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Trust and Assurance Cyber Tech | The MITRE Corporation

Problem

Position, navigation, and timing (PNT) are fundamental for critical infrastructure, ranging from air traffic control, emergency services, telecom, financial markets, personal navigation, power grids, space applications, etc. However, the problem of estimating how much to trust a position, velocity, and time (PVT) solution in the presence of adversaries is open.

Threats

Some of the important threats that we are concerned about include:

- **Jamming**: Efforts by an adversary to disrupt the availability of sources.
- **Spoofing**: Efforts by an adversary to pass manipulated information as legitimate.

Challenges

We need to design assurance metrics for position, velocity, and time (PVT) estimates when:

- The availability of the sources is unknown.
- Different sources are trusted differently.
- There is uncertainty about how adversaries influence the sources.
- Conditions vary over time. For example, trust of inputs and outputs, situational awareness, and SW/HW concerns.

Probabilistic Programming as Foundation for Assurance Models

To overcome these challenges, we need a formal framework for designing assurance metrics that adequately model object uncertainty and relational uncertainty. We argue that probabilistic programs with possible worlds semantics [1] enable the definition of richer models than those traditionally used to define PVT estimators (see Figure 1).

Beyond Sensor Fusion

- Increasingly, PVT estimators integrate anti-spoofing (A/S) techniques that aim to detect spoofed signals. However, multiple A/S signals are integrated in ad hoc ways.
- We argue that probabilistic programming can provide a foundation for rigorously defining how to integrate multiple A/S techniques (e.g., relations among A/S assessments and relations between A/S assessments and PVT solutions).

Conclusion

Our work demonstrates that probabilistic programs provide a powerful way to define assurance models with strong foundations. While our work is motivated by the need to define PNT assurance metrics, our ideas apply more generally to other applications of Bayesian filters that require high levels of assurance. For example, autonomous vehicles use Bayesian filters to identify other vehicles or obstacles on the road.

References


Additional Information

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