Hybrid positioning algorithms
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Outline

- Research area
- Bayesian filtering
  - General formulation
  - Good filter?
  - Pros and cons
- Current research topics
  - Gaussian Mixture Filter (GMF)
  - Using restrictive information
Bayesian filtering in Hybrid Positioning

- GNSS
- GSM
- IMU
- WLAN

Measurements

- EKF
- GMF
- PF

Approximate solutions

- Optimal solutions

Motion model

- Position, Velocity, ...

...
Problem formulation

Initial state: \( x_0 \)

Motion model: \( x_{k+1} = f(x_k) + w_k \)

Measurement model: \( y_k = h(x_k) + v_k \)

The aim is to compute

\[
p(x_k | y_{1:k}) = \frac{ \underbrace{p(y_k | x_k)} \underbrace{p(x_k | y_{1:k-1})} } {\int p(y_k | x_k) p(x_k | y_{1:k-1}) \, dx_k} \]

current meas. state model and past meas. normalization
Good filter is:

**Accurate** estimates are accurate enough for personal positioning.

**Consistent** error estimates are accurate too.

**Robust** filter tolerates some modeling errors.

**Fast** can be computed in a portable terminal.
Pros and cons of some existing filters

**EKF:** Kalman filtering applied to *linearized* problem. EKF is *fast* and usually *accurate* but *not always consistent*.

**EKF2:** an elaboration of EKF that models nonlinearity better. EKF2 is *fast* and a bit more *accurate* than EKF but *not always consistent*.

**PF:** The Particle Filter based on *Monte Carlo* integration. PF is *slow* to compute but is otherwise almost *optimal* solution.
Current research topic: Gaussian Mixture Filter
Current research topic: Using restrictive information
Conclusion

Thank you for your attention!
Questions?