CPS: Medium: Computation-Aware Autonomy for Timely and Resilient Multi-Agent Systems

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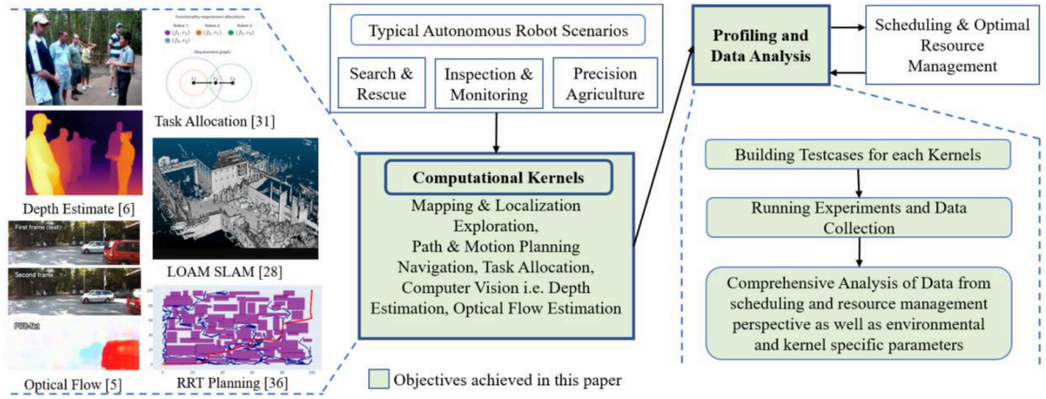
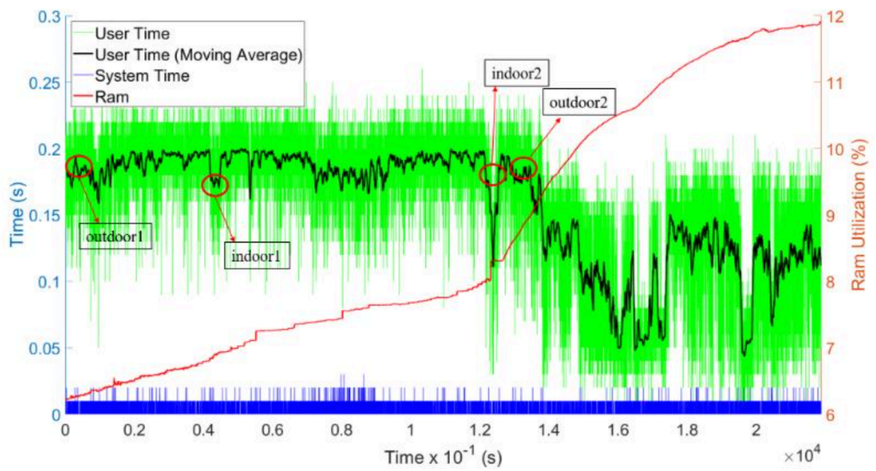
Challenge

- An agent's high-level tasks and motion directly impacts how it interacts with the world and thus **what it computes and how reliably it does so**.
- Account for the relationships between environments, tasks, motion, computation, and software reliability.
- Computational scheduling for runtime operation and flexible and efficient software multi-versioning.

Key Results (Year 1)

- Created a benchmarking dataset and conducted a study of the timing, power, and memory performance of kernels for localization and mapping, path planning, task allocation, depth estimation, and optical flow, across three embedded computing platforms.
- Conducted a follow-up study on scheduling these kernels on the real-time version of the Linux operating system, RTLinux, focusing on the impact of thread-level priority assignment and scheduler class assignment on timing.





Embedded computational benchmarking pipeline for autonomy workloads.

Education and Outreach

- K-12 academic experiences for students in collaboration with Virginia Tech's Center for Enhancement of Engineering Diversity.
- Participation in a series of symposiums through the Ridge and Valley chapter of the Association for Unmanned Vehicle Systems International.

Scientific Impact

- Advance knowledge in the largely unexplored areas of:
  - Computation and reliability aware task allocation and motion planning.
  - Runtime resource optimization for autonomous systems.
  - Flexible software reliability for autonomy computational workloads.
- Unified approach closes the loop for robust CPS with provable behaviors in increasingly complex multi-agent missions across dynamic environments.

Broader Impact

- CPS are driven by relationships between algorithms, computing, physical platforms and their interaction with the environment, thus our methods will transfer to broad spectrum of CPS.
- Computational awareness for guaranteed autonomous behaviors will transform safety-critical applications.

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