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Blind-spot Analysis using Stochastic Geometry

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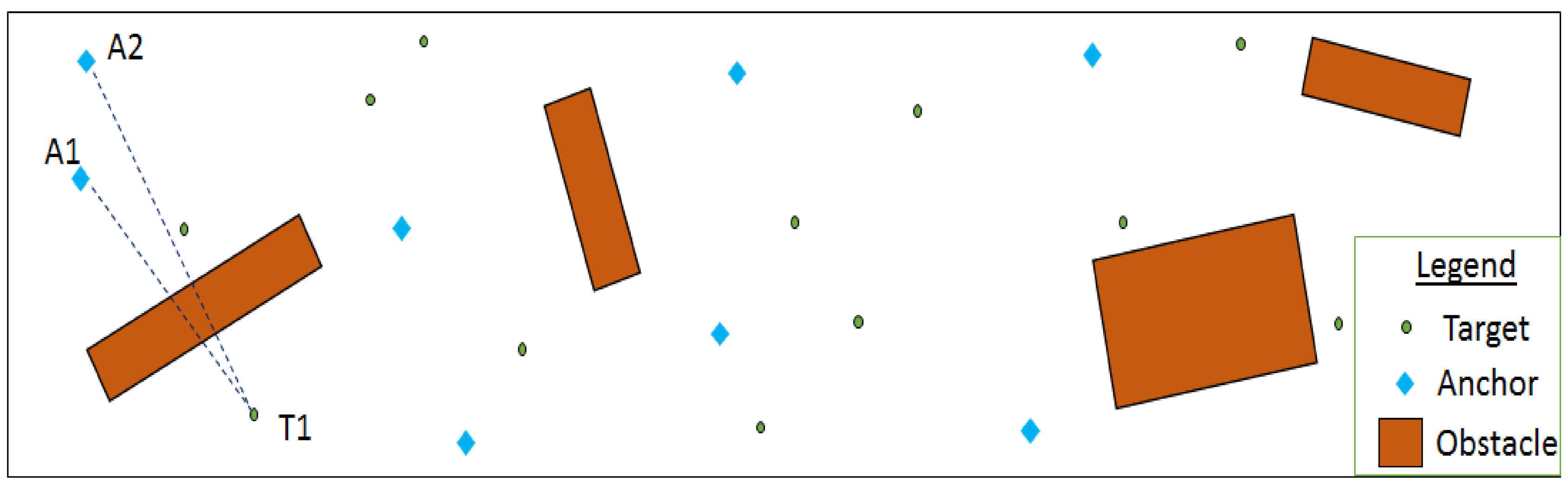
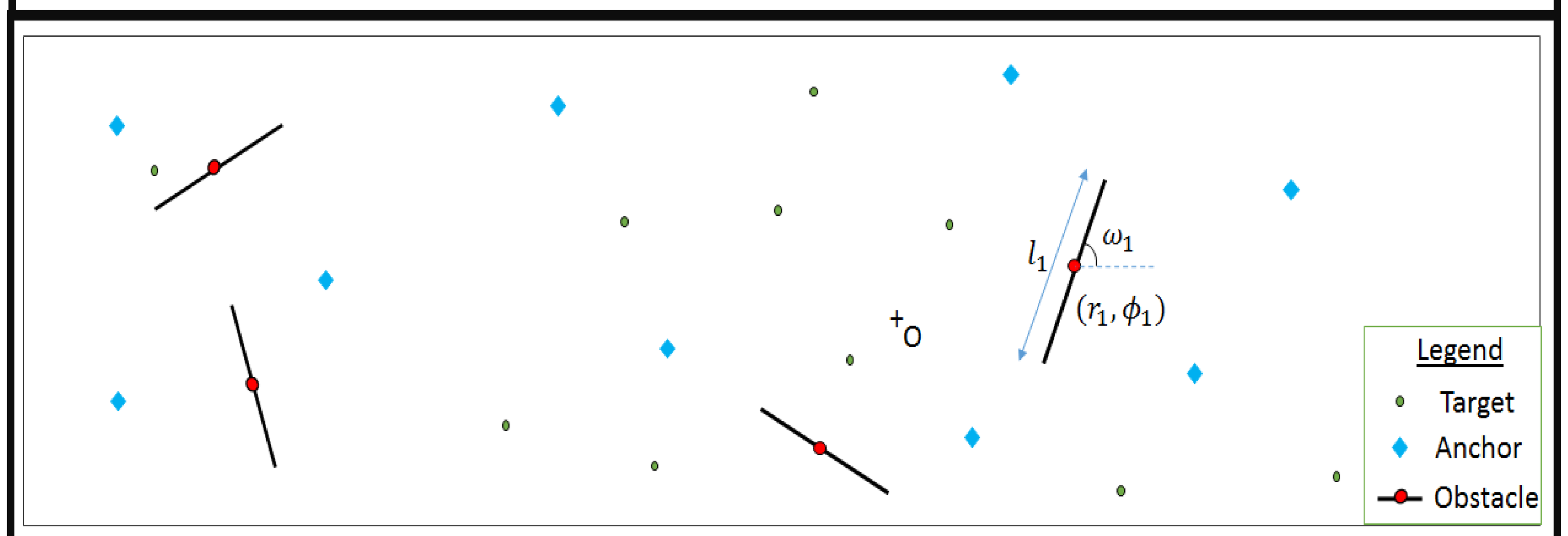
Motivation

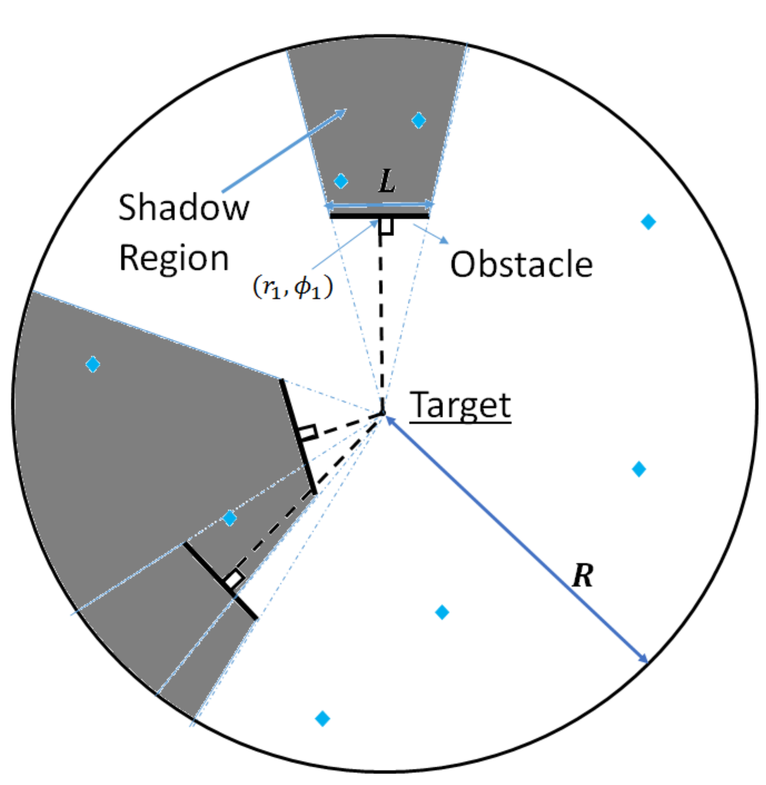


- Targets in environment
- LoS required to at least 3 anchors for localization
- Obstacles block LoS, cause blind-spots
- LoS blocking statistically dependent across links
- Design network satisfying P(blind-spot)$\leq \epsilon$

Stochastic Geometry Model



- i-th obstacle denoted by $(r_i, \phi_i, l_i, \omega_i)$
- (r_i, ϕ_i): Obstacle mid-point (polar coordinates)
- $l_i \in [0, L]$: Length; $\omega_i \in [0, \pi)$: Orientation
- $\{(r_i, \phi_i)\}$: Poisson point process (PPP) with intensity λ_0
- Anchors: PPP with intensity λ

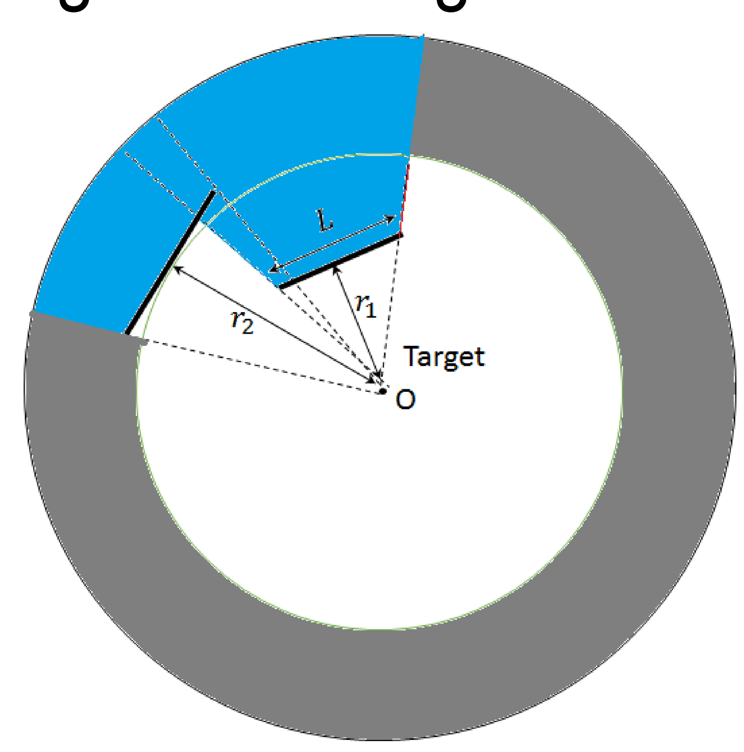


- PPP stationary, assume target at origin
- Anchors have power constraint
- Each obstacle induces shadow region
- Worst-case configuration

$$l_i = L,$$
$$\omega_i = \phi_i + \pi/2$$

Blind-spot Probability

- $P(B|A_v) = \exp(-\lambda A_v)(1 + \lambda A_v + \frac{(\lambda A_v)^2}{2})$
- B: Blind-spot event, A_v: Visible area (white region)
- Independent blocking: Evaluate $P(B|A_v)$ at $E[A_v]$
- Dependent blocking: Need p.d.f of A_v
- Difficult to characterize a realization of A_v for more than one obstacle
- Overlapping shadow regions



- Additional shadow region due to other obstacles a subset of grey region
- Quasi-independent blocking: assume independent blocking over grey region
- $A_v(\boldsymbol{r}^{(k)}, \boldsymbol{\phi}^{(k)})$ = Area of white region + $E[A_v]$(over grey region)
- Average over location of nearest 2 obstacles
- Models dependent blocking caused by nearby obstacles

Simulation Results

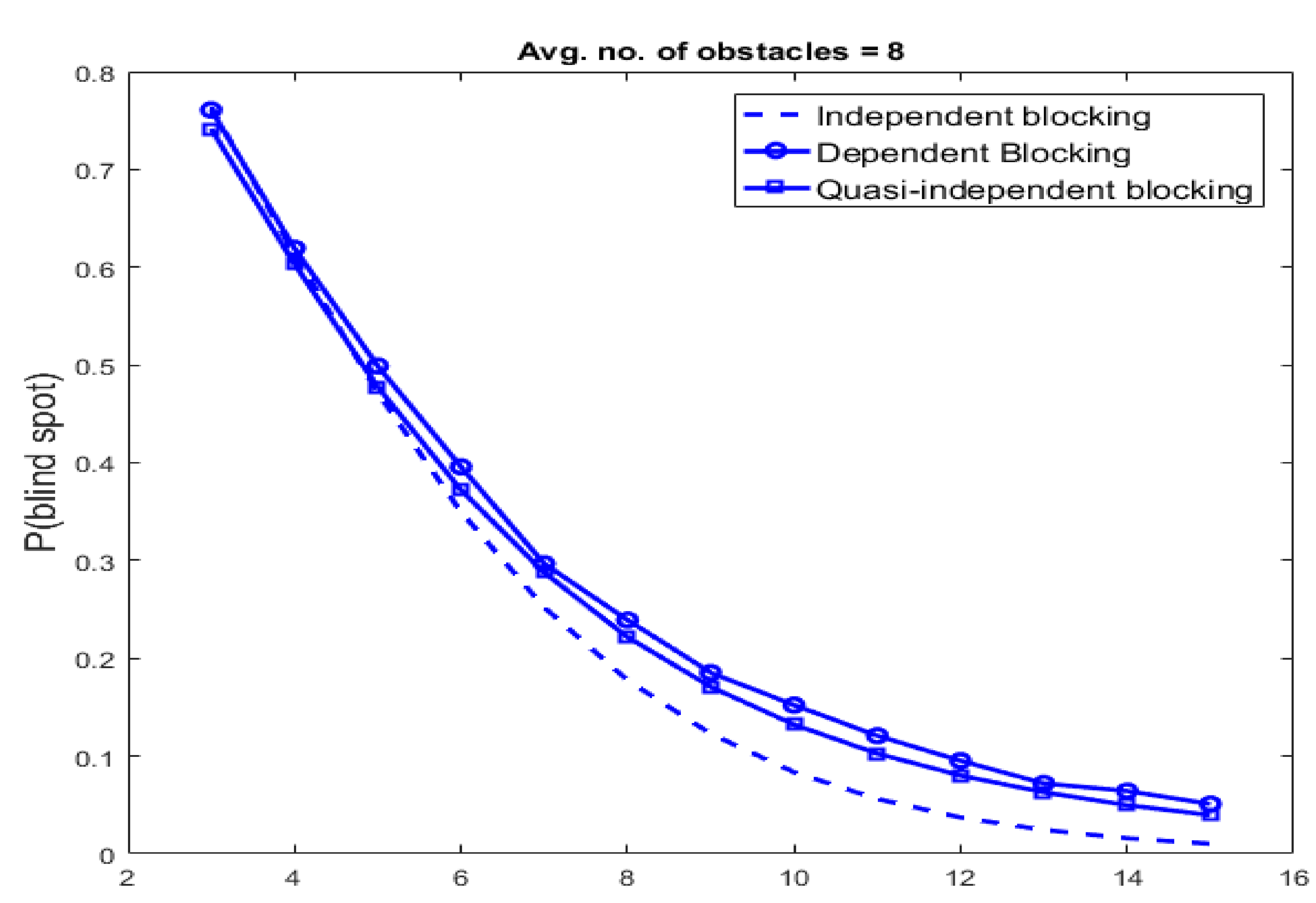


Fig 1: $R = 10m, L = 5m$

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