무선 통신 공학 과제

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1. 과제 개요 및 요약

- Received power=[0.1, 0.4, 1, 1.5, 2] dB 이고 평균 전력=1dB 일 때, water-filling 을 이용하여 cutoff value 를 구하고 power allocation 그래프를 그림
- 평균 전력=2, 5, 10dB 일 때 위의 과정을 반복

2. 소스 코드

```
clear
%% received snr and total power budget
% r: vector of received powers
% Ptot: total power budget, positive quantity
r = [0.1, 0.4, 1, 1.5, 2];
Ptot = 1;
%% find optimal mu: Lagrange multiplier
M = 1e4;
mu = linspace(1e-15, 5, M);
P = max(1./mu - (1./r)', 0);
g = sum(log(1+P.*(repmat(r', 1, M)))) - mu.*(sum(P)-Ptot);
mu_opt = mu(g==min(g));
%% optimal power allocation = 1/mu_opt - 1/r
P_opt = max(1/mu_opt - 1./r, 0)
P_sum = sum(P_opt)
%% threshold: find gamma where 1/mu_opt=1/gamma
gamma = 0:0.001:10;
P_alloc = max(1/mu_opt - 1./gamma, 0);
idx = find(P_alloc==0);
gamma_cutoff = gamma(idx(end))
%% water-filling
figure(1)
clf
% plot 1/mu
yline(1/mu_opt, '-')
hold on
% plot 1/gamma
plot(gamma, 1./gamma, 'b')
% optimal power allocation for r
xline(r, 'r--')
for x = r
    if 1/mu_opt > 1/x
        plot([x x], [1/x, 1/mu_opt], '-k', 'linewidth', 1.4)
        text(x, (1/x+1/mu_opt)/2, num2str(1/mu_opt-1/x), ...
            'fontsize', 14, 'HorizontalAlignment', 'center')
    else
        text(x, 1/mu_opt, '0', 'fontsize', 14, 'HorizontalAlignment', 'center')
    end
end
xlim([0, max(r)+1])
ylim([0, 1/mu_opt+1])
hold off
grid on
title('Power Allocation: Water-Filling', ...
    strcat('Total Transmit Power:', num2str(P_sum)), ...
    'fontsize', 14)
```

3. 코드 실행 결과

소스코드에서 Ptot = 1, 2, 5, 10으로 변경해 가며 코드를 실행

1) 평균 전력=1dB

Threshold: 0.9470dB

Power allocation: [0, 0, 0.0553, 0.3886, 0.5553] dB

Power allocation 그래프: 아래와 같음

```
P_opt =

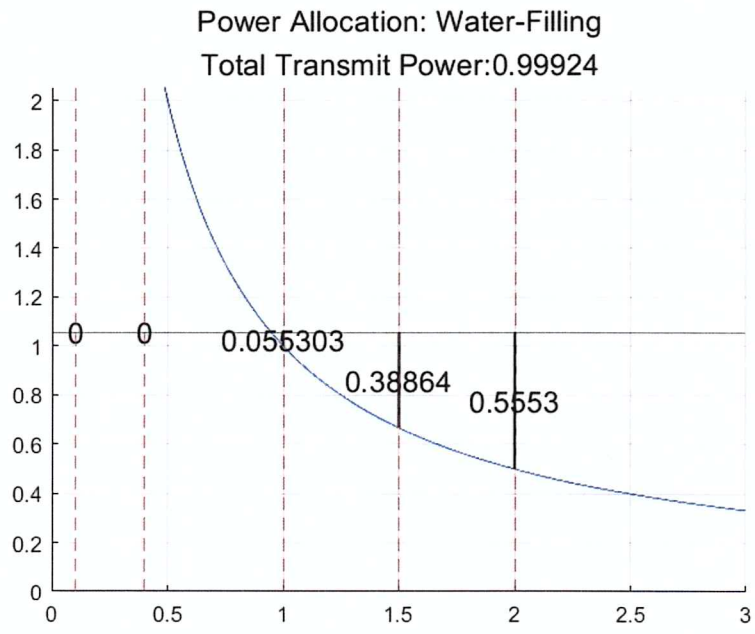
         0         0    0.0553    0.3886    0.5553


P_sum =

    0.9992


gamma_cutoff =

    0.9470
```



2) 평균 전력=2dB

Threshold: 0.7200dB

Power allocation: [0, 0, 0.3887, 0.7221, 0.8887] dB

Power allocation 그래프: 아래와 같음

```
P_opt =

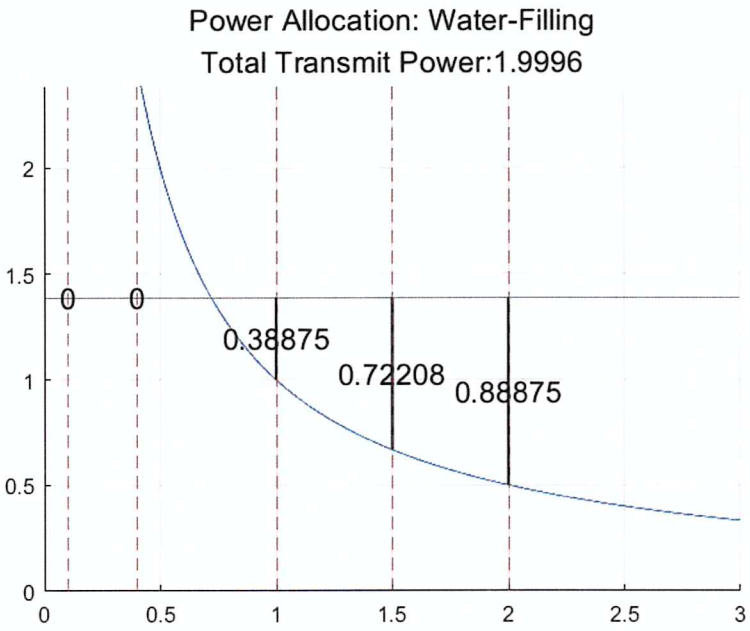
         0         0    0.3887    0.7221    0.8887


P_sum =

    1.9996


gamma_cutoff =

    0.7200
```



3) 평균 전력=5dB

Threshold: 0.4180dB

Power allocation: [0, 0, 1.3892, 1.7226, 1.8892] dB

Power allocation 그래프: 아래와 같음

```
P_opt =

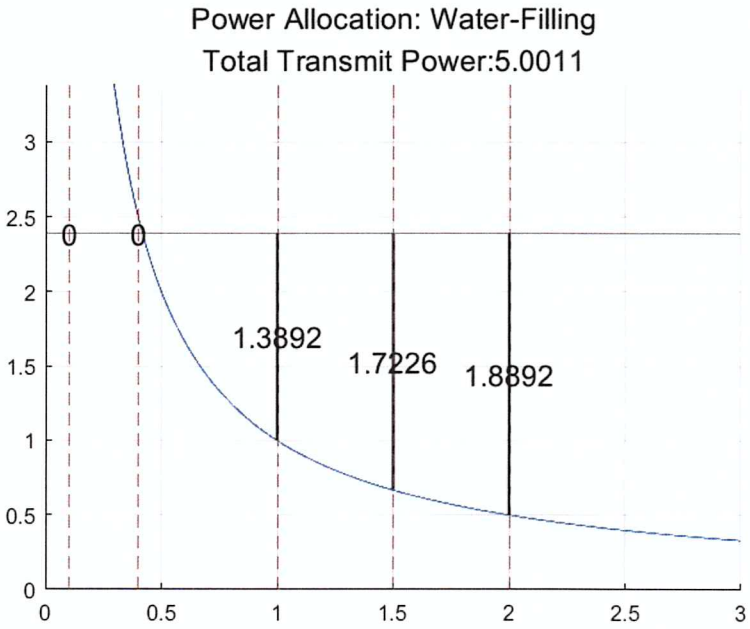
         0         0    1.3892    1.7226    1.8892


P_sum =

    5.0011


gamma_cutoff =

    0.4180
```



4) 평균 전력=10dB

Threshold: 0.2720dB

Power allocation: [0, 1.1694, 2.6694, 3.0027, 3.1694] dB

Power allocation 그래프: 아래와 같음

```
P_opt =

         0    1.1694    2.6694    3.0027    3.1694


P_sum =

   10.0108


gamma_cutoff =

    0.2720
```

