Errata for
Basic Radar Analysis, 2nd ed.

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Chapter 5

- On page 96, at bottom of page insert paragraph:

We will continue our example by adding atmospheric loss. We assume the L-band radar is a long-range search radar that operates out to about 500 km. Because of its long operating range, we assume the elevation angles of interest are in the range of 1 degree. With this, the two-way atmospheric attenuation at 500 km will be about 1.8 dB (see *Figure 5.7*). At shorter ranges it will be less. For example, at 200 km, the two-way attenuation will be about 1.6 dB. We will use a compromise value of 1.7 dB.

- On page 103, Table 5.9, under Taylor weighting. The over lines should be over the *n*, not to the right.
- On page 104, 3rd paragraph, Table 5.9 should be Table 5.7.

Chapter 7

- Code for MSCA CFAR function, Figure 7.21, and Figure 7.22 updated. Updated figures below:

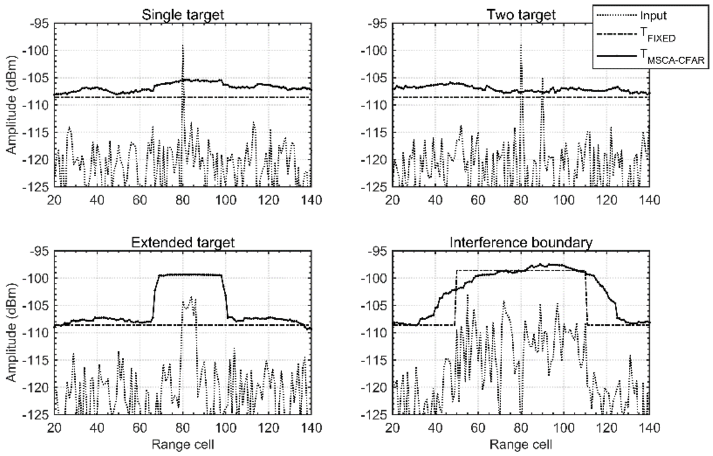


Figure 7.21 MSCA-CFAR example – single run.

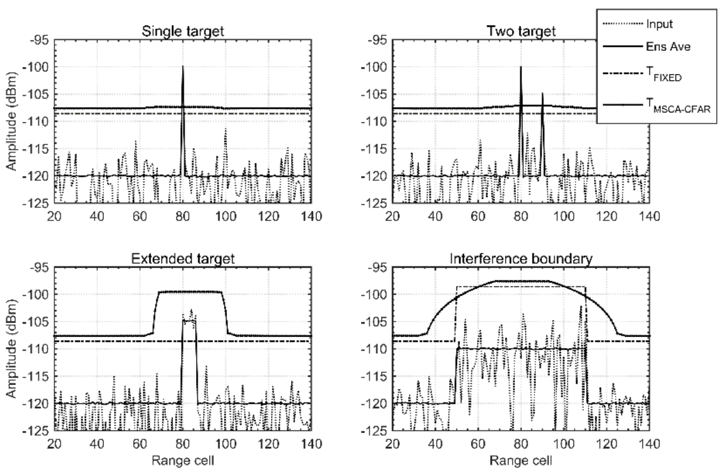


Figure 7.22 MSCA-CFAR example – 2000 ensembles.

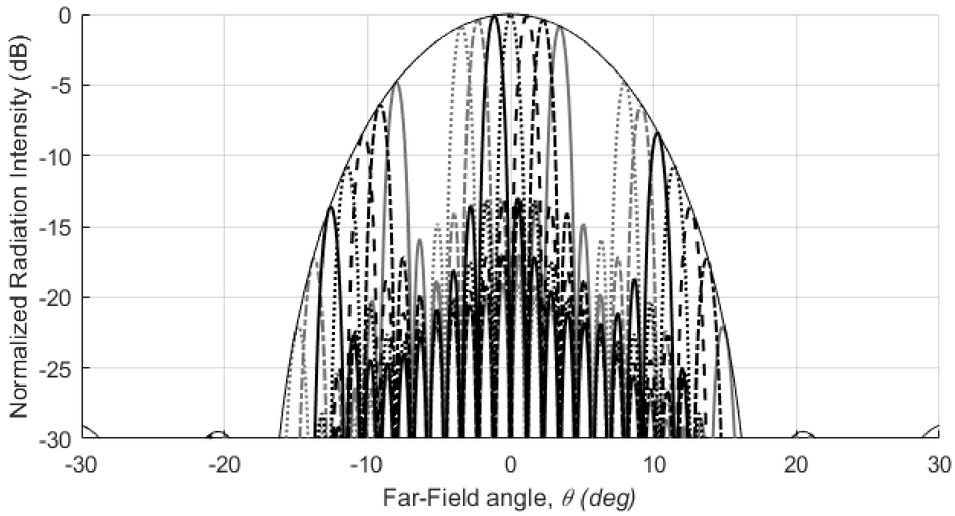
- On page 200, exercise numbers 5 and 6 should not be duplicated.

Chapter 8

- On page 224: The first problem is not in line with the other problems (not all are left-justified)

Chapter 14

- On page 446, 447: The first problem is not in line with the other problems (not all are left-justified)
- On page 433, Figure 14.18 should be:



Chapter 19

- On page 539, Equation (19.25), which is missing a G_{SCR} in numerator, should be

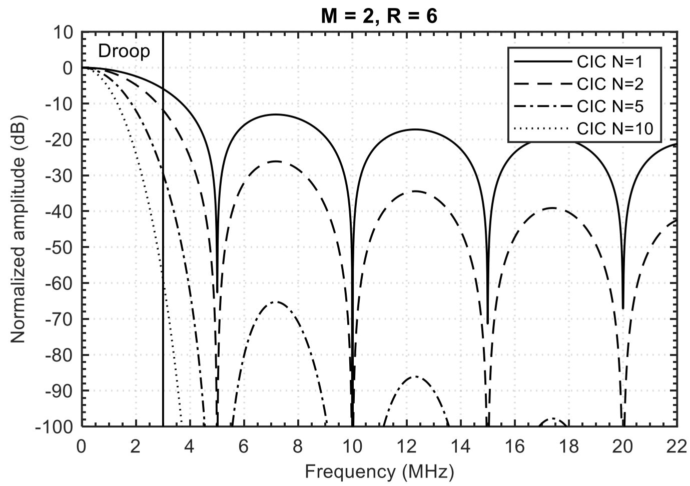
$$I_{scr} = \frac{G_{SCR}G_{SNR}P_{ADC}}{G_{SNR}P_{ADC} + G_{SCR}P_{ADC}\Phi_0 B + G_{SCR}P_{NADC}/(\tau_p F_s)}$$
$$= \frac{G_{SCR}G_{SNR}P_{ADC}}{G_{SNR}P_{ADC} + G_{SCR}P_{ADC}\Phi_0/\tau_p + G_{SCR}P_{NADC}/(\tau_p F_s)}$$

Chapter 22

- On page 584, 2nd from last paragraph, .2, 3 should be [2, 3].
- On page 614, Equation (22.52), which has typos on second line, should be

$$OIP3_C = OIP3_2 - 10\log\left(1 + \frac{1}{G_2}\cdot\frac{OIP3_2}{OIP3_1}\right)$$
$$= 18.5 - 10\log\left(1 + \frac{1}{0.282}\cdot\frac{0.0708}{0.501}\right)$$
$$= 16.74 \text{ dBm}$$

- On page 632, Figure (22.26), in title, should be M = 2 not M=1.



- On page 652-654: The first problem is not in line with the other problems (not all are left-justified). Additionally, exercise numbering starts at 5 instead of 1.

Equation Chapter 1 Section 1EQUATION 10.35 CLARIFICATION/ERRATA – M. BUDGE – NOVEMBER 2020

In reviewing Equation 10.35 [1], we realized it was not correct. That equation is

$$\Im\left[\chi(\tau,f)\right]=\Im\left[\int_{-\infty}^{\infty}u(t)e^{j2\pi ft}v^*(t+\tau)d\tau\right]=\Im^*\left[u(\tau)e^{j2\pi f\tau}\right]\Im\left[v(\tau)\right] \tag{1}$$

where $\Im$ denotes the Fourier transform. The proper relation between the Fourier transforms is

$$\Im\left[\chi^*(\tau,f)\right]=\Im\left[\left(\int_{-\infty}^{\infty}u(t)e^{j2\pi ft}v^*(t+\tau)d\tau\right)^*\right]=\Im^*\left[u(\tau)e^{j2\pi f\tau}\right]\Im\left[v(\tau)\right]. \tag{2}$$

We now proceed to derive (2). We start by using the definition [1, Equation 10.34]

$$\chi(\tau,f)=\int_{-\infty}^{\infty}u(t)e^{j2\pi ft}v^*(t+\tau)dt\,. \tag{3}$$

When we take the conjugate of (3) we get

$$\chi^*(\tau,f)=\left(\int_{-\infty}^{\infty}u(t)e^{j2\pi ft}v^*(t+\tau)dt\right)^*=\int_{-\infty}^{\infty}u^*(t)e^{-j2\pi ft}v(t+\tau)dt\,. \tag{4}$$

We will make use of this extra step later. For now, we want to find the Fourier transform of $\chi^*(\tau, f)$.

We start by making the substitution $w(t) = u(t)e^{j2\pi ft}$. With that we have

$$\chi^*(\tau,f)=\int_{-\infty}^{\infty}w^*(t)v(t+\tau)dt\,. \tag{5}$$

We next form the Fourier transform of $\chi^*(\tau, f)$ as

$$\Im\left[\chi^*(\tau,f)\right]=\int_{-\infty}^{\infty}\chi^*(\tau,f)e^{-j2\pi\theta\tau}d\tau=\int_{-\infty}^{\infty}\left(\int_{-\infty}^{\infty}w^*(t)v(t+\tau)dt\right)e^{-j2\pi\theta\tau}d\tau\,. \tag{6}$$

We make the change of variables $x = t + \tau$ and replace the τ variable of integration. This gives

$$\begin{aligned}\Im\left[\chi^*(\tau,f)\right]&=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}w^*(t)v(x)e^{-j2\pi\theta(x-t)}dt\,dx=\left(\int_{-\infty}^{\infty}w^*(t)e^{j2\pi\theta t}dt\right)\left(\int_{-\infty}^{\infty}v(x)e^{-j2\pi\theta x}dx\right)\\&=\left(\int_{-\infty}^{\infty}w(t)e^{-j2\pi\theta t}dt\right)^*\left(\int_{-\infty}^{\infty}v(x)e^{-j2\pi\theta x}dx\right)\end{aligned}. \tag{7}$$

We recognize the last two integrals as Fourier transforms. If we make the change of variables $t = \tau$ in the first integral and the change of variables $x = \tau$ in the second integral we get

$$\Im\left[\chi^*(\tau,f)\right]=\Im^*\left[w(\tau)\right]\Im\left[v(\tau)\right]. \tag{8}$$

We next replace $w(\tau)$ with $u(\tau)e^{j2\pi f\tau}$ to get

$$\Im\left[\chi^*(\tau,f)\right]=\Im^*\left[u(\tau)e^{j2\pi f\tau}\right]\Im\left[v(\tau)\right] \tag{9}$$

which is the result indicated in (2).

We note that the error indicated in this paper does not affect the final formulation of the ambiguity function. Indeed, we have

$$\left|\chi(\tau,f)\right|^2=\left|\chi^*(\tau,f)\right|^2 \tag{10}$$

which means it doesn't matter whether we use $\chi(\tau, f)$ or $\chi^*(\tau, f)$ to compute the ambiguity function. The advantage of using $\chi^*(\tau, f)$ is that it makes the use of Fourier transforms easier to implement. Had we attempted to use Fourier transforms to compute $\chi(\tau, f)$, the Fourier transform notation would have been somewhat cumbersome. Indeed, we can write

$$\begin{aligned}\Im\left[\chi(\tau,f)\right]&=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}w(t)v^*(x)e^{-j2\pi\theta(x-t)}dt\,dx=\left(\int_{-\infty}^{\infty}w(t)e^{j2\pi\theta t}dt\right)\left(\int_{-\infty}^{\infty}v^*(x)e^{-j2\pi\theta x}dx\right)\\&=\left(\int_{-\infty}^{\infty}w(t)e^{j2\pi\theta t}dt\right)\left(\int_{-\infty}^{\infty}v(x)e^{j2\pi\theta x}dx\right)^*\end{aligned}. \tag{11}$$

With (11), we would need to interpret the integrals as inverse Fourier transforms, or as Fourier transforms as a function of $-\theta$. Both of these would be somewhat cumbersome.

REFERENCE

[1] Budge, Mervin C., Jr. and Shawn R. German, *Basic Radar Analysis – Second Edition*, Artech House, Norwood, MA, 2020.