DOWNLOAD PDF INTRODUCTION TO INFRARED AND ELECTRO-OPTICAL SYSTEMS

Chapter 1 : Introduction to infrared and electro-optical systems (eBook,) [racedaydvl.com]

This newly revised and updated edition of a classic Artech House book offers a current and complete introduction to the analysis and design of Electro-Optical (EO) imaging systems.

Infrared Basics Terms and Laws Irradiance All IR detectors respond to irradiance, that is, to the density of the radiant power that is incident on their surface. The SI unit for radiant power is the watt. The SI unit for area is the square meter or centimeter. The conventional symbol used for irradiance is the capital letter E. Irradiance for aviation application usually has units of watts per square centimeter. Intensity Intensity also known as radiant intensity is the most widely used measure of the IR signature or the susceptibility of an aircraft to detection by threat IR sensors. In that sense, intensity is analogous to radar cross section RCS in the radar world. However, it is important to remember that the target aircraft in the IR world is an active emitter rather than the passive reflector of a distant RF illuminator. For this reason, intensity is actually more closely related to RF effective radiated power ERP of radar, which combines transmitter power with antenna beam width. As we learned earlier irradiance is area power density at the receiver. Intensity is defined as the angular power density from the source or in other words: The units of radiant intensity are watts per steradian. The conventional symbol for intensity is the capital letter I. What is solid angle?. In geometry, the ratio of the area on the surface of a sphere to the square of the radius is the unit of solid angle or steradian in the SI system of units. Irradiance and intensity are related by the square of the distance. Radiance Radiance is comparable to the quantity brightness in the visible wavelength, while intensity specifies radiation from the total visible area of a source, radiance specifies that from only a small area. It can be thought of as intensity per unit area. Summary Reflectance Reflectance can be understood as the efficiency of a surface in reflected off radiation illuminate it. Reflectance is generally categorized as either specular mirror-like or diffuse scattered by reflection from a rough surface. Most surfaces exhibit both types of reflection, but one typically dominates. On the other hand, if an object reflects energy from another radiating source with a lower temperature, the apparent temperature that is calculated for the object will be lower than its true temperature. With other types of objects, the amount of energy radiated also depends on factors other than the temperature of the object, such as the properties of the material and surface reflection. The efficiency an object in emitting infrared radiation compared to a perfect emitter is called emissivity. The value of emissivity ranged from 0 to 1. Given two objects with the same true temperature but different emissivity, the one with the low emissivity will radiate less energy. Objects with light colors, made from metal often have low emissivity while objects with a dark color, made from organic often has high emissivity. Objects with higher emissivity are not only better at emitting infrared radiation, they are also better at absorbing infrared radiation. The most common transformation is the transformation from heat to infrared radiation. Any object with the temperature above absolute zero will radiate in the infrared. In layman terms, a hotter object can emit IR radiation with a shorter wavelength and higher intensity. In layman term, SWIR sensor is very similar to a visible camera with better clarity. While LWIR sensors can be used to observe extremely cold targets such as ICBM missiles in mid phase outside the stratosphere , MWIR sensors are more commonly used for aviation and Navy applications because MWIR sensors operate in the region of the spectrum where the thermal contrast is much higher due to black body physics. In perfect condition, MWIR can see 2. A good example of the dirty-battlefield power of LWIR is burning barrels as shown in the photo below. It is measured in electrons per photon or amps per watt. Therefore, it is desirable to have a NEP as low as possible, since a low NEP value corresponds to a lower noise floor and therefore a more sensitive detector Infrared Sensors Infrared sensors can be simply understood as electronic systems designed to capture infrared radiation and through that form a picture of outside world. In general, most infrared sensors consist of following basics components: The other role of optics is to form an image in which information can be analyzed. A spectral filter restricts response to a limited band of wavelengths to help distinguish known target features from natural background. On the early infrared sensors, the detector is often only a single element whereas modern Infrared sensors often have an array of detectors that can determine spatial information in addition to generating a signal. Domes IR sensors on aircraft and missiles are protected from weather conditions, aerodynamic pressure and aerodynamic heating by domes window. They are the outter most layer of any infrared sensor. The infrared window of various material are as follow: The percentage of left over energy is measured by a variable called the transmittance. The transmittance of infrared radiation at different wavelength through various materials are as follow: The reason is that intensity of weak absorption will increase. Moreover, as windows get heated by aerodynamic heating, they will also emit infrared radiation. This emission from the window can be so great that radiation from targets is obscured. Alternatively, the radiation from the domes can be so great that it over saturate the detector with photons, making them unresponsive against signals. It is generally agreed that it is emission rather than absorption that significantly limit performer of Infrared systems at high temperature. Emittance of some sample Infrared domes at different temperatures are as follows: However, due to lower thermal shock than Sapphire, it has not replaced Sapphire in infrared applications. As previously shown, hotter objects will emit infrared radiation with higher intensity, this raised an important question for designers, how hot do the domes of IR sensor on aircraft and missiles get in flight?. The degradation of an infrared sensor when their window reach high-temperature mainly come from the reduction of signal to noise ratio. The higher the noise, the higher the signal need to be so that they can be detected. It is important to remember that, the degradation due to rising domes temperature also change significantly depending on operating wavelength of the infrared sensor. As a general rule long-wave infrared sensor can tolerate much greater emittance from the dome than a mid-wave sensor. So how come long wave infrared sensor can tolerant higher domes temperature than Mid-wave infrared sensor?. The answer lies in the spectral radiance of objects in Mid-wave and Long-wave region. The Mid-wave emittance from the domes are very insignificant at low temperature and rise dramatically as the dome is heated up around times between K and K. On the other hand, the Long-wave emittance from the domes compared to background radiation are already significant at low temperature and only rise slightly as temperature increased around 30 times between K and K. Most aircraft cruising at speed below Mach 1 and has top speed less than Mach 2 so their infrared sensors rarely need protection from aerodynamic heating. The majority of measures based on the fact that the temperature of the domes will decrease very significantly with distance from the stagnation point. Some common methods are as follow: This is a device attached to the front of missiles nose so as to create a detached shock ahead of the body. The shock cone is wider than the body of the missile, as result not only the dome of missiles get colder but drag also reduced. The spike will also partly block the field of regard of the sensor. One way to reduce the effect of aerodynamic heating on missiles seeker is to put the dome to one side of the missiles and a certain distance from the nose. The main disadvantage of this method is that the field of regard of the seeker will very limited compared to nose mounted seeker. A pyramidal domes is a dome made up of a heat-resistant metal nose tip and several side panels. The face of the pyramid is much cooler than the metal nose and this design also offers a better field of regard than a side mounted flat window design, and better aerodynamic than infrared guided missiles with a blunt nose. However, the main disadvantage is of this design is the multiple internal reflections of sunlight whenever the sun is in the forward hemisphere. In simple terms refractive index is the ratio of the speed of light in a vacuum to the speed of light within a given material. For example refractive index of diamond is 2. In general, the higher the refractive index, the more light would bend toward the normal line. Refractive index for some common domes materials are as follow:

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Chapter 2 : Introduction to Infrared and Electro-optical Systems : Ronald G. Driggers :

Ronald G. Driggers holds a Ph.D. in electrical engineering from the University of Memphis. He is a senior engineer with the U.S. Army Night Vision and Electronic Sensors Directorate and is the U.S. representative to the NATO panel on advanced thermal imager characterization.

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This introduction emphasizes the analysis and design of infrared and electro-optical imaging systems, beginning with a background review of mathematics, LSI systems, and diffraction principles necessary to perform sensor analysis.

Chapter 4 : ARTECH HOUSE USA : Introduction to Infrared and Electro-Optical Systems, Second Edition

EO includes lasers, photometry, infrared, and other types of imaging systems. This newly revised and updated edition of a classic Artech House book offers a current and complete introduction to the analysis and design of EO imaging systems.

Chapter 5 : Introduction to infrared and electro-optical systems (Book,) [racedaydvl.com]

Introduction to Infrared and Electro-Optical Systems, Second Edition (Artech House Remote Sensing Library) - Kindle edition by Ronald G. Driggers, Melvin H. Friedman, Jonathan M. Nichols. Download it once and read it on your Kindle device, PC, phones or tablets.

Chapter 6 : Electro-Optics Handbook, Second Edition

Introduction to Infrared and Electro-Optical Systems by Ronald G. Driggers, Melvin H. Friedman Electro-Optics (EO) is a technology area that involves the generation, modulation, detection, measurement, and display of optical radiation by electrical means.

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Chapter 7 : RF Cafe Quiz # Introduction to Infrared and Electro-Optical Systems - RF Cafe

A complete and up-to-date introduction to the analysis and design of infrared and electro-optical (eo) imaging systems. The text details the principles and components of the Linear Shift-Invariant (lsi) infrared and electro-optical systems and combines it with calculus and domain transformations to achieve a successful imaging system analysis.