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# Basics of Image Processing Formulas

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# List of 17 Basics of Image Processing Formulas

## Basics of Image Processing

### 1) Band Loads Associated with Principle Components

$$\text{fx } R_{kp} = a_{kp} \cdot \frac{\sqrt{\lambda_p}}{\sqrt{\text{Var}_k}}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$\text{ex } 0.968246 = 0.75 \cdot \frac{\sqrt{5}}{\sqrt{3}}$$

### 2) Bilinear Interpolation

$$\text{fx } V_{x,y} = A \cdot X + B \cdot Y + C \cdot X \cdot Y + D$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$\text{ex } 207.85 = 3.5 \cdot 7 + 1.15 \cdot 6 + 4.15 \cdot 7 \cdot 6 + 2.15$$

### 3) Cumulative Frequency for Each Brightness Value

$$\text{fx } K_i = \frac{1}{n} \cdot \sum (x, 0, N_{\max}, (f[BV_i]))$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$\text{ex } 36 = \frac{1}{40\text{px}} \cdot \sum (x, 0, 17.48\text{W/m}^2, 80)$$



4) Digital Image Column 

$$fx \quad N = \frac{n_b}{M^2}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 0.061728 = \frac{5}{(9)^2}$$

5) Digital Image Row 

$$fx \quad M = \sqrt{\frac{n_b}{N}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 9.053575 = \sqrt{\frac{5}{0.061}}$$

6) Digital to Analog Converter 

$$fx \quad V_r = \frac{V}{2^n - \{b\} - 1}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 6.096774V = \frac{189V}{2^5 - 1}$$

7) Energy of Various Components 

$$fx \quad E = [hP] \cdot f$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$ex \quad 0.413567eV = [hP] \cdot 100THz$$



8) Image File Size 

$$fx \quad S_i = R_i \cdot \frac{B_d}{8000}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)


$$ex \quad 4.25\text{bits} = 1000\text{px} \cdot \frac{34\text{bits}}{8000}$$

9) Linear Combination of Expansion 

$$fx \quad f[x] = \sum (x, 0, k, \alpha_k \cdot \phi[x])$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 50 = \sum (x, 0, 4, 2 \cdot 5)$$

10) Number of Bits 

$$fx \quad n_b = (M^2) \cdot N$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 4.941 = ((9)^2) \cdot 0.061$$

11) Number of Grey Level 

$$fx \quad L = 2^N$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 1.043189 = 2^{0.061}$$



## 12) Probability of Intensity Level Occurring in given Image

$$fx \quad P_{zK} = \frac{N_k}{n}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 0.075 = \frac{3}{40px}$$

## 13) Quantization Step Size in Image Processing

$$fx \quad \Delta_b = \left(2^{R_b - \epsilon_b}\right) \cdot \left(1 + \frac{\mu_b}{2^{11}}\right)$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 443.1024kW/m^2 = \left(2^{21dB - 2.245}\right) \cdot \left(1 + \frac{3.24}{2^{11}}\right)$$

## 14) Rejection of Image Frequency

$$fx \quad CSP = \left(1 + Q^2 \cdot \rho^2\right)^{0.5}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 300.0017 = \left(1 + (20)^2 \cdot (15)^2\right)^{0.5}$$

## 15) Run-Length Entropy of Image

$$fx \quad H_{RL} = \frac{H_0 + H_1}{L_0 + L_1}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 0.044262J/K = \frac{0.25J/K + 2.45J/K}{30px + 31px}$$



16) Standard Deviation by Linear Function of Camera Exposure Time 

$$\text{fx } \Sigma = \zeta \cdot (I_p) \cdot \delta \cdot \left( \frac{1}{d^2} \right) \cdot (\tau_1 \cdot t + \tau_2)$$

Open Calculator 

$$\text{ex } 87.09663 = 1.75 \cdot (2.45\text{mA}) \cdot 6 \cdot \left( \frac{1}{(2.85\text{cm})^2} \right) \cdot (3.15 \cdot 6\mu\text{s} + 2.75)$$

17) Wavelet Coefficient 

$$\text{fx } (d_j[k]) = \int ((f_s[x]) \cdot (\psi_{j,k}[x]) \cdot x, x, 0, k)$$

Open Calculator 

$$\text{ex } 160 = \int (2.5 \cdot 8 \cdot x, x, 0, 4)$$



## Variables Used

- **A** Coefficient  $a$
- **$a_{kp}$**  Eigen Band  $k$  Component  $P$
- **B** Coefficient  $b$
- **$B_d$**  Bit Depth (*Bit*)
- **C** Coefficient  $c$
- **CSP** Customer Selling Price
- **d** Distance between Camera and the IRED (*Centimeter*)
- **D** Coefficient  $d$
- **$d_j[k]$**  Detail Wavelet Coefficient
- **E** Energy of Component (*Electron-Volt*)
- **f** Frequency (*Terahertz*)
- **$f_s[x]$**  Scaling Function Expansion
- **$f[BV_i]$**  Frequency of Occurrence of Each Brightness Value
- **$f[x]$**  Linear Combination of Expansion Functions
- **$H_0$**  Entropy Black Run Length (*Joule per Kelvin*)
- **$H_1$**  Entropy of White Run Length (*Joule per Kelvin*)
- **$H_{RL}$**  Run Length Entropy Image (*Joule per Kelvin*)
- **$I_p$**  Radiant Intensity (*Milliampere*)
- **k** Integer Index for Linear Expansion
- **$K_i$**  Cumulative Frequency for Each Brightness
- **L** Grey Level Image
- **$L_0$**  Average Black Run Length (*Pixel*)



- $L_1$  Average White Run Length (Pixel)
- $M$  Digital Image Row
- $n$  Total Number of Pixels (Pixel)
- $N$  Digital Image Column
- $n_b$  Number of Bits
- $N_k$  Intensity Occurs in Image
- $N_{max}$  Maximum Brightness Value (Watt per Square Meter)
- $P_{ZK}$  Probability of Intensity
- $Q$  Quality Factor Image
- $R_b$  Nominal Dynamic Range (Decibel)
- $R_i$  Image Resolution (Pixel)
- $R_{kp}$  K Band Loads with P Principle Components
- $S_i$  Image File Size (Bit)
- $t$  Camera Exposure Time (Microsecond)
- $V$  Reference Voltage Image (Volt)
- $V_r$  Digital to Analog Converter Resolution (Volt)
- $V_{x,y}$  Bilinear Interpolation
- $Var_k$  Band Variance Matrix
- $X$  X Co-ordinate
- $Y$  Y Co-ordinate
- $\alpha_k$  Real Valued Expansion Coefficients
- $\delta$  Model Behaviour Function
- $\Delta_b$  Quantization Step Size (Kilowatt per Square Meter)
- $\epsilon_b$  Bits Allotted Exponent Number
















- $\zeta$  Model Function
- $\lambda_p$  Pth Eigenvalue
- $\mu_b$  Bits Allotted to Mantissa Number
- $\rho$  Rejection Constant Image
- $\Sigma$  Standard Deviation
- $\tau_1$  Model Coefficient 1
- $\tau_2$  Model Coefficient 2
- $\varphi[\mathbf{x}]$  Real Valued Expansion Functions
- $\psi_{j,k}[\mathbf{x}]$  Wavelet Expansion Function



## Constants, Functions, Measurements used

- **Constant:** [hP], 6.626070040E-34  
*Planck constant*
- **Function:** **int**, int(expr, arg, from, to)  
*The definite integral can be used to calculate net signed area, which is the area above the x -axis minus the area below the x -axis.*
- **Function:** **sqrt**, sqrt(Number)  
*A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- **Function:** **sum**, sum(i, from, to, expr)  
*Summation or sigma ( $\Sigma$ ) notation is a method used to write out a long sum in a concise way.*
- **Measurement:** **Length** in Centimeter (cm)  
*Length Unit Conversion* 
- **Measurement:** **Time** in Microsecond ( $\mu$ s)  
*Time Unit Conversion* 
- **Measurement:** **Electric Current** in Milliampere (mA)  
*Electric Current Unit Conversion* 
- **Measurement:** **Energy** in Electron-Volt (eV)  
*Energy Unit Conversion* 
- **Measurement:** **Frequency** in Terahertz (THz)  
*Frequency Unit Conversion* 
- **Measurement:** **Data Storage** in Bit (bits)  
*Data Storage Unit Conversion* 
- **Measurement:** **Electric Potential** in Volt (V)  
*Electric Potential Unit Conversion* 



- **Measurement: Sound** in Decibel (dB)  
*Sound Unit Conversion* 
- **Measurement: Resolution** in Pixel (px)  
*Resolution Unit Conversion* 
- **Measurement: Entropy** in Joule per Kelvin (J/K)  
*Entropy Unit Conversion* 
- **Measurement: Intensity** in Watt per Square Meter ( $W/m^2$ ), Kilowatt per Square Meter ( $kW/m^2$ )  
*Intensity Unit Conversion* 



## Check other formula lists

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