

APPENDIX C

MATLAB[®] code for plotting far-field patternsListing C.1 Code for plotting far-field patterns on a constant θ plane

```

1 function polar_plot_constant_theta(phi,pattern_1,pattern_2, ...
    max_val, step_size, number_of_rings,...
3     line_style_1, line_style_2,constant_theta, ...
    legend_1,legend_2,scale_type)
5
6 % this function plots two polar plots in the same figure
7 plot_range = step_size * number_of_rings;
    min_val = max_val - plot_range;
9
10 hold on;
11 th = 0:(pi/50):2*pi; circle_x = cos(th); circle_y = sin(th);
    for mi = 1:number_of_rings
13         r = (1/number_of_rings) * mi;
            plot(r*circle_x,r*circle_y,':','color','k','linewidth',1);
15         text(0.04,r,[num2str(min_val+step_size*mi)],...
                'verticalalignment','bottom','color','k',...
17             'fontweight','demi','fontsize',10);
    end
19
20 r=[0:0.1:1];
21 for mi = 0:11
    th=mi*pi/6;
23     plot(r*cos(th),r*sin(th),':','color','k','linewidth',1);
    text(1.1*cos(th),1.1*sin(th),[num2str(30*mi)],...
25         'horizontalalignment','center','color','k',...
        'fontweight','demi','fontsize',10);
27 end
29
30 pattern_1(find(pattern_1 < min_val)) = min_val;
    pattern_1 = (pattern_1 - min_val)/plot_range;
31 pattern_2(find(pattern_2 < min_val)) = min_val;
    pattern_2 = (pattern_2 - min_val)/plot_range;
33
34 % transform data to Cartesian coordinates
35 x1 = pattern_1.*cos(phi);
    y1 = pattern_1.*sin(phi);
37
38 x2 = pattern_2.*cos(phi);
39 y2 = pattern_2.*sin(phi);

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41 % plot data on top of grid
p = plot(x1,y1,line_style_1,x2,y2,line_style_2,'linewidth',2);
43 text(1.2*cos(pi/4),1.2*sin(pi/4),...
    ['\theta = ' num2str(constant_theta) '^o'],...
    'color','b','fontweight','demi');
45 legend(p,legend_1,legend_2,'location','southeast');
47 text(-1, -1.1, scale_type,'fontsize',12);
text(1.02 * 1.1, 0.13 * 1.1,'\uparrow',...
49 'color','b','fontweight','demi');
text(1.08 * 1.1, 0.13 * 1.1,'\phi',...
51 'fontname','arial','color','b','fontweight','demi','fontsize',12);

53 if constant_theta == 90
    text(1.2, 0.06,'x','fontname','arial',...
    'color','b','fontweight','demi');
54 text(1.2, 0,'\rightarrow','color','b','fontweight','demi');
55 text(0.06,1.23,'y','fontname','arial',...
    'color','b','fontweight','demi');
57 text(0,1.23,'\uparrow','color','b','fontweight','demi');
text(1.2*cos(pi/4),1.18*sin(pi/4)-0.12,...
59 'xy plane','color','b','fontweight','demi');
end
61 axis([-1.2 1.2 -1.2 1.2]);
63 axis('equal');axis('off');
hold off;
65 set(gcf,'PaperPositionMode','auto');
set(gca,'fontsize',12);

```

Listing C.2 Code for plotting far-field patterns on a constant ϕ plane

```

1 function polar_plot_constant_phi(theta,pattern_1,pattern_2, ...
    max_val, step_size, number_of_rings,...
3     line_style_1, line_style_2,constant_phi, ...
    legend_1,legend_2,scale_type)
5
% this function plots two polar plots in the same figure
7 plot_range = step_size * number_of_rings;
min_val = max_val - plot_range;
9
hold on;
11 th = 0:(pi/50):2*pi; circle_x = cos(th); circle_y = sin(th);
for mi = 1:number_of_rings
13 r = (1/number_of_rings) * mi;
    plot(r*circle_x,r*circle_y,':','color','k','linewidth',1);
17 text(0.04,r,[num2str(min_val+step_size*mi)],...
    'verticalalignment','bottom','color','k',...
19 'fontweight','demi','fontsize',10);
end
21
r=[-1:0.1:1];
23 for mi = 3:8
    th=mi*pi/6;

```

```

25 plot(r*cos(th),r*sin(th),':','color','k','linewidth',1);
text(1.1*cos(th),1.1*sin(th),[num2str(30*(mi-3))],...
27 'horizontalalignment','center','color','k',...
'fontweight','demi','fontsize',10);
29 text(-1.1*cos(th),1.1*sin(th),[num2str(30*(mi-3))],...
'horizontalalignment','center','color','k',...
31 'fontweight','demi','fontsize',10);
end
33 text(0,-1.1,'180',...
'horizontalalignment','center','color','k',...
35 'fontweight','demi','fontsize',10);

37 pattern_1(find(pattern_1 < min_val)) = min_val;
pattern_1 = (pattern_1 - min_val)/plot_range;
39 pattern_2(find(pattern_2 < min_val)) = min_val;
pattern_2 = (pattern_2 - min_val)/plot_range;
41 % transform data to Cartesian coordinates
x1 = -pattern_1.*cos(theta+pi/2);
43 y1 = pattern_1.*sin(theta+pi/2);

45 x2 = -pattern_2.*cos(theta+pi/2);
y2 = pattern_2.*sin(theta+pi/2);
47
% plot data on top of grid
49 p = plot(x1,y1,line_style_1,x2,y2,line_style_2,'linewidth',2);
text(1.2*cos(pi/4),1.2*sin(pi/4),...
51 ['\phi = ' num2str(constant_phi) '^o'],...
'color','b','fontweight','demi');
53 legend(p,legend_1,legend_2,'location','southeast');
text(-1, -1.1, scale_type,'fontsize',12);
55 text(0.2,1.02,'\rightarrow','color','b','fontweight','demi');
text(0.2, 1.08,'\theta','fontname','arial','color','b',...
57 'fontweight','demi','fontsize',12);
text(-0.21,1.02,'\leftarrow','color','b','fontweight','demi');
59 text(-0.2, 1.08,'\theta','fontname','arial','color','b',...
'fontweight','demi','fontsize',12);
61
if constant_phi == 0
63 text(1.2,0.06,'x','fontname','arial','color','b','fontweight','demi');
text(1.2,0,'\rightarrow','color','b','fontweight','demi');
65 text(0.06,1.23,'z','fontname','arial','color','b','fontweight','demi');
text(0,1.23,'\uparrow','color','b','fontweight','demi');
67 text(1.2*cos(pi/4),1.18*sin(pi/4)-0.12,'xz plane',...
'color','b','fontweight','demi');
69 end
if constant_phi == 90
71 text(1.2,0.06,'y','fontname','arial','color','b','fontweight','demi');
text(1.2, 0,'\rightarrow','color','b','fontweight','demi');
73 text(0.06,1.23,'z','fontname','arial','color','b','fontweight','demi');
text(0,1.23,'\uparrow','color','b','fontweight','demi');
75 text(1.2*cos(pi/4),1.18*sin(pi/4)-0.12,'yz plane',...
'color','b','fontweight','demi');
77 end

```

```
axis([-1.2 1.2 -1.2 1.2]);  
79 axis('equal');axis('off');  
hold off;  
81 set(gcf,'PaperPositionMode','auto');  
set(gca,'fontsize',12);
```