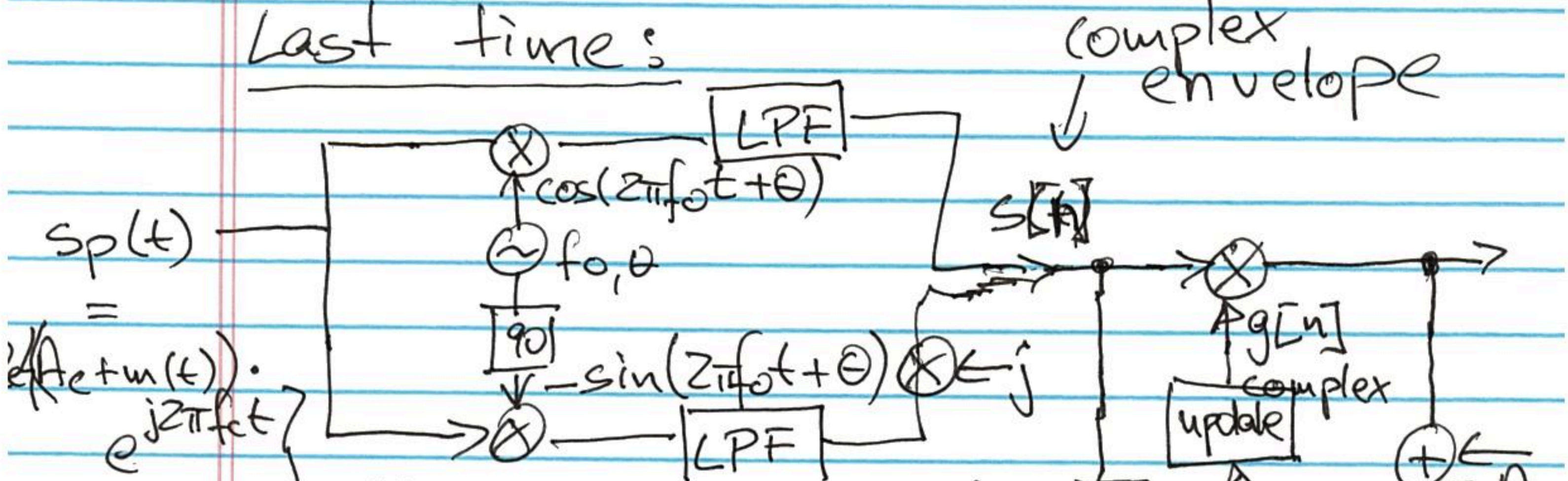
10/3/18

Adaptive Phase and Freq. Control

Last time:



$f_o \neq f_c$ freq. error
$\theta \neq 0$ phase error

Simplifications (last time):

- ignored $m(t)$ – assumed carrier only
- focused on phase error

Recall:

1. defined objective function

$$J(g) = |e[n]|^2$$
$$= |s[n]\cdot g[n] - A_c|^2$$

2. compute gradient

$$\nabla_g J = s^*[n]\cdot(\underbrace{s[n]\cdot g[n] - A_c}_{e[n]})$$

3. Update / Adaptation

$$g[n+1] = g[n] - \mu \cdot \nabla_g J(g) \Big|_{g=g[n]}$$

step size

want minimum of J

$$= g[n] - \mu \cdot s^*[n] \cdot \big(\underbrace{s[n]g[n] - A_c}_{e[n]}\big)$$

Assume:

~~$g[n]$~~ $s[n] = A \cdot e^{j\phi} \Rightarrow \hat{g} =$ phase error only

~~Find steady state of $g[n]$~~

Want: $s[n] \cdot \hat{g} = A_c$

$$\Rightarrow A \cdot e^{j\phi} \cdot \hat{g} = A_c$$

$$\Rightarrow \hat{g} = \frac{A_c}{A} \cdot e^{-j\phi}$$

Find steady state:

$$\underset{n+1}{\cancel{g[\infty]}} = \underset{n}{\cancel{g[\infty]}} - \mu \cdot A \cdot e^{-j\phi} \cdot \big(\underbrace{A \cdot e^{j\phi} \cdot g[\infty] - A_c}_{\text{must be } 0}\big)$$

$$\Rightarrow g[\infty] = \frac{A_c}{A} e^{-j\phi} = \hat{g}$$

1.) To deal with frequency offset:

- add update term that involves sum of errors

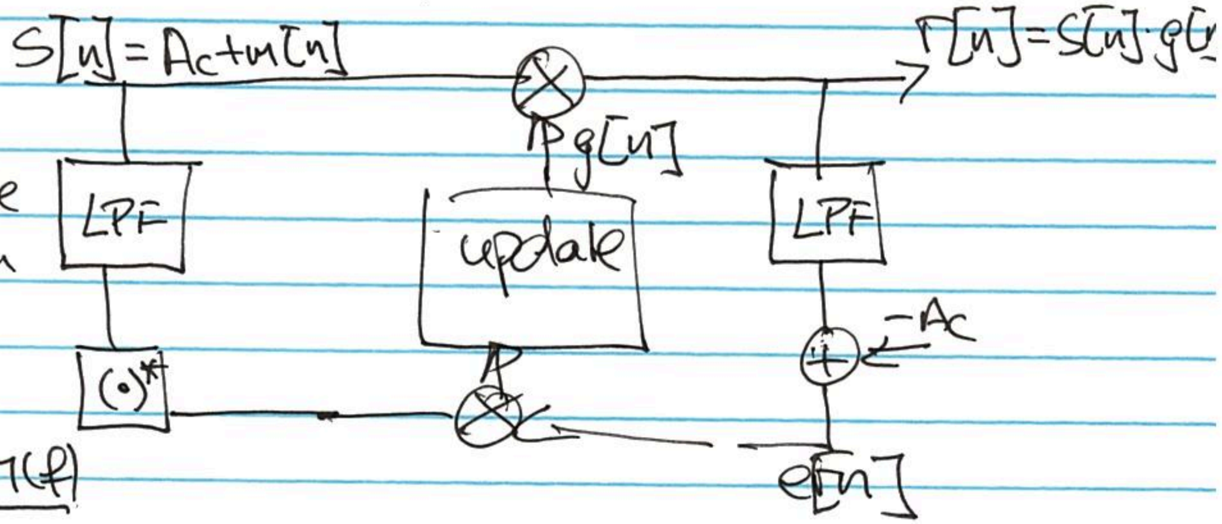
$$\Sigma[n] = \sum_{k=1}^{n} e[k] = \Sigma[n-1] + e[n]$$

→ update

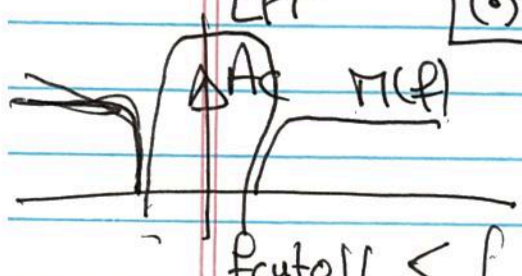
$$g[n+1] = g[n] - \mu \cdot s^*[n] \cdot e[n] - \eta \cdot s^*[n] \cdot \Sigma[$$

2.) To deal with carrier and $m(t)$:

Modify update circuit



LPF separate carrier from message



fcutoff < fmin of message