# ESE 531 Recitation 12: Project 2 Overview

Plan: 1. Adaptive filtering

2. Project 2. Part A, B

1. Optimization:

Know: input, output (goal, objective)

Design: ① Structure / architecture

② Algorithm.

Reference: ① Lec 25

② On canvas: Files / project refs. / "Douglas"

Algorithm: Gradient Descent.

$$\min\left\{\left|\text{Goal} - \text{Output}\right|^2\right\}$$

$$\| \quad G \text{ (cost / loss function)}$$

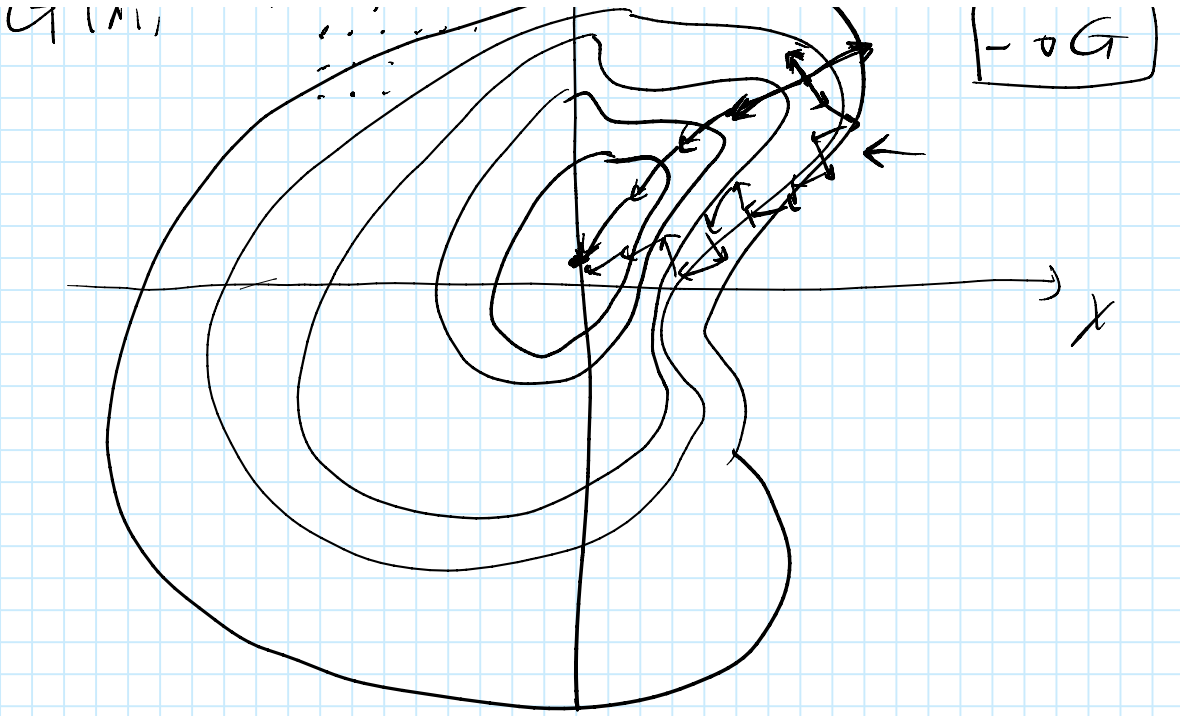
⇒ minimize $G$ ⇒ $\nabla G$

If $G(x, y)$

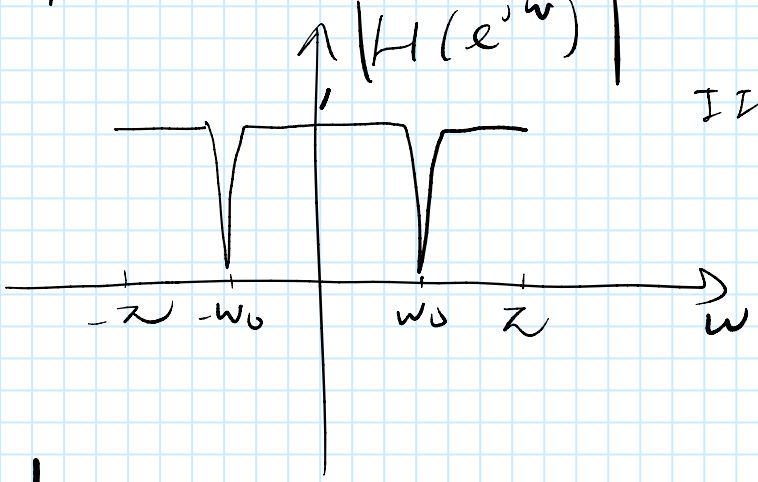
$G(x_1, \cdots, x_n)$


$$\nabla G = \hat{x}\frac{\partial G}{\partial x} + \frac{\partial G}{\partial y}\hat{y}$$

$-\nabla G$

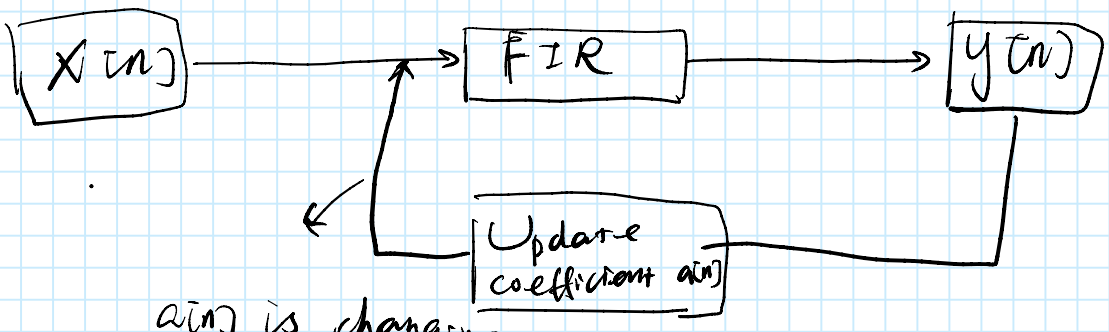



Part A: Adaptive notch filtering



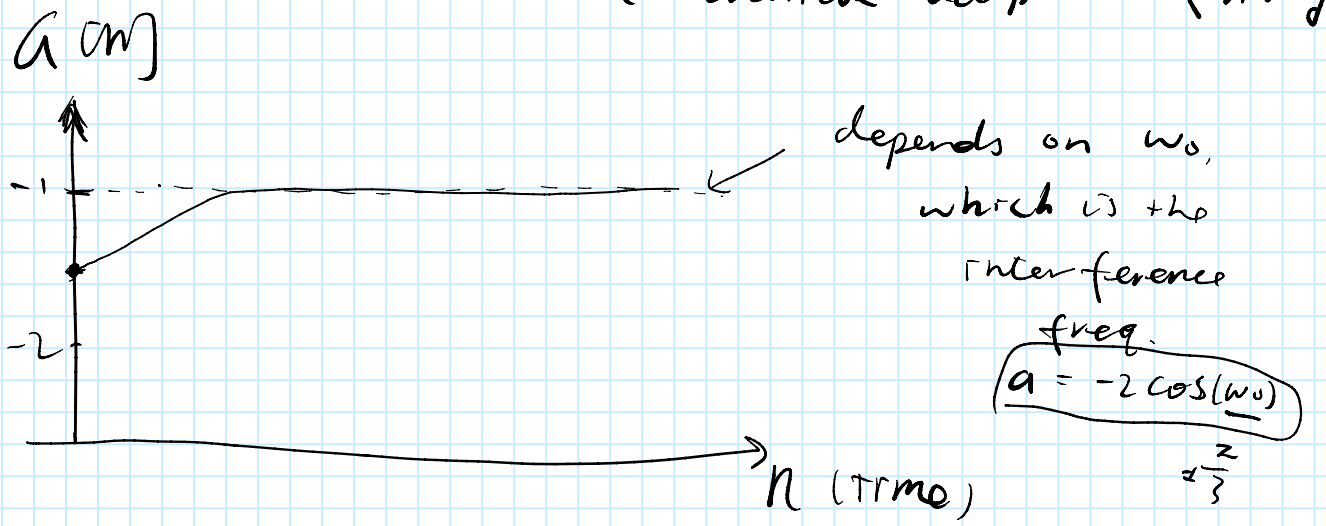

1. For FIR adaptive filters:

a is random at first




a[n] is changing over time => Feedback loop is how we achieve adaptive filtering

over time → feedback loop is how we achieve adaptive filtering




Algorithm: minimize $E(y[n])^2$

↳ $\boxed{a[n+1] = a[n] - \mu y[n] x[n-1]}$

↳ Update a in each iteration.

Notes:

① Strong interference.

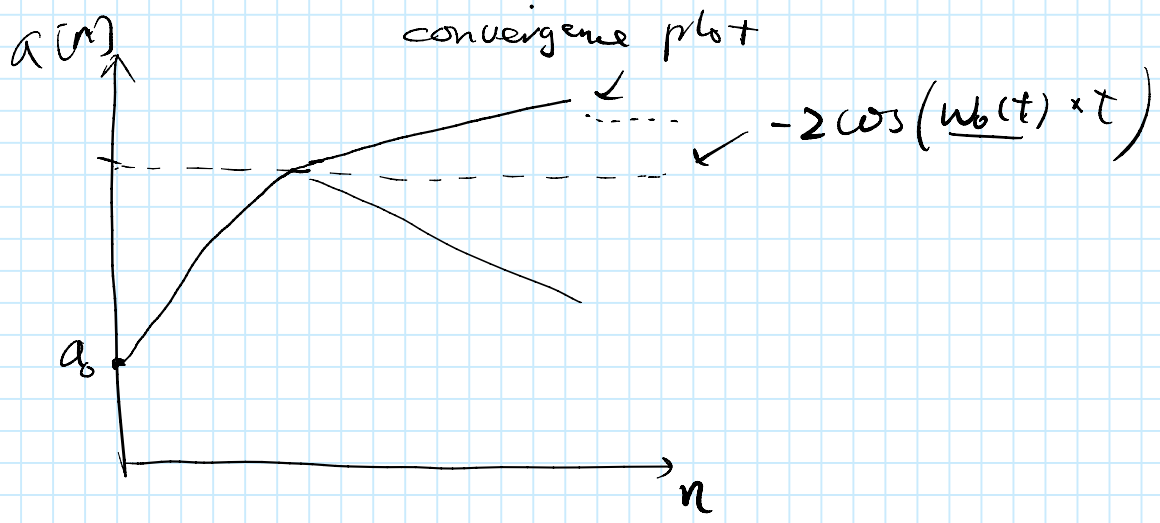
$$\frac{\text{Noise amplitude}}{\text{inf}[n]} \gg \frac{\text{signal}}{s[n]}$$

$$x[n] = \text{inf}[n] + s[n]$$

$$|\text{inf}[n]| \gg |s[n]|$$

② $\mu$. $\mu \ll 1$

2. Frequency of $\sin(n)$ is changing over time. Need to examine the tracking ability of adaptive notch filter.



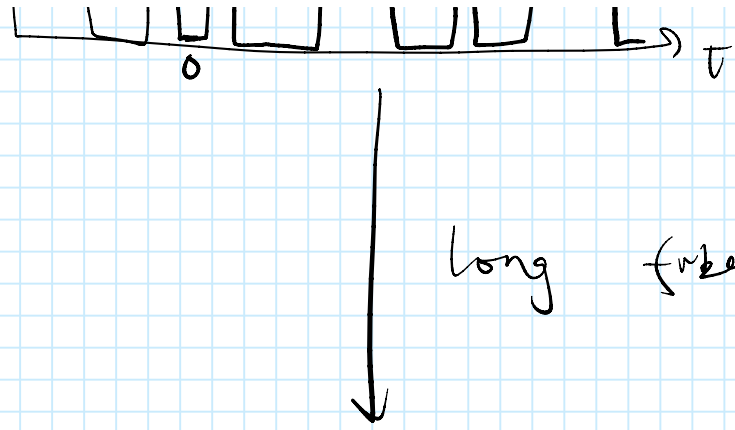

## Part B: Adaptive Equalization

Equalization: inverse of a system,

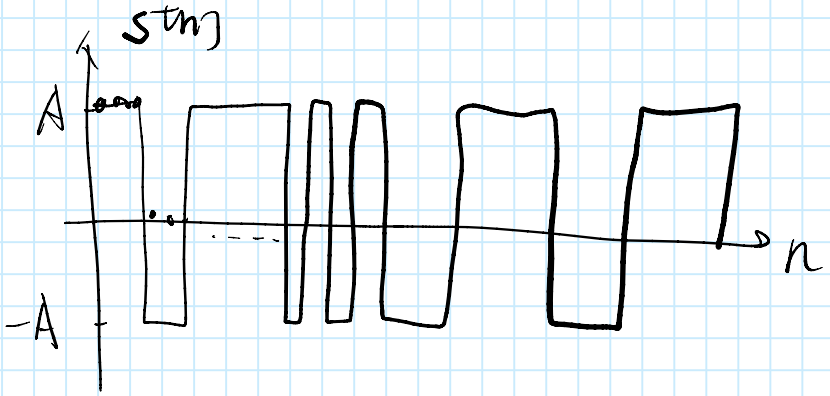
to equalize a system,

so that the output is a shifted version of the input.

One eg.: fiber communication across continents.




Use equalizer to equalize / inverse this distortion.




get $x[n]$ because distortion, instead of $s[n]$

↳ $x[n] = h[n] * s[n] + w[n]$

↓ represents the distortion from the transmission

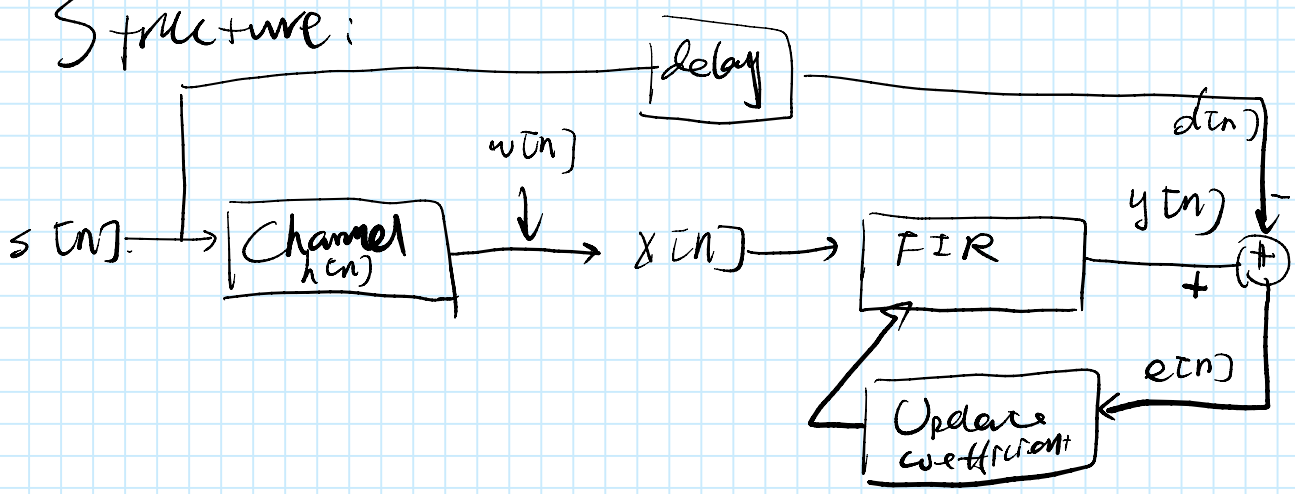
↓ represents the distortion from the transmission channel

Goal: plug $x[n]$ into our adaptive equalizer to get rid of the effects brought by $h[n]$ & $w[n]$

$$x[n] \longrightarrow s[n-nd]$$

↳ nd: time shift

Structure:




Algorithm:

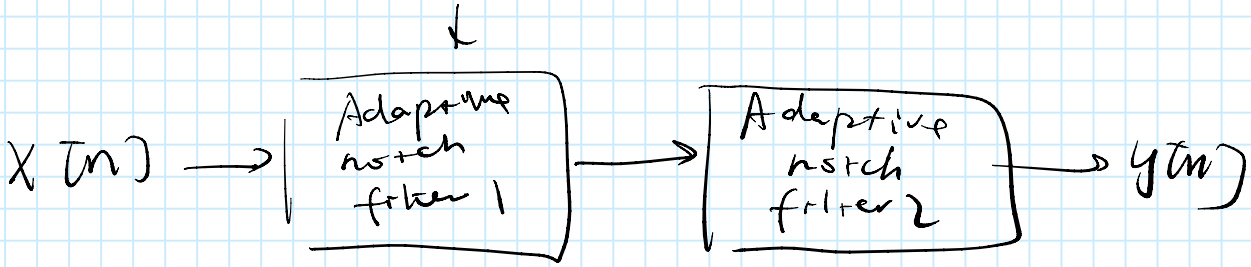
→ Go check out Section 6.5 "The LMS Algorithm" in Douglas.

→ Relevant Lec slides: Lec 25 P10-15 ✓

Update coefficient according to algorithm.

# Part C:

## 1. Cascaded Notch filters:

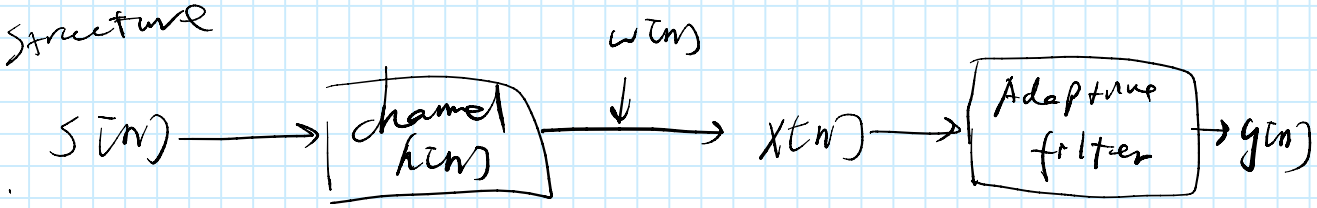



Two strong interference signals

$inf_1[n]$ $inf_2[n]$

## 2. Blind Equalization

Structure




Algorithm: new algorithm compared with that in part B.

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Check out grading rubrics for project 2 on Canvas when you write/submit your pdf.