005] (19) . The cause of this study is to facilitate transferring the signal from the sender to receiver by reflection using selection materials.

The project benefits to download, guidance, and selection of sites and types of reflected surfaces to specific signal of user. The aim of the research is to determine the best reflected material covering the wall of hall to the near IR laser signal.

IR Effect on Electric Dipole Moment of Material

The incident of IR (750-830nm) on material leads to reflectance. The external field generated can be electronically polarized. The molecular vibrations take place variations in polarization and in dipole moment, when the relative positions varied. If the dipole moment varied at vibrating molecule, constant alternative electric field will generate that its value periodically varied with time. On this principle the vibration movements in molecules is exited, and the radiation is absorbed as the electromagnetic frequency is equal to the frequency of alternative electric field. The vibration formations of IR become active, if the variation of dipole moment have occurred, depending on number of bonds [Overendm,1963] (20).The sensor receives reflected IR after series of interactions with material, depending on nature and kind of reflectors. The volume reflectance flows the reflection laws of electromagnetic radiation. Albanakis K.S.Sept.(1990) (21) used a laboratory model to test three different sediments(unmixed materials) of known size, then tested spectral reflectance of model programmed correspond to green, red and near infrared. Volume reflectance was tested for different bands. It was found that IR and thermal infrared wavelengths cannot penetrate snow, and there are a decrease reflectance NIR response for snow[Fearnside,1989] (22). There are a number of external factors involved in remote sensor, but they can correctly for inclination, azimuthal orientation of remote sensor[Everitt,1989] (6).Clark(1999) suggests that it is possible to model the reflectance from an exposed rock consisting of several mineral based on Hapke ’s (1993) equation:

$r\lambda=[(w'/4p)(\mu/\mu o+$
$\mu o)][(1+Bg(g))Pg(g)+H(\mu)H(\mu o)-1]$ [1]

Where $r\lambda$ is the reflectance at wavelength λ, μo is the cosine of the angle of incident light on the rock or mineral of interest, μ is the cosine of the angle of emitted light, g is the phase angle, w' is the average single scattering Albedo from the rock or mineral of interest, Bg is a back-scattering function, Pg is the average single particle phase function and H is the function for isotropic scatters. It must known optical constants and the angle of incident and emitted light. In infrared (2000–8000nm), the phenomenon is molecular vibrations, bond stretching or rotation. The interaction of E.M.(light)with material changes the energy, reflection and absorption by using Beer 's law:

$I=Ioe-kx$ [2]

Where I is the observed light intensity, Io is the original light intensity, x is the distance traveled through the medium and k is the absorption coefficient that as a function of wavelength is a fundamental parameter describing the interaction photons with material or:

$k=4\pi m/\lambda$ [3]

The complex index of reflection (m):

m = n–jK ; n is"real" part of index, j = (–1)1/2, K is extinction coefficient. Also from Fresnel equation:

$R=[(n-1)2-K2]/[(n+1)2+K2]$ [4]

Where R is the reflection of light normally incident onto plane surface.

The reflection is the process by which light incident on a surface interacts with the surface such that it leaves an incident side without change in frequency.

In perfect mirror Q1 = Q2 (intensity of light incident equal to intensity of light exiting. At perfect diffuse reflector :intensity of reflected parts of light are equal in all directions(diffused part).The reflectance is the ratio of the reflected part to the incident light of the observed amount of light ("observed " "amount" and "light" later)to perfect diffuse reflector identically illuminated of observed. The reflective properties of the surface are captured in the bi-directional reflectance distribution function.

The near infrared red portion of the EM spectrum occurs in the 0.7μm to 1.3 μm region. NIR is within the reflective portion of the spectrum and can be recorded photographically using special false colors photographic films. Conventional photogram emulsions and CCD arrays will typically not able to detect reflected or radiated electromagnetic energy beyond near IR. A specially designed thermal sensor or radiometer is required to sense energy in the mid IR and thermal bands.

There are two types of processes from (0.4 – 50 μm):

a)Electronic (0.4-1.5μm) with high – energy photons observed by bound electrons, energy states / wavelength controlled by atom and crystal and primarily interactions with transition metal (e.g. Fe)

b)Vibrational (>~6μm) with extinction of fundamental vibrational motions ,stretching and bending, frequencies related to strength and length of bonds, ~1.5–~6μm are weaker overtones and combination bonds and complex transitional region between reflection and emission.

In vibrational processes, bonds is in a molecular vibrate. The frequency is dependent on the type of vibration,bond length and the atom masses and certain materials have important vibrational absorption bands.

The depth of absorption feature is defined as:

$D=1-Rb/Rc$ [5]

Where Rb is the reflectance at the bottom of the absorption feature, and Rc is the reflectance of the continuum at the same wavelength.

Practical Procedures and Conditions

The sensor (detector) and remote(transmitter) are using by directed IR and invisible Laser radiation at various test indoor sites (4×10m2)dimensions. Different reflected surfaces (white paper, black body, plastic, stainless steel, synthetic rubber, synthetic leather, wood, concrete, mirror and shadow glass) are positioned towards signals. The reflecting areas with values (0.09, 0.16, 0.25 m2) are located. It applies with average slope about 30 degrees for IR signal and 45 degrees for invisible Laser signal to measure maximum distances. The selection of distances and angles depend on the best reflection of the signal from the surfaces by observing the flash signal. These had practically the optimum position. The invisible Laser signal (950nm) is emitted from remote controller to the sensor(detector) of video instrument by diode laser(GaAs) system. Effects that account for these differences include the change in reflectance caused by surfaces. A simple instrument for measurement of remote sensing reflectance in coastal environment was used from[Hu.2002] (23) . Remote sensed data must be used with care in areas of surfaces. The system mounted vertically on a fixed receiver (sensor) and the installation of the transmitter

units(remote) are horizontally moving with different positions as shown in Fig. 1 . Data was collected at different study sites. Reflectance measurements take into account all the returned radiation of scene. Correlation coefficient was obtained from maximum distance (Dmax.) that the sensor receives the signal, which IR or Laser signal transfers from reflector to it. The flat portion of NIR was extended from 800 to 1130nm wavelengths provided to the receiver that determined from data company. . Large field distance were significantly correlated to reflectance measurements made at the corresponding varied surface, areas and angles. The study areas were sampled with the transmission taken from 0 to 13m distance in an indirect line of sight from the remote controller to remote sensor. Also the maximum distance (dmax.) is measured from the reflector to the remote controller at (Dmax.) (at largest areas of surfaces). The maximum incident angles (θmax.) at different areas are measured by using large protractor that perpendicular fixed to the reflected surface of IR or Laser signals by using He-Ne Laser beam guide(λ=6823 Å). This was carried out for 3.5m distance from the receiver and 3m from the remote for most surfaces.

The small oblique-angle sensor and normalizing of view angle are possible. Several testing sites were selected in every areas that used to classify the entire process and to be potentially suitable determined. The flashes display in the receiver or screen when the signal data has arrived from remote control, and then produce image in the monitor, if an electronic video or receiver satellite is emitted. Also it is preferable to adjust the operation setting before starting to use the remote controller operations. If the reception is interrupted, it repeats the installation unit horizontally again or adjusting the volume level with programmed values by moving the reflector and the director incident . If the reception signal status is bad, it must adjust the reflector to get an indicator signal. The compatibility with reflector can set by changing the selected limits. This enables user to download and update new program from satellite. The data of characterized instruments and conditions was obtained from the companies [Strong,1998]and[Goktekin,1999](24) that describes the relationship between the effect of ambient light sources and in dark ambient on threshold DC irradiance. Also they indicated the slow variation in supply current as ambient temperature increases. Also they showed that the supply current increases in dark ambient when supply voltage increases. However the relationship between the threshold irradiance and ambient temperature varied in dark ambient. The range of wavelengths that the system have worked is from 800nm to 1130nm which use practically the value (950nm) wavelength [Vishay,2000](25) .The difference in physical and chemical properties of the reflected materials using most of them to cover the walls of the halls or rooms of building in light of specifications.

Results and Discussion

It is shown that the incident angle of infrared and Laser signals have volume reflectance from all different response surfaces.

Effect of IR Signal Reflectance Surfaces on Maximum Distance:

Table (1) indicates the receiving signal with maximum distance (Dmax.) and background reflectance effects at different values of areas. Demetriades-Shah, et al.(1990) (26) was derivatives in chemistry to eliminate background effects, the practical use in many areas of remote sensing. The reflectance surfaces (mirror, stainless steel, wood, white, plastic, black, concrete, synthetic rubber, shadow glass, synthetic leather) decrease in reflectivity of IR alternatively that display from reception of signal after reflection from the surface to receiver. The best correlated was obtained for largest areas (0.25m2) of mirror with (0.96) reflectivity of IR radiation because the surface reflect most the radiation. The reflectance factor varies inversely with distance from remote because of absorbance, dispersion and reflectance factors of air media particles. But this factor is proportional with surface areas because the quantity of radiation that reach the receiver is more than at large surfaces. This also depend upon guide incident angle. The probability of reception of signals is varied by changing in an incident angle of sending radiation.

Effect of Invisible Laser Signal Reflectance Surfaces on Maximum Distance:

Table(2) refers to video signal arrival at different maximum distances (Dmax.) and variation in area surfaces that is shown decreasing in (Dmax.) respectively (mirror, stainless steel, white ,plastic ,wood ,black ,concrete synthetic leather, shadow glass ,synthetic rubber), because the quantity of absorbed invisible Laser due to type and nature of reflected material. The lowest absorbance(high reflectivity) (e.g. mirror) have maximum distance compare with any other reflected surfaces (for ex. Stainless steel to

synthetic rubber). The difference between IR and Laser signals as shown in tables (1) and (2) describe that IR undergoes almost twice dimensions compare to invisible Laser signals from the remote as in mirror reflector because the intensity is more twice. This attributes to wavelength and intensity of incident radiation on the equal surface areas. The longest wavelength have a great effect on reaching largest distances. Moreover the high intensity have large reflected distances. Also this is connected with the sensitivity of detector to radiation and converted design of flashes.

Some ways in which the condition of stable surface can be assessed, and place some constrains of the use of remotely sensed data which will provide a means of estimating surface type based reflectance properties. Monitor conditions indoor determine future movement of remote by human. Detection concerns examination of evidence of reflectance surface types and effects as well as movement patterns. The nature and color of nearby object is important, as dark object have less of an effect than do light or shiny object.

Effect of Maximum Angles on IR and Invisible Laser Signals of Reflected Surfaces:

The orientation can have misleading effects on remotely sensed data. It is based on measured values of the spectral bi-directional reflection properties of the surfaces. The sensor measures radiance which are directly flat linked to the nature of the targets. The differences among high reflected surfaces were greater than the differences among low reflected surfaces. The Also the fluorescent light are interfering with remote controller or is correctly conducted to determine optimal threshold levels for the individual transformed signals and obtain good detection. The selection of seat surfaces to reflect the signal radiation of user system make easy reception for signal.

effect of maximum incident angles (θmax.) on receiving IR and invisible laser(video) signals are shown in tables (3) and (4) respectively. It is observed that (θmax.)increases as increasing in reflectance values of surfaces because the dispersion of coarse surface decreases and the reflectance angle is limited without dispersion. The values of maximum incident angle for IR is differed from invisible laser for using reflected surfaces and lead to different in deflection of two types of wavelengths. However the succession of surfaces for IR are (mirror, stainless steel, wood, white, plastic, black, synthetic leader, concrete, synthetic rubber, shadow glass) and for invisible laser are(white, plastic, shadow glass, concrete, leather, rubber, black, mirror, wood, stainless steel)respectively. These are depending on the distance between the remote and surface so as whenever the remote is close from the surface, the maximum incident angle will be largest. The absorbance, tendency of dispersion and color and nature of surface material have a great effect for limitation of maximum distances and incident angles of type of radiation. It is observed that the invisible laser is very different compare with IR radiation. The effect of local incident angle variation on NIR is insignificant. The IR spectrum (850nm) showed changes in response due to different surfaces. It was observed that the disturbance from peripheral devices might occur, and the other products which might cause interference are placed further away from the receiver.

Also the fluorescent light are interfering with remote controller or is correctly aimed. Response surface analyses were

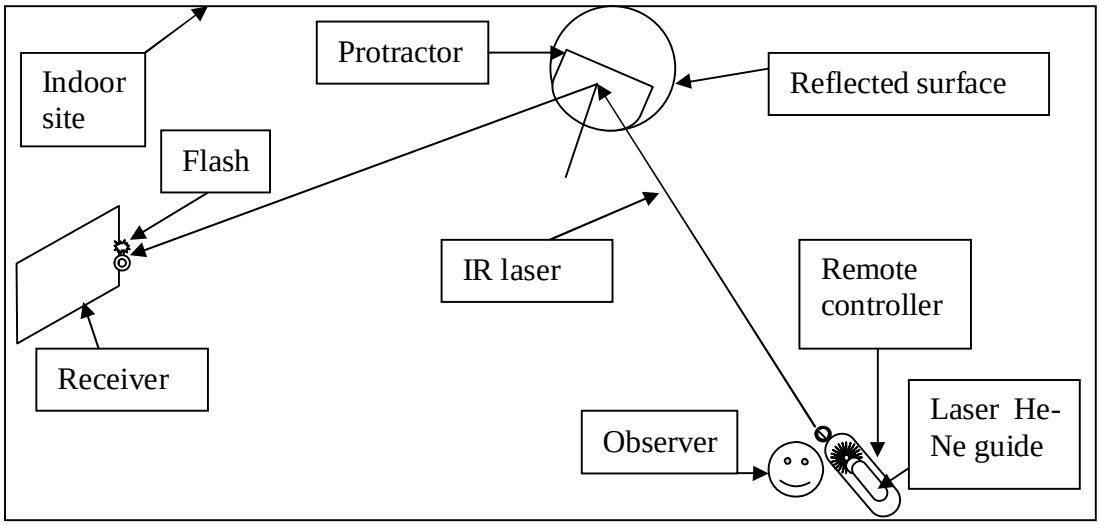

Fig.(1) schematic draw of reflected surfaces of IR laser signals from remote sensor to receiver in test site.

Table 1. shows a different reflectance surfaces and areas against maximum distance of IR signal.

Surface Reflectance	Synthetic Leather	Shadow Glass	Synthetic Rubber	Concrete	Black Body	Plastic	White Paper	Wood	Stainless Steel	Mirror
$D_{max.}$(m) $A=0.25m^2$	1.06	2.00	2.97	3.72	4.87	5.74	5.75	5.83	9.35	11.25
$D_{max.}$(m) $A=0.16m^2$	0.87	1.78	2.42	3.61	4.85	5.56	5.60	5.65	9.25	11.00
$D_{max.}$(m) $A=0.09m^2$	0.75	1.53	2.34	3.41	4.79	5.30	5.33	5.45	9.00	10.73
$d_{max.}$(m) $A=0.25m^2$	0.12	0.15	0.25	0.35	1.40	0.26	0.53	0.75	3.52	4.51

Table 2.shows a different reflectance surfaces and areas against maximum distance of invisible Laser signal.

Surface Reflectance	Synthetic Rubber	Shadow Glass	Synthetic Leather	Concrete	Black Body	Wood	Plastic	White Paper	Stainless Steel	Mirror
$D_{max.}$(m) $A=0.25m^2$	0.54	0.66	1.06	1.77	1.92	2.05	2.33	2.45	5.21	5.33
$D_{max.}$(m) $A=0.16m^2$	0.45	0.53	0.87	1.67	1.82	1.91	2.15	2.28	5.10	5.22
$D_{max.}$(m) $A=0.09m^2$	0.38	0.48	0.66	1.53	1.73	1.88	2.01	2.12	4.88	5.11
$d_{max.}$(m) $A=0.25m^2$	0.18	0.13	0.29	0.11	0.22	0.29	0.19	0.25	0.39	0.51

Table 3. shows different reflectance surfaces and areas against maximum incident angles of IR signal.

Surface Reflectance	Shadow Glass	Synthetic Rubber	Concrete	Synthetic Leather	Black Body	Plastic	White Paper	Wood	Stainless Steel	Mirror
$\theta_{max.}$(degrees) $A=0.25m^2$	18	19	21	30	35	36	34	47	50	58
$\theta_{max.}$(degrees) $A=0.16m^2$	17	18.5	20	24	32	28	36	46	53	55
$\theta_{max.}$(degrees) $A=0.09m^2$	16	18.3	19	23	24	27	30	43	47	50

Table 4. shows different reflectance of surfaces and areas against maximum incident angles of invisible Laser signal.

Reflectance surfaces	Stainless Steel	Wood	Mirror	Black Body	Rubber	Synthetic Leather	Concrete	Shadow Glass	Plastic	White Paper
$\theta_{max.}$(degrees) $A=0.25m^2$	10	22	30	35	44	57	62	66	71	80
$\theta_{max.}$(degrees) $A=0.16m^2$	8	20	28	30	37	50	53	54	60	75
$\theta_{max.}$(degrees) $A=0.09m^2$	6	14	25	20	32	47	50	53	57	66
$\theta_{max.}$(degrees), $A=0.25m^2$at $d_{max.}$	4	13	22	25	28	37	39	41	40	53

Conclusions

The optimal surface is mirror reflectance for obtaining the greatest distance and angle reflection of IR and invisible Laser radiation. The possibility of sensors with finer spatial resolution is less than (13m) , contrast measures the best results for improving obstacles. Mapping and remote sensing applications in isolated regions would greatly benefited for receiver technology . There are significant differences in reflectance among different surface targets for certain type of remote in addition to background surfaces. The surface classification was able to produce fairly accurate estimates of percent area unsuitable for surface due to reflectivity problem. The operation get by select channels at random with changing the distance and angle of the reflector surface.

To obtaining optimal signal reception in large hole that preferably covered with wood indoor walls. But the concrete wall is bad to cover the wall. The mirror have an excellent reflection to signal.

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الأشعة تحت الحمراء القريبة المنعكسة من على سطوح المواد :الأبعاد والزوايا

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الخلاصة:

لقد تمت دراسة الأشعة والإشارة تحت الحمراء القريبة NIR المنعكسة عن سطوح لمواد مختلفة في أنواعها وألوانها ولمسافات مختلفة بين جهاز التحكم عن بعد والعاكس ووحدة الاستقبال ،حيث تم نقل الإشارة الى المستقبلة بصورة غير مباشرة ،وهذا يؤدي الى استخدام طريقة جديدة في العمل .إن التناغم ألموقعي الصحيح للسطوح العاكسة يؤدي الى مسح الشاشة بالإشارة المستلمة على شكل ومضة .ولقد بينت النتائج العملية أن للمسافات المستخدمة بين جهاز التحكم والسطوح العاكسة ووحدة الاستقبال حدودا عليا تعتمد على نوع ولون العاكس بالإضافة الى زاوية سقوط الأشعة تحت الحمراء على تلك السطوح .وباستخدام مؤشر استقبال الإشارة فيا إذا كانت الإشارة جيدة أم رديئة ..إن زيادة المسافة فوق حد معين يتقاطع مع جودة الاستلام .كما تبين أن تناقص مساحة العاكس أو انعكاسيته يؤدي الى تناقص قدرة التحسس للإشارة المستلمة ،غير أن الحد الأعلى لقيمة زاوية السقوط يتناقص مع زيادة انعكاسية السطح المستخدم.