Towards collective perception hybrid testing in a roundabout scenario with AVs

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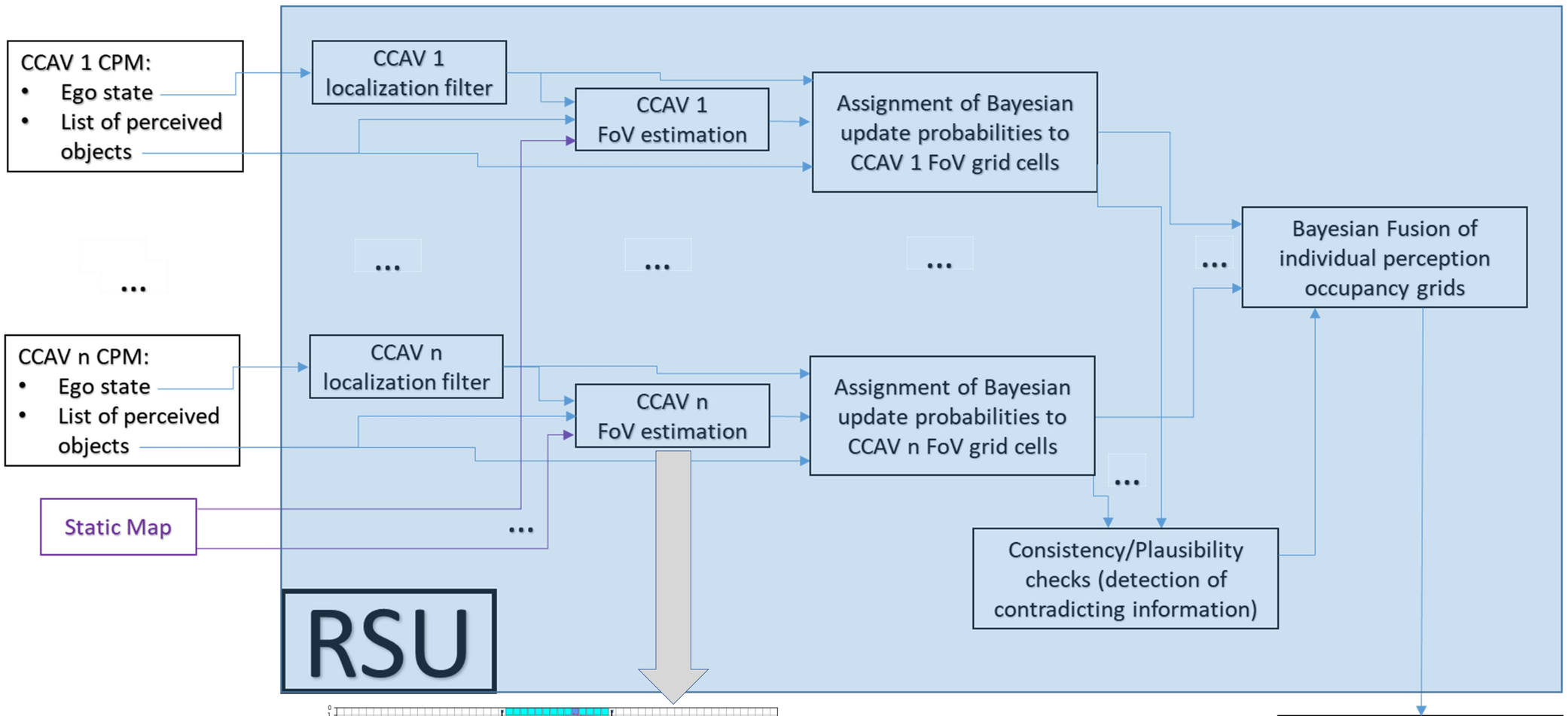
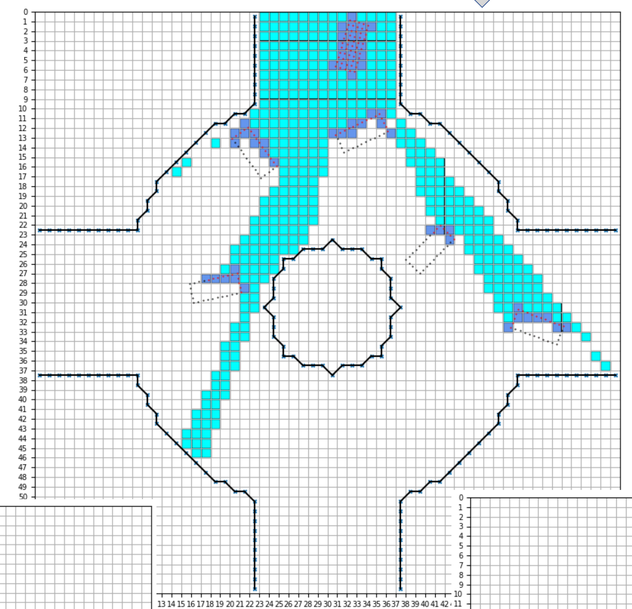
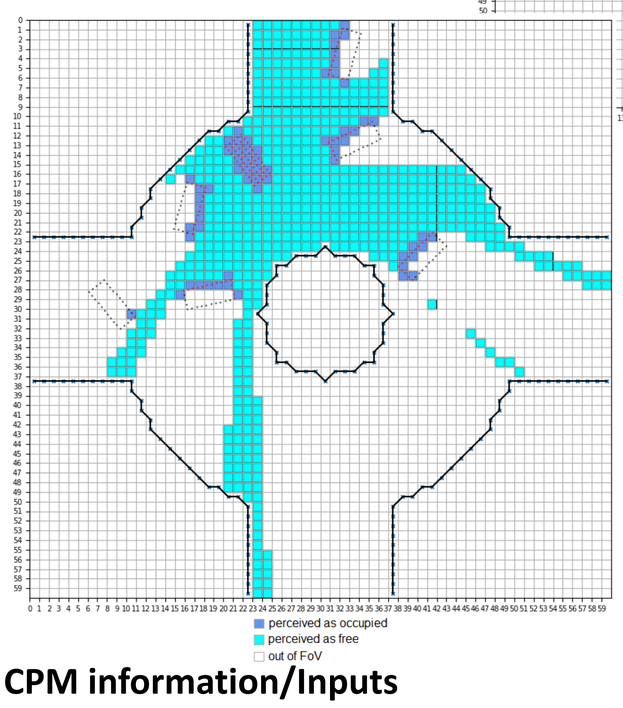
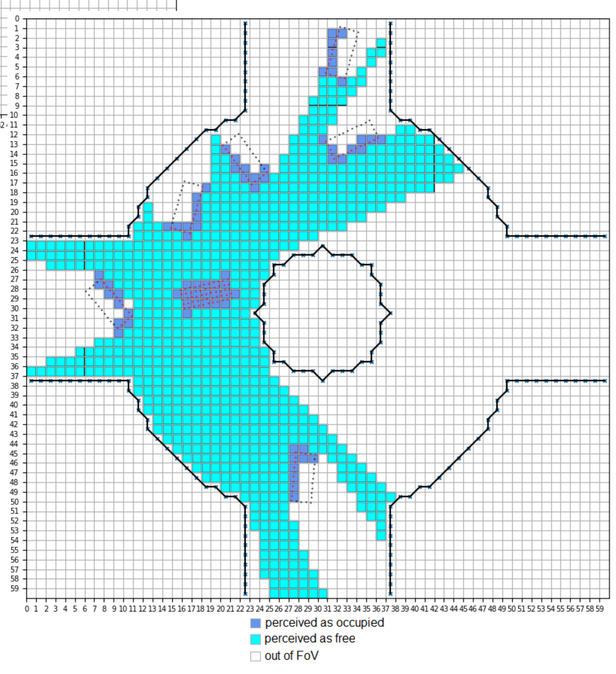
Research Objectives

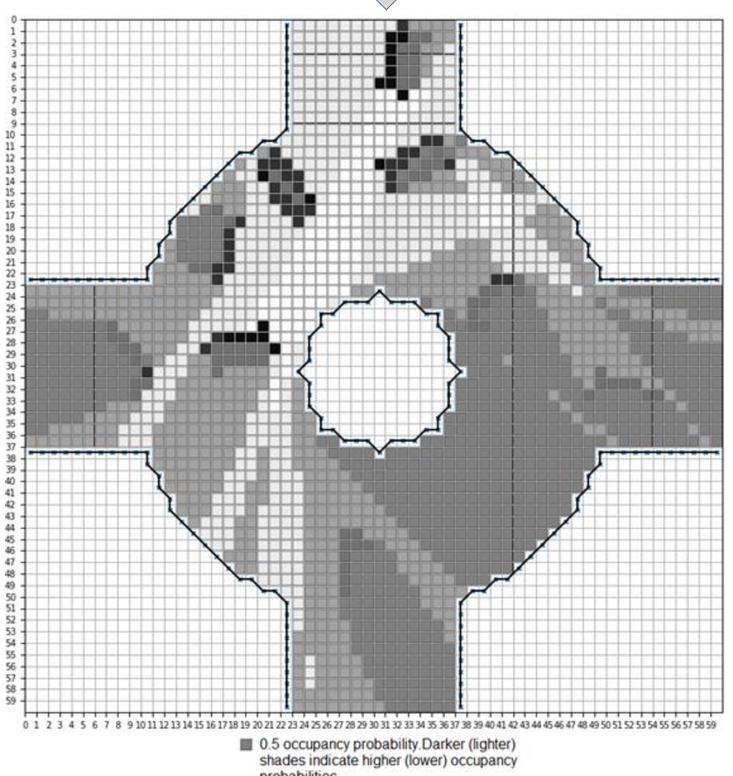
1. **Develop algorithms for fusion of object information coming from multiple observers based on probabilistic scene state estimation via occupancy grid maps**
2. Develop data reliability metrics enabling false data detection and object associations' conflict resolution.











CPM information/Inputs

- *Ego FoV angle.*
- *Ego state information*

  for each CCAV:
  - *Ego Position coordinates in x,y*
  - *Ego Speed vector v_x, v_y*
  - *Ego Heading (yaw angle)*
- *Perceived objects information*

  for each perceived object:
  - *Position coordinates in x,y*
  - *Speed vector v_x, v_y*
  - *Heading (yaw angle)*

Individual CCAV perception model

A known individual perception model is assumed for each CCAV, provided in terms of a standard forward sensor model i.e. the 4 probabilities $P(M_i = 0|A_i = 0)$, $P(M_i = 1|A_i = 0)$, $P(M_i = 0|A_i = 1)$, $P(M_i = 1|A_i = 1)$ where

- ✓ $A_i \epsilon \{0,1\}$ denotes the random variable "cell i is actually occupied $(A_i = 1)$ or not $(A_i = 0)$"
- ✓ $M_i \epsilon \{0,1\}$ denotes the random variable "cell i is perceived as occupied $(M_i = 1)$ or not $(M_i = 0)$"

Bayesian Fusion

$$\left(A_i = 1 \middle| M_i^1, \dots, M_i^k\right) = \frac{P\left(M_i^k \middle| A_i = 1\right) P(A_i = 1|M_i^1, \dots, M_i^{k-1})}{P\left(M_i^k \middle| A_i = 1\right) P\left(A_i = 1|M_i^1, \dots, M_i^{k-1}\right) + P\left(M_i^k \middle| A_i = 0\right) P(A_i = 0|M_i^1, \dots, M_i^{k-1})}$$

$$P\left(A_i = 0 \middle| M_i^1, \dots, M_i^k\right) = \frac{P\left(M_i^k \middle| A_i = 0\right) P(A_i = 0|M_i^1, \dots, M_i^{k-1})}{P\left(M_i^k \middle| A_i = 1\right) P\left(A_i = 1|M_i^1, \dots, M_i^{k-1}\right) + P\left(M_i^k \middle| A_i = 0\right) P(A_i = 0|M_i^1, \dots, M_i^{k-1})}$$

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