

# Index

$1/f$  noise, 123

3CCD cameras, 116

## A

active pixel sensor (APS), 117

aperture stop, 42

aspect ratio, 42, 94

atmospheric model, 104

atmospheric transmittance,  
10, 106

atmospheric window, 106

attenuation coefficient, 106

azimuth, 41, 42

## B

bar target, 60

Beer's law, 106

blackbody, 12, 13, 50

blackbody radiation, 11

bolometer, 121

boresight, 41

broadband, 16, 48

## C

calibration, 125

camera, 3, 45

charge-coupled device (CCD),  
113, 124

CIE standard observer, 115

color CCD, 115

complementary metal-oxide  
semiconductor (CMOS), 113, 117

conservation of energy, 17

content domain, 96

covert illumination, 73

critical target dimension, 103

current responsivity, 53

cutoff wavelength, 112

## D

day/night imager, 73

definition, 5, 27

diffuse reflectance, 18

diffuse surface, 11

discrimination, 100

## E

EIA 170 standard, 93

emission, 10

Exchangeable Image Format  
(EXIF), 89

extinction coefficient, 106

## F

$f$ -number ( $f/\#$ ), 39, 40

Federal Aviation Administration  
(FAA), 131

field of view (FOV), 42

field stop, 42

fixed pattern noise (FPN), 125

fixed-wing platform, 42

flux, 11, 16

focal length, 39, 54

four-bar target, 60, 81, 82

forward-looking infrared (FLIR),  
97, 100

frame rate, 92, 95

frame transfer, 114

**G**

gap energy, 111  
gimbal, 68, 69  
Global Hawk, 3, 65–67  
global scan, 93  
grazing incidence, 20  
ground sample distance (GSD), 23, 43, 44, 96, 103

**H**

heading, 90, 91  
high definition (HD), 5  
horizontal blanking, 94  
hyperspectral imaging, 2, 35, 47–49

**I**

instantaneous field of view (IFOV), 5, 23, 24  
imagery interpretability rating scale (IIRS), 97  
imager, 1–3  
imagery analysis, 97, 98, 137  
imagery authentication, 89  
incoherent sources, 28  
intelligence, surveillance, and reconnaissance (ISR), 2, 5  
interlaced scan, 92, 94  
interline transfer, 113, 114  
interoperability, 95  
irradiance, 31–36

**J**

Johnson noise, 122

**K**

Kirchoff's law, 16, 17

**L**

Lambert's law, 106,  
Lambert–Bouguer–Beer law, 106  
Lambertian approximation, 18, 20  
laser rangefinder, 69  
laser target designator, 67, 73

line of sight (LOS), 68  
long-wave infrared (LWIR), 5, 11, 14, 15  
LOWTRAN, 104

**M**

magnification, 40  
medium-wave infrared (MWIR), 5, 10, 11, 15  
metadata, 41, 89–91  
micro-UAV, 65  
microbolometer, 73, 120–122  
microbridge, 121  
microlens, 117  
minimum resolvable temperature difference (MRTD), 81–85  
MODTRAN, 104  
modulation  
modulation transfer function (MTF), 59, 60, 61  
motion imagery, 45, 91, 96  
Motion Imagery Standards Board (MISB), 90, 91, 107  
MPEG-2, 91  
multirotor platform, 42

**N**

nadir, 41, 70, 72  
National Imagery Interpretability Rating Scale (NIIRS), 5, 96–100, 103  
National Institute of Standards and Technology (NIST), 9  
National Television Systems Committee (NTSC), 93–95  
near-infrared (NIR), 5, 11  
noise, 53–56, 76–79, 122–125  
noise equivalent bandwidth, 56, 78  
noise equivalent irradiance (NEI), 2, 57, 58  
noise equivalent power (NEP), 53,  
noise equivalent radiance (NEL), 54,

noise equivalent reflectance  
  difference ( $NE\Delta\rho$ ), 58, 77  
noise equivalent spectral radiance  
  (NESR), 56  
noise equivalent temperature  
  difference (NETD), 76, 79  
noise voltage, 77, 122  
non-uniformity correction (NUC),  
  73, 125  
Normalized Difference Vegetation  
  Index (NDVI), 2, 48  
numerical integration, 14, 50

## O

optical invariant, 29

## P

path length, 106, 107  
path radiance, 105  
Phase Alternate Line (PAL), 93–95  
photon noise, 80, 123, 124  
photoresponse nonuniformity  
  (PRNU), 125  
pitch, 71  
pixel, 23  
Planck equation, 32, 36,  
platform, 3, 65–68  
Predator, 3, 4, 66  
probability of detection, 69, 100  
probability of identification, 100  
probability of recognition, 100,  
  102–103  
progressive scan, 92–94

## Q

quantization noise, 124

## R

radian, 23  
radiance, 27, 28  
radiance invariance, 28  
radiant exitance, 32  
radiant intensity, 33

radiant power, 34  
radiative transfer, 29,  
radiative transfer code, 104, 105  
radiator, 13  
radiometry, 9  
Raven, 4, 66  
reconnaissance, 2, 5, 67  
reflection, 9–11, 15  
relative azimuth angle, 41  
relative elevation angle, 41  
resistance, 118–121  
resolution, 47, 59  
responsivity, 53, 112  
roll angle, 91  
rolling scan, 92,  
root-mean-square (rms), 53

## S

sensor, 3, 9  
short-wave infrared (SWIR), 5, 11  
shot noise, 122  
size, weight, and power (SWaP), 5,  
  45, 67  
slant range, 45  
Society of Motion Picture and  
  Television Engineers (SMPTE), 91  
spectral irradiance, 34  
spectral radiance, 27, 34  
spectral radiant intensity, 34  
spectrum, 4, 5, 9  
standard definition (SD), 5  
Stefan–Boltzmann law, 13  
steradian, 25  
surveillance, 2, 5, 67, 134  
swarm, 67  
synthetic aperture radar (SAR),  
  3, 9, 67

## T

target transform probability  
  function (TTPF), 102  
target wheel, 82  
thermal equilibrium, 16, 17

thermal noise, *see* Johnson noise  
thermalization loss, 111, 112  
throughput, 29  
traceability, 9

**U**

uncooled thermal microbolometer, 73  
unmanned aerial vehicle (UAV), 1–6

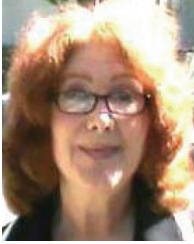
**V**

V-NIIRS, 5, 96  
vertical blanking, 94  
video, 91  
voltage responsivity, 120

**W**

Wien displacement law, 12, 14, 75





**Barbara Grant** received a B. A. in Mathematics from San Jose State University in 1983 and a M. S. in Optical Sciences from The University of Arizona in 1989. Her career spans more than three decades and has included employment with Lockheed Martin and NASA contractors, as well as two decades of self-employment. Her interests include imagery analysis, radiometric systems, remote sensing, and calibration. She teaches professional engineers and scientists at meetings of SPIE, through the Optical Engineering and Optical Instrument Design Program at University of California-Irvine Extension, and through commercial firms and government agencies. This book is her third for SPIE Press, the others being *Field Guide to Radiometry* (2011) and *The Art of Radiometry* (2010), which she co-authored with the late Jim Palmer. A lifelong student of the art of rhetoric, she trains professionals in public speaking as well as in science.