REPORT

Water-Filling Coding

과목명	무선통신공학
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□ Condition

○ **Calculate the optimal cutoff(γ_0) with the average power and cutoff given**

○ **given cutoff(γ_i, $(\overline{P}=1)$)**

$\gamma_1 = 0.1$
$\gamma_2 = 0.4$
$\gamma_3 = 1$
$\gamma_4 = 1.5$
$\gamma_5 = 2$

○ $\gamma_i = \overline{P} g_i / N_0 B$

- $\overline{P}$**(1, 2, 5, 10)에 따른 cufoff 계산**

○ **Assume that the p(γ_i) are uniform**

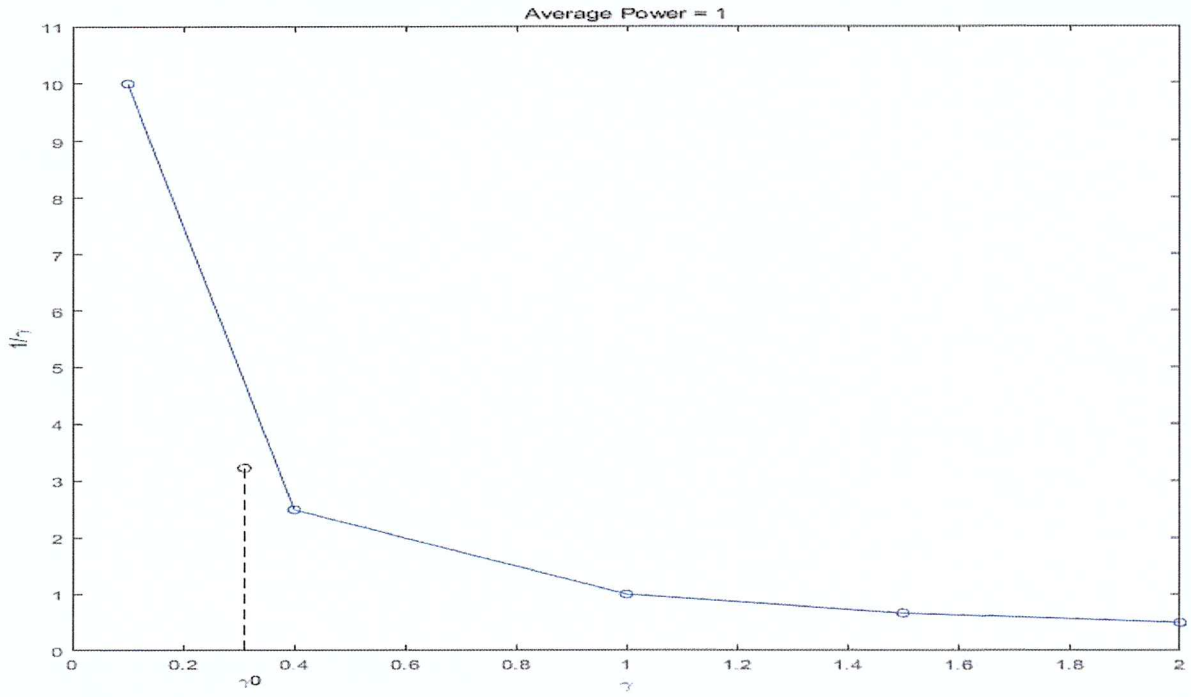
$p(\gamma_i) = 0.2$

○ $\sum_{\gamma_i \geq \gamma_0} (\frac{1}{\gamma_0} - \frac{1}{\gamma_i}) p(\gamma_i) = 1$

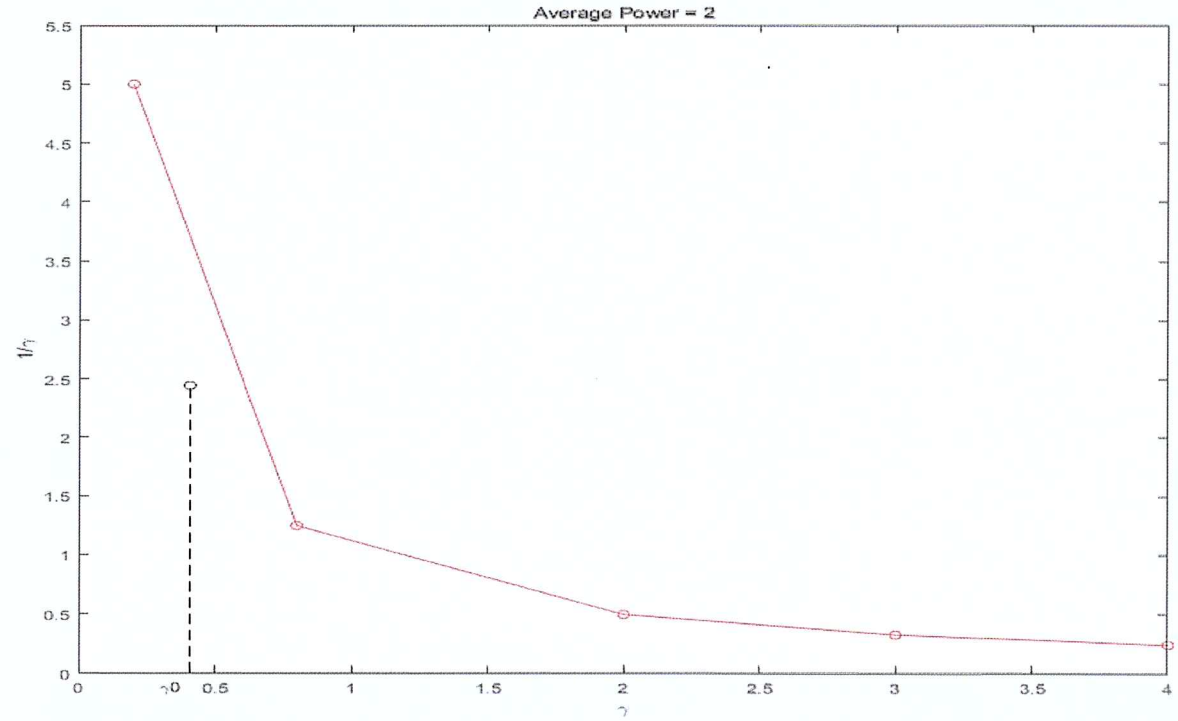
- **주어진 조건과 식을 이용하여** γ_0 **를 구하고, 가장 작은** γ_i **와 비교**
- γ_0**가 가장 작은** γ_i**보다 작거나 같을 때까지** γ_i**를 제외하여 다시 계산**

□ Cutoff for power allocation

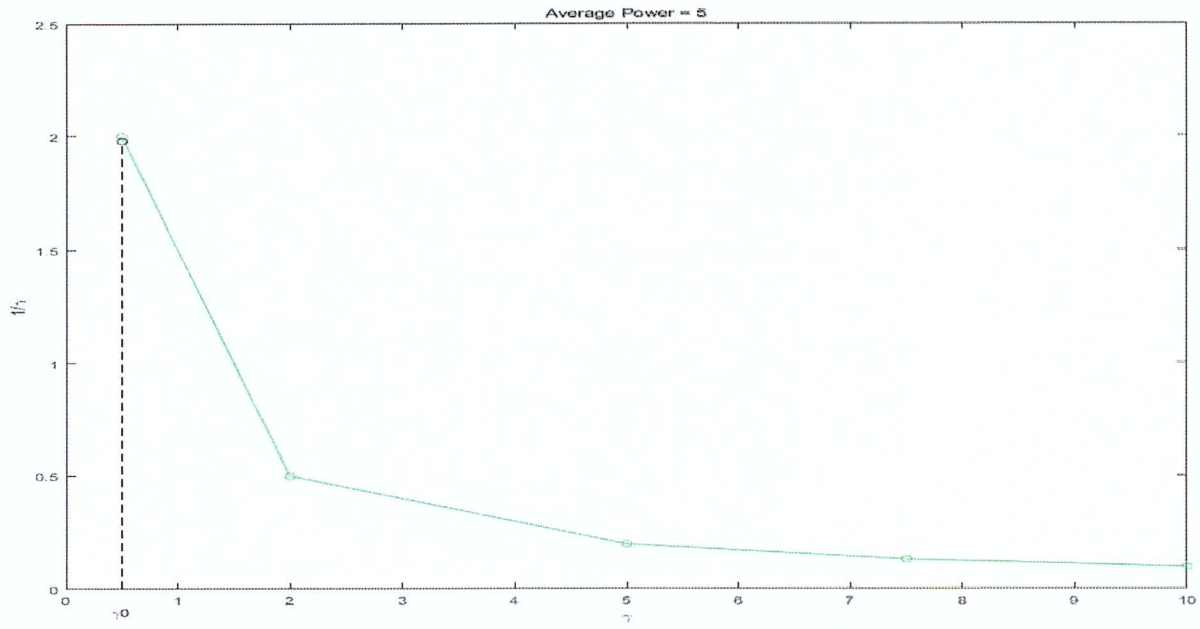
○ $\overline{P}$ = **1일 때,** $\gamma_0 \cong 0.3103$ $(\gamma_1 < \gamma_0 < \gamma_2)$



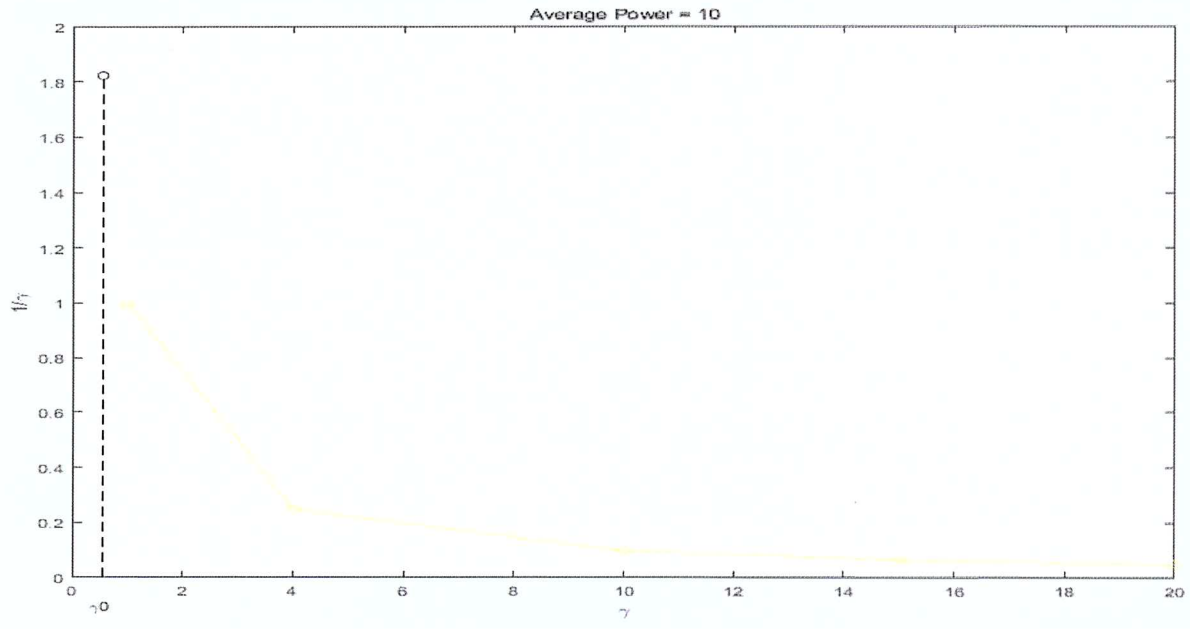
○ $\overline{P}$ = **2일 때,** $\gamma_0 \cong 0.4091$ $(\gamma_1 < \gamma_0 < \gamma_2)$



○ $\overline{P}$ = **5일 때,** $\gamma_0 \cong 0.5056\ (\gamma_1 < \gamma_0 < \gamma_2)$



○ $\overline{P}$ = **10일 때,** $\gamma_0 \cong 0.5488\ (< \gamma_1)$



□ $\overline{P}$ **가 증가할수록 power allocation을 위한 cutoff gain이 낮아짐을 확인할 수 있다.**

□ Matlab code

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%      Water-Filling    %%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

cutoff=[0.1 0.4 1 1.5 2];              % given cutoff, where avr pwr = 1
avr_pwr=[1 2 5 10];
p_gamma = 1/length(cutoff);            % assume uniform probability

for p=1:length(avr_pwr)
    cutoff(p,:)=cutoff(1,:).*avr_pwr(p); % cutoff by avr pwr(1,2,5,10)
end

i=1;
true=0;

for count=1:length(avr_pwr)            % solving for best cutoff(gamma0)
    while true==0
        temp=1;

        for n=i:length(cutoff)         % sigma opeartion
            temp = temp + p_gamma/cutoff(count,n);
        end

        temp_cutoff = p_gamma*(length(cutoff)-i)/temp;

        if temp_cutoff > cutoff(count,i)  % compare gamma0 to weakest channel
            i=i+1;
        else
            true=1;
            best_cutoff(count,:) = temp_cutoff;
        end
    end
    true = 0;
end
best_cutoff

subplot(411);
plot(cutoff(1,:),1./cutoff(1,:),'b-o');
hold
stem(best_cutoff(1),1./best_cutoff(1),'k--o');
axis([0 2 0 11]);
xlabel('\gamma'); ylabel('1/\gamma');
```

```
text(0.3,-0.5,'\gamma0');
title('Power = 1');

subplot(412);
plot(cutoff(2,:),1./cutoff(2,:),'r-o')
hold
stem(best_cutoff(2),1./best_cutoff(2),'k--o')
axis([0 4 0 5.5]);
xlabel('\gamma'); ylabel('1/\gamma');
text(0.3,-0.5,'\gamma0');
title('Power = 2');

subplot(413);
plot(cutoff(3,:),1./cutoff(3,:),'g-o')
hold
stem(best_cutoff(3),1./best_cutoff(3),'k--o')
axis([0 10 0 2.5]);
xlabel('\gamma'); ylabel('1/\gamma');
text(0.4,-0.1,'\gamma0');
title('Power = 5');

subplot(414);
plot(cutoff(4,:),1./cutoff(4,:),'y-o')
hold
stem(best_cutoff(4),1./best_cutoff(4),'k--o')
axis([0 20 0 2]);
xlabel('\gamma'); ylabel('1/\gamma');
text(0.3,-0.1,'\gamma0');
title('Power = 10');
```