

Today

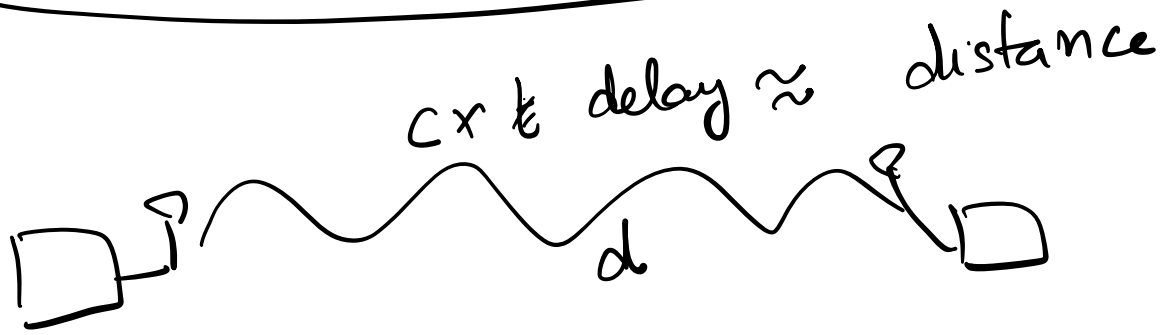
→ Distance estimation

→ Wireless Sensing.

→ Static vs. Dynamic Multipath

→ WiTrack & FMCW

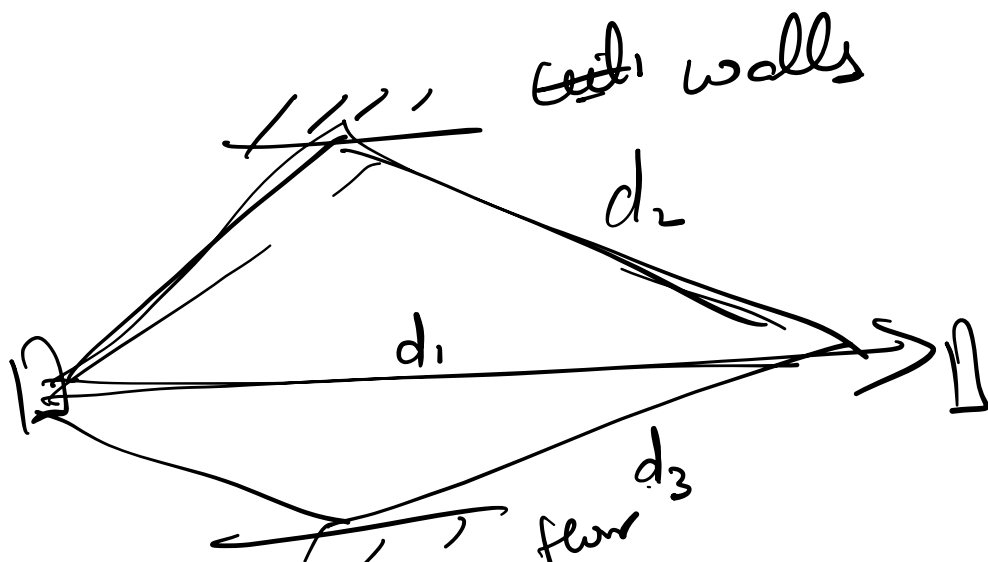
Time of Flight 1



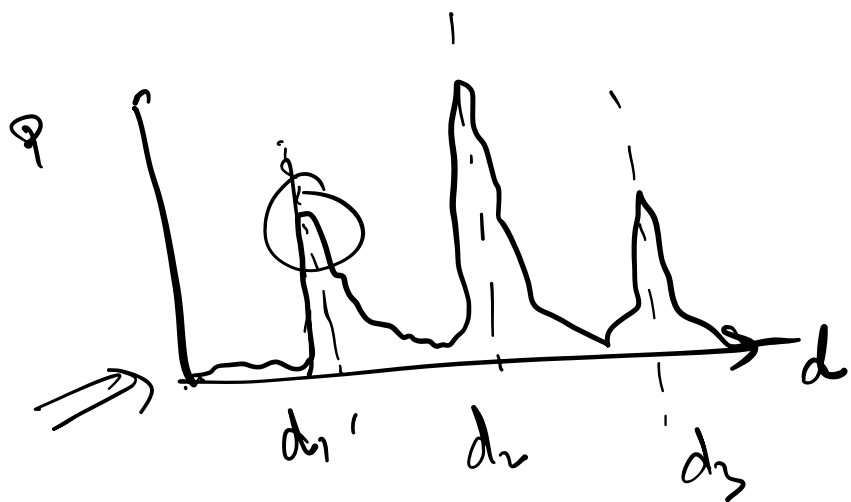
$$\angle h_1 = -\frac{2\pi}{\lambda_1} d \quad \text{mod } 2\pi$$

$$\angle h_2 = -\frac{2\pi}{\lambda_2} d \quad \text{mod } 2\pi$$

Multipath Effect



Multipath profile



$$h_{\lambda_1} = \alpha_1 e^{-j \frac{2\pi}{\lambda_1} d}$$

$$h_{\lambda_2} = \alpha_2 e^{-j \frac{2\pi}{\lambda_2} d}$$

$$h_{\lambda_1} = \sum_j \alpha_1^{(j)} e^{-j \frac{2\pi}{\lambda_1} d_j}$$

$$h_{\lambda_2} = \sum_j \alpha_2^{(j)} e^{-j \frac{2\pi}{\lambda_2} d_j}$$

$$h_{\lambda_k} = \sum_j \alpha_k^{(j)} e^{-j \frac{2\pi}{\lambda_k} d_j}$$

$$P(d) = \sum_k \left(h_{\lambda_k} e^{+j \frac{2\pi}{\lambda_k} d} \right)$$



$$h_{d_k} = \alpha_k e^{-j \frac{2\pi}{\lambda_k} d_k} \quad \downarrow$$

$$P(d) = \sum_k \alpha_k e^{-j \frac{2\pi}{\lambda_k} d_k} e^{+j \frac{2\pi}{\lambda_k} d} \quad \text{①}$$

$$= \sum_k \alpha_k \underbrace{e^{-j \frac{2\pi}{\lambda_k} (d_k - d)}}_{\downarrow 1}$$

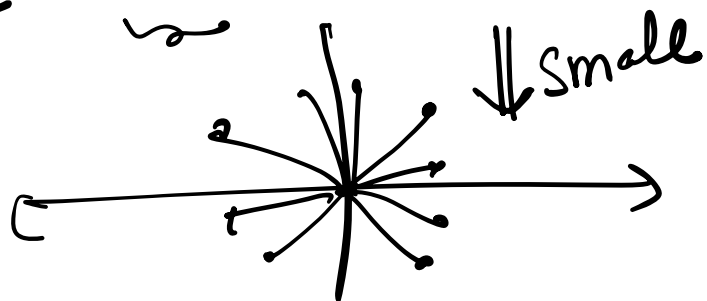
$$d_k = d$$

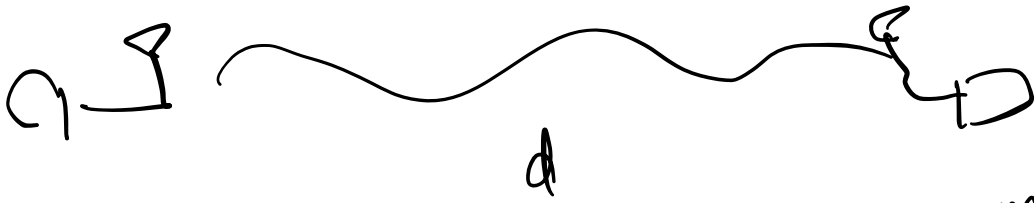
$$P(d_k) = \sum_k \alpha_k$$

$$d_k \neq d$$

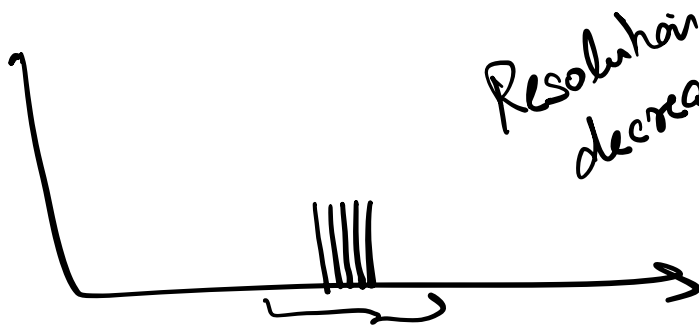
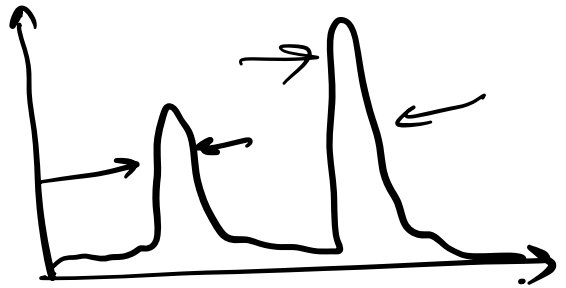
$$\sum_k \alpha_k e^{-j \frac{2\pi}{\lambda_k} (d_k - d)} \quad \underbrace{\hspace{2cm}}_{0.5}$$

$$\sum_k \alpha_k e^{-j \frac{2\pi}{\lambda_k} d_k}$$





accumulate phase.



Resolution decreases.

